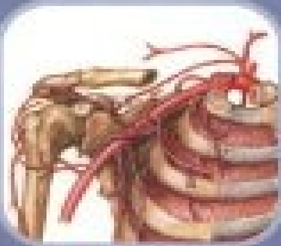
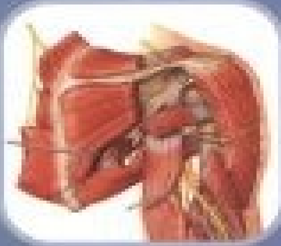
Netter's Concise Atlas of Orthopaedic Anatomy





Jon C. Thompson, MD

Illustrated by
Frank H. Netter, MD

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Netter's Concise Atlas of Orthopaedic Anatomy

Jon C. Thompson, M.D.

Dedication

To my parents, for their unwavering faith in me.

To my in-laws, for their continual support.

To my daughters, who make it meaningful and fun.

Especially to my wife Tiffany, who inspires me in every aspect of my life.

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PREFACE

While working on the Orthopedic Service as a medical student I found myself in need of a quick, but comprehensive reference to help me get through my busy clinics and morning rounds. Having had success with pocket references, I searched the bookstores for something similar for orthopedics. Several were available, but none of them had the quick and easy-to-read format I wanted. As a result, I made pocket-sized note cards for my own use.

These cards started with basic anatomy such as diagrams of the Brachial plexus or fascial compartments of the leg. I then added cards for various conditions including notes on pertinent History and Physical Exam findings and treatment options. Many years later, when the growing stack of note cards was too big, unwieldy and tattered to use any longer, I converted the information into a more usable book format. That original hand-assembled book is the foundation of the atlas you are now holding.

> *One well-drawn anatomic picture often explains far more than several pages of detailed text.*

This concise, quick-reference atlas covers the spine and extremities as well as diagnosis and treatment of orthopedic conditions with primary emphasis on illustrations that educate, oftentimes without the need for explanatory text. Text, when necessary, is presented in tabular form to allow for fast review of essential information.

The first nine chapters are divided anatomically. Because I believe quite strongly that the treatment of orthopedic problems is based in anatomy, I have incorporated an extensive review of the anatomy of both the spine and extremities. There are also subsections within each chapter to help in the clinical diagnosis and treatment of the orthopedic patient. For example, the History table offers help in developing a differential diagnosis while the Trauma and Disorder tables assist in the work-up and treatment options of many orthopedic conditions. Chapter Ten is a brief introduction to orthopedic-related basic science.

From the first time I opened Frank Netter's Atlas of Human Anatomy, I was impressed, and even inspired, by the clarity and the incredible amount of information contained within each of his illustrations. I consider his work incomparable. As the basis for this text is also deeply rooted in its extensive use of illustrations, you can imagine how pleased I was when Icon Learning Systems asked me to combine our efforts to create this new publication. I thank them for their diligence, expertise,and patience with this project. I would also like to thank Dr. Jim Heckman for lending his wisdom and years of publishing experience to this effort.

This book is the result of several years of accumulating and condensing Orthopedic-related data. Indeed, as it stands now, this is truly the reference I had searched for as a medical student, but was never able to find. The information inside these covers served to help me synthesize and retain a large body of information when I was a student and young physician. I trust its readers will be as equally well served.

Jon C. Thompson, MD

ABOUT THE AUTHOR

Jon Thompson, MD, received his medical degree from the Uniformed Services University of the Health Sciences in Bethesda, Maryland. He received his undergraduate degree from Dartmouth College. Dr. Thompson has worked as both an emergency room physician and a research assistant in the Extremity Trauma Branch of the Institute of Surgical Research. Currently, he is a resident in orthopedic surgery in the San Antonio Uniformed Services Health Education Consortium at Brooke Army Medical Center and is a corresponding member of the Department of Surgery at the Uniformed Services University of the Health Sciences.

Thompson: Netter's Concise Atlas of Orthopaedic Anatomy, 1st ed.

INTRODUCTION

Netter's Concise Atlas of Orthopedic Anatomy is an easy-to-use reference and compact atlas of orthopedic anatomy for students and clinicians. Using images from both the Atlas of Human Anatomy and the 13-Volume Netter Collection of Medical Illustrations, this book brings together over 450 Netter images together for the first time in one book.

Tables are used to highlight the Netter images and offer key information on bones, joints, muscles and nerves, and surgical approaches. Clinical material is presented in a clear and straightforward manner with emphasis on trauma, minor procedures, history and physical exam, and disorders.

Users will appreciate the unique color-coding system that makes information look-up even easier. Key material is highlighted in black, red, and green to provide quick access to clinically relevant information.

BLACK for standard text

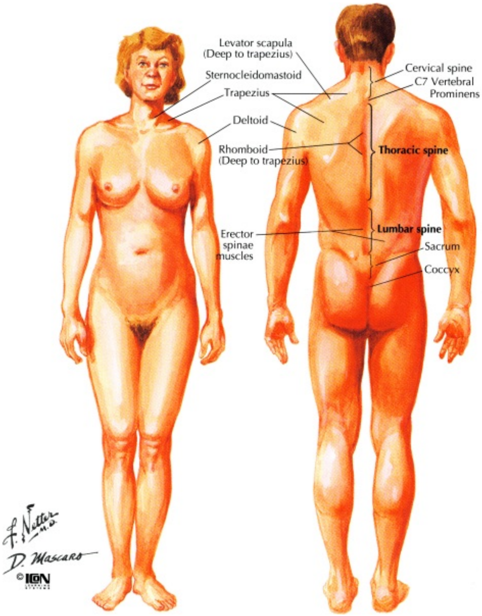
RED highlights key information that if missed could result in morbidity or mortality

GREEN highlights “must know” clinical information.

CHAPTER 1 - SPINE

CHAPTER 1 – SPINE

TOPOGRAPHIC ANATOMY



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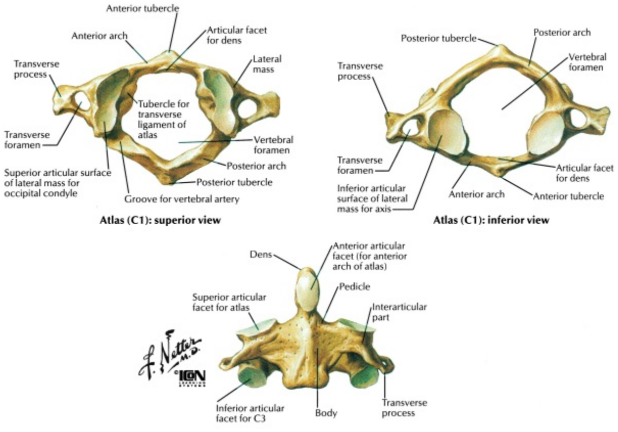
OSTEOLOGY



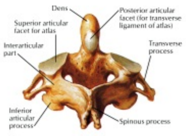
Atlas (C1): superior view

Atlas (C1): inferior view

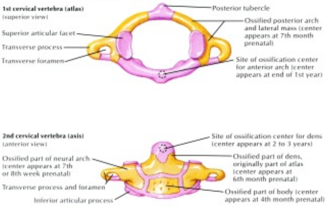
Axis (C2): anterior view

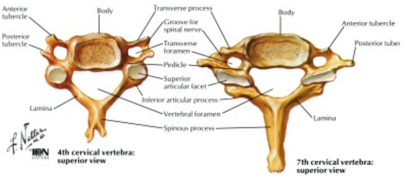
CHARACTERISTICS	OSSIFY		FUSE	COMMENT
		C1 ATLAS		
• Ring shaped • Two lateral masses with facets on them • No body, no spinous process • Post. Arch has a sulcus/groove	Anterior arch (1) Posterior arch (2) (1 for each half)		6 yrs Birth	• Superior facet articulates with occiput, anterior arch articulates with dens • Fractures: most have 2 sites • Vertebral artery runs in groove on posterior arch
		C2 AXIS		
• Dens/odontoid articulates w/atlas at median atlantoaxial joint	Lower body (2) Dens (2) Arch (2)	Body Tip	6yrs Birth 12yrs Birth	• Odontoid has precarious vascular supply watershed area): increased incidence of nonunion with fractures • Rotation in neck mostly occurs between C1 and C2
		CERVICAL (C3-7)		
• Foramina in transverse process • Facets: “semi-coronal” allow flex/extension, no rotation • Narrow intervertebral foramina • Bifid spinous processes	Primary Arch Body Secondary	7-8wk (fetal) 11-14 yr	1-2 yr 7-10 yr 18-25 yr	• Vertebral artery runs through transverse foramina • Nerve roots at risk of compression • No foramina in transverse process of C7 • C7 is *vertebral prominens*, nonbifid spinous process • Klippel-Feil syndrome: congenital fusion of cervical vertebrae
		THORACIC		
• Facets: form semi-circle: allow rotation		7-		• T1 spinous process is as

Costal facets (for ribs) • T1-9: on the transverse process T10-12: on the pedicle	Primary Arch Body Secondary	7-8wk (fetal) 11-14 yr	1-2 yr 7-10 yr 18-25 yr	• prominent as that of C7 • Rotation of spine occurs within the thoracic region • Spinous processes overlap the next lower vertebrae



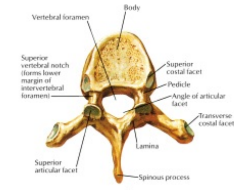
Axis (C2): posterosuperior view



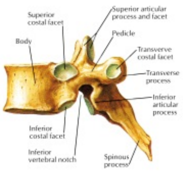


4th cervical vertebra: superior view

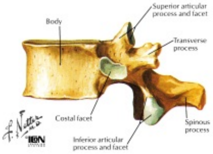
7th cervical vertebra: superior view



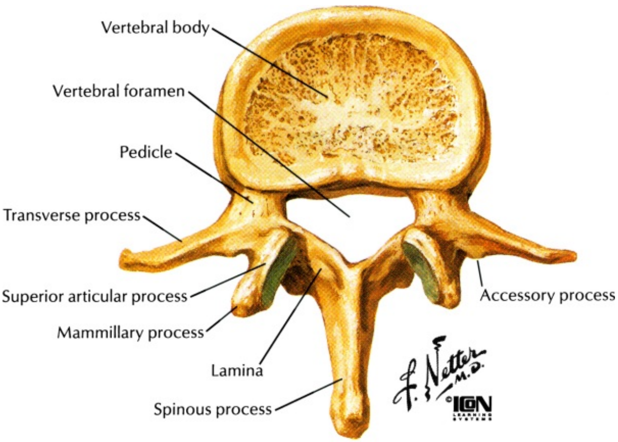
T6 vertebra: superior view



T6 vertebra: lateral view



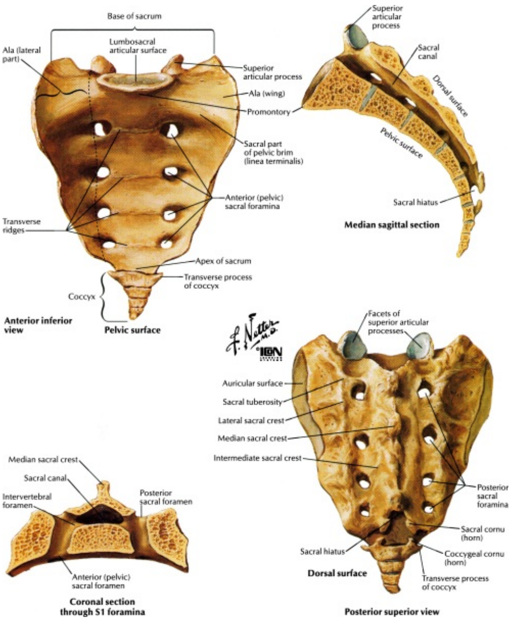
T12 vertebra: lateral view



L2 vertebra: superior view

CHARACTERISTICS	OSSIFY		FUSE	COMMENT
LUMBAR				
• Large vertebral bodies • Short lamina and pedicles	Primary Arch	7-8	1-2	• L5 is the largest vertebrae

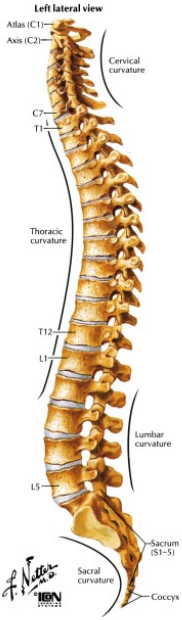
pedicles • Mamillary and accessory processes • Facets: sagittal: good for flexion/extension, not rotation • No costal facets	Body Secondary Mamillary process	7-8 wk (fetal) 11-14 yrs	yrs 7-10 yrs 18-25 yrs	vertebrae • Large vertebral bodies capable of bearing weight • L5 has a ligamentous attachment to the ilium
SACRAL				
• 5 vertebrae are fused • 4 pairs of sacral foramina • Sacral canal opens to hiatus	Body Arches Cpstal elements Secondary	8 wk (fetal) 11-14 yrs	2-8 yrs 2-8 yrs 2-8 yrs 20 yrs	• Transmits weight of body to the pelvis • Nerves exit through the sacral foraminae • Segments fuse to each other at puberty
COCCYGEAL				
• 4 vertebrae are fused • Lacks most of the features of typical vertebrae	Primary Arch Body	7-8 wk (fetal)	1-2 yrs 7-10 yrs	• Is attached to Gluteus maximus and coccygeal muscle
Ossification: Typically 3 primary (body each arch), 5 secondary ossification centers (spinous process, transverse process (2), upper and lower plates of the body (2))				
The arches fuse dorsally; spina bifida occurs when it does not fuse				
The arches unite with the bodies (6-10years old) in order: thoracic, cervical, lumbar, sacral (7 years). Neurocentral joint (fusion of arch and body) is in the body				



GENERAL INFORMATION

• 33 Vertebrae: 7 cervical, 12 thoracic, 5 lumbar, 5 sacral (fused), 4 coccygeal

• Cancellous bone in cortical shell	
• Vertebral canal between body and lamina: houses the spinal cord.	
• Spinal Curves: Cervical: lordosis Thoracic: kyphosis (increase in Scheuermann's disease) Lumbar: lordosis	
• Vertebrae:	**1.** Body (centrum): have articular cartilage on superior/inferior aspects; get larger inferiorly **2.** Arch (pedicles lamina) [no arch develops in spina bifida] **3.** Processes: spinous, transverse, costal, mamillary **4.** Foramina: vertebral, intervertebral, transverse
• 3 Columns	
Anterior	ALL, anterior half of body annulus
Middle	PLL, posterior half of body annulus
Posterior	Ligamentum flavum, lamina, pedicles, facets
LEVEL	CORRESPONDING STRUCTURE
C2-3	Mandible
C3	Hyoid cartilage
C4-5	Thyroid cartilage
C6	Cricoid cartilage
C7	Vertebral prominens
T3	Spine of scapula
T7	Xiphoid, tip of scapula
T10	Umbilicus
L1	End of spinal cord
L3	Aorta bifurcation
L4	Iliac crest


Left lateral view
Atlas (C1)
Axis (C2)
Cervical curvature
C7
T1
Thoracic curvature
T12
L1
Lumbar curvature
L5
Sacrum (S1–5)
Sacral curvature
Coccyx
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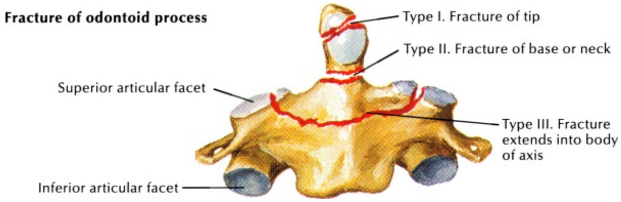
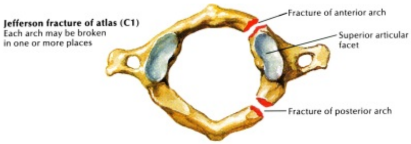
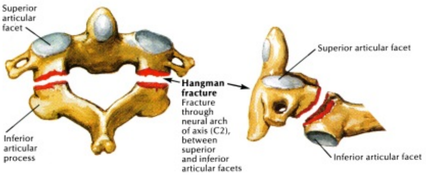
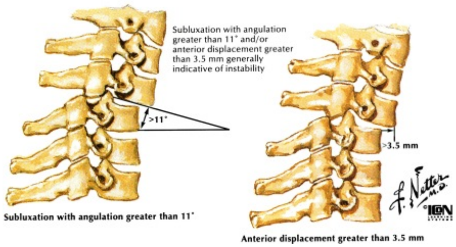
TRAUMA



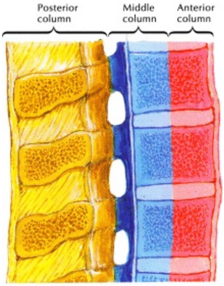






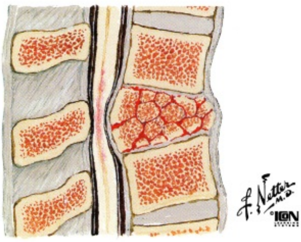
DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
CERVICAL FRACTURE			
• High energy injury: Young - MVA, old - fall • Axial compression (most common mech.-anism) results in burst fracture	HX: Trauma. Pain, worse with movement, +/- numbness weakness. PE: Tender to palpation, +/- "step off" neurologic or	Based on level location: C1-Jefferson fracture: both arches fractured C1-Lateral mass fracture C2-Hangman's (isthmus):	Immobilize all fractures, traction on unstable, lower c-spine fractures C1 and 2: Stable: Collar or halo Unstable: Halo for 3 months

• Flexion/distraction injury results in dislocation • Neurologic injury rare (esp. with C12 fracture) seen • Often have associated injuries • 9 criteria checklist predicts instability	myelopathic signs. Do rectal genital exams. XR: AP, lateral, odontoid: note anterior soft tissue CT: Shows canal (fragments may compress canal) MR: Evaluate soft tissues	Levine classification C2-Odontoid: Type 1,2,3 C3-7 Fracture Spinous process (Clay shoveler's fracture): C6, 7, T1 (C7 most common)	and/or fusion Odontoid type 2: ORIF (worse with traction) C3-7: Stable: Collar or halo Unstable: Fusion Spinous process: Symptomatic
COMPLICATIONS: Neurologic injury (e.g., CN VIII with C1 fracture, etc.); Residual pain; Osteoarthritis; Nonunion (especially odontoid type 2 fracture)			



Three-column concept. If more than one column involved in fracture, then instability of spine usually results

Lateral view. Note that lateral facet (zygapophyseal) joints in posterior column, with intervertebral foramina in middle column

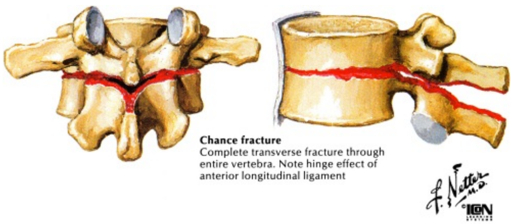


Burst fracture of vertebral body involving both anterior and middle columns resulted in instability and spinal cord compression

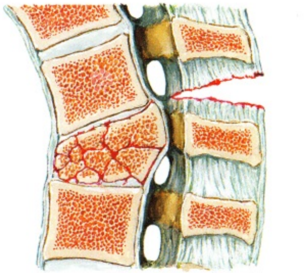
Three-Column Concept of Spinal Stability

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
THORACOLUMBAR FRACTURE			
• Mechanism: MVA, fall • 1 column fracture: stable • 2 column fracture: unstable • Anterior column (Wedge) fracture 50% height loss is	HX: Trauma. Pain, +/- numbness weakness PE: Tender to palpation, +/- "step off" neurologic or myelopathic signs. Do rectal genital	Mechanism: Compression/wedge: anterior column Burst: fragments displace posteriorly; anterior middle columns (unstable)	Stable fractures: bed rest, orthosis (TLSO) Unstable (or with

50% height loss is considered 2 columns • Compression/wedge fracture: (most common) • Chance fracture: rare • Neurologic deficits rare, but seen with Burst fractures	exams XR: AP, lateral T-L spine: body height, splaying pedicle CT: Shows any canal impingement MR: Evaluate soft tissues	Flexion/distraction (Chance/seatbelt fracture): 2 (or 3) columns: posterior middle (anterior). Fracture/dislocation: all 3 columns involved.	neurologic symptoms/compressed canal): Spinal canal decompression and spinal fusion
COMPLICATIONS: Neurologic injury; Osteoarthritis; Associated injuries.			



Chance fracture
Complete transverse fracture through entire vertebra. Note hinge effect of anterior longitudinal ligament



Fracture/Dislocation: All 3 columns moved

Stable Fracture

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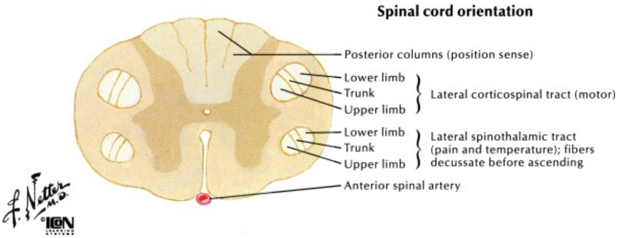
SPINAL CORD TRAUMA



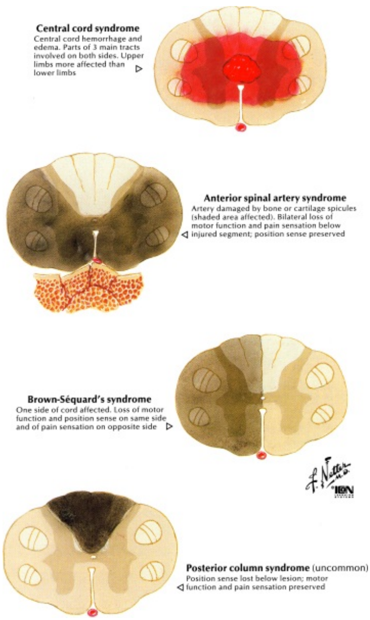
Cervical Spine Injury: Incomplete Spinal Syndromes

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
• Young males most common • Complete cord injury: no function AND bulbocavernosus reflex has returned. (spinal shock over) • Incomplete cord injury: 4 types • Anterior cord: #2. Flexion injury; worst prognosis • Central cord: most common. Hyperextension injury, seen in elderly (who fall), associated with spondylosis • Posterior: very rare (may not exist) • Brown-Sequard: rare, best prognosis	HX: Trauma. Symptoms depend on injury/lesion. PE: Depends on injury Complete: no motor or sensory function below injury level. Anterior: LEUE paralysis, pain temperature sensory loss, vibratory proprioception intact. Central: Weakness UELE, sacral sensation spared. Posterior: Loss of vibratory sensation and proprioception. B-S: *Ipsilateral* motor, vibratory, proprioception loss; *contralateral* pain temperature loss. XR: C-spine series, +/- TL spine CT: if evidence of fracture	Complete cord injury: cord severed, no function (spinal shock must be resolved to diagnose it) Incomplete: Anterior: Spinothalamic corticospinal tracts out, posterior columns spared. Central: gray matter injury Posterior: posterior columns disrupted Brown-Séquard (lateral): hemi-section of cord	Treat associated injuries: lifethreatening first. Mannitol and early IV steroids may improve neurologic function Immobilization is the key to treatment Stable injures: collar, brace Unstable injuries: Halo vest or internal fixation

COMP: Neurogenic shock; Autonomic dysreflexia (requires urinary catheterization and/or fecal disimpaction); Neurologic sequelae

Spinal Shock: Physiologic cord injury/dysfunction (often from compression or swelling) including paralysis areflexia. Return of bulbocavernosus reflex (arc reflexes) marks the end of spinal shock.

Neurogenic Shock: *Hypotension with* **bradycardia**. Cord injury results in decreased sympathetic release (unopposed vagal tone)



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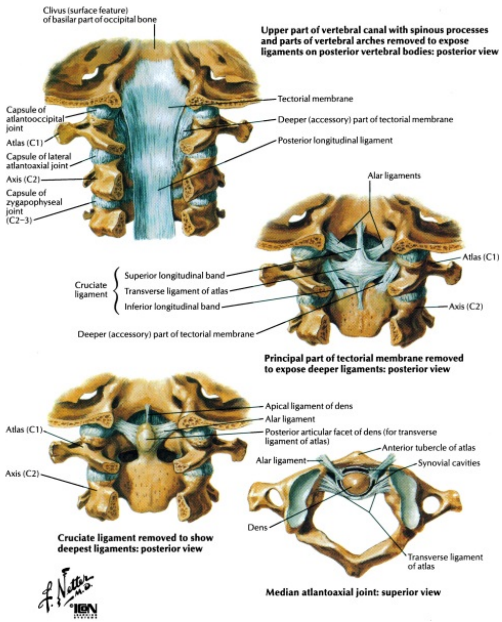
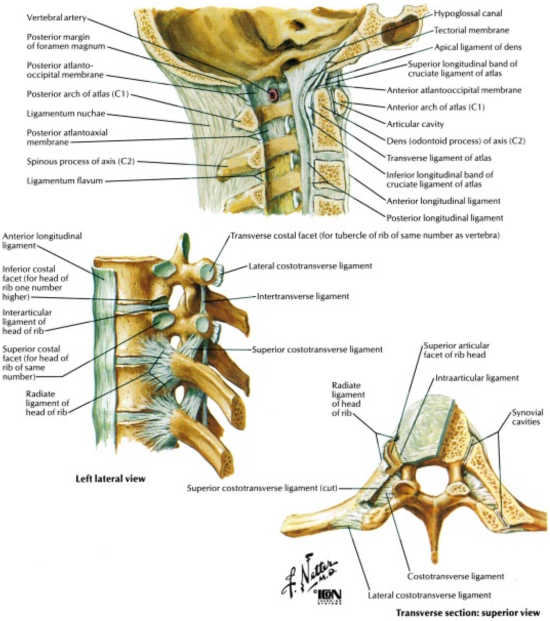
JOINTS



LIGAMENT	ATTACHMENT	COMMENT
ATLANTOOCCIPITAL (Ellipsoid)		
Primarily involved in flexion, extension, lateral bending movements		
Tectoral membrane Anterior/Posterior capsule	Axis body to occiput around facets	Extension of the PLL Joint stabilized by attachment to dens; known to be weak in Down's Syndrome
MEDIAN ATLANTOAXIAL C1-2 (Plane and Pivot)		
Primarily involved in rotation; dependent on ligaments for stability; instability in Down's syndrome		
Transverse Apical Alar Superior Longitudinal Inferior Longitudinal	Lateral mass-dens-lateral mass Dens to occiput Dens to occiput condyles Dens to basilar occiput Dens to axis body	Strongest ligament: holds dens in place Part of cruciate ligament Prevent excessive head rotation With transverse apical forms cruciate ligament



LIGAMENT	ATTACHMENT	COMMENT
ZYGAPOPHYSEAL (Facet Plane)		
Has articular discs: this joint allows the most mobility in the spine		
Capsule	Around facets	Changes orientation at different vertebral levels Orientation dictates plane of motion; C5-6 most mobile (#1 degeneration site) L4-5 most flexion
INTERVERTEBRAL		
Intervertebral disc ALL PLL	Inferior superior aspect of bodies Anterior: body to body Posterior: body to body	Strongest attachments of bodies Thicker than PLL Thinner, disc herniation usually posterolateral.
COSTOVERTEBRAL (Luschka)		
Capsule Intraarticular Radiate	Surrounds rib head joint Head of rib to disc Anterior head to both bodies	Holds head to vertebrae Reinforces joint anteriorly

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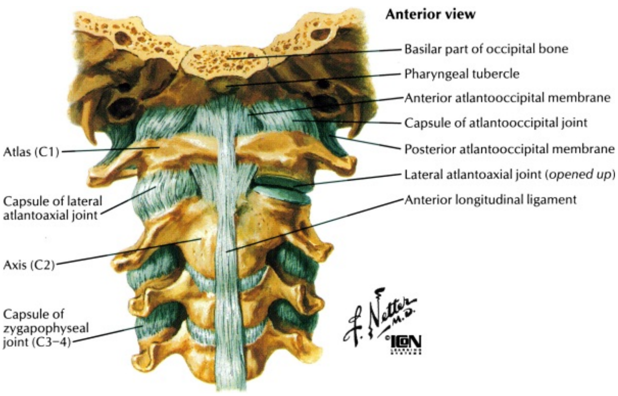
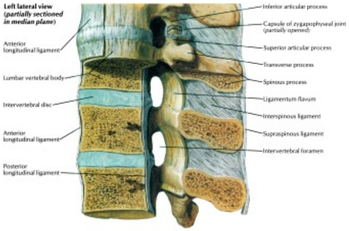
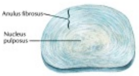
LIGAMENTS

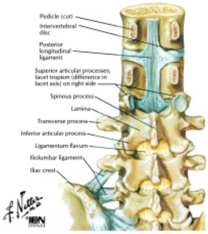


LIGAMENT	LOCATION	COMMENT
Anterior Longitudinal [ALL]	Anterior surface of vertebral bodies	Strong; thicker in center of body
Posterior Longitudinal [PLL]	Posterior surface of bodies (connects discs]	Weaker thinner [herniation occurs laterally or posterolaterally]
Intertransverse	Between transverse processes	Weak, adds little support
Apophyseal joint capsule	Around facet joint	Weak, adds little support
Ligamentum Flavum	Connects anterior surfaces of laminae	Strong; constantly in tension
Ligamentum Nuchae	C7 to occipital protuberance	Extension of supraspinous ligament
Supraspinous	Along dorsal spinous processes to C7	Unknown contribution to stability
Interspinous	Between spinous processes	Unknown contribution to stability
Tectoral membrane	Posterior aspect of bodies dens to clivus	Extension of PLL
Transverse ligament	Lateral mass to dens to lateral mass	Part of cruciate ligament, major stabilizer
Alar	Dens to occiput tubercles	Resists excessive rotation
Iliolumbar	L5 transverse process to ilium	Avulsion fracture can occur in trauma
INTERVERTEBRAL DISCS [made of fibrocartilage]		
Annulus fibrosis	Outside, type I collagen, connects to vertebral hyaline cartilage, buffers compression	
Nucleus pulposus	Inside, type II collagen, high water content until old age, derived from notochord, can protrude/herniate through annulus, is avascular	





Intervertebral disc



Posterior view

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HISTORY

Head-on collision with stationary object or oncoming vehicle may, if seat belts not used, drive forehead against windshield. This sharply hyperextends neck, resulting in dislocation with or without fracture of cervical vertebrae

QUESTION	ANSWER	CLINICAL APPLICATION
1. AGE	Young Middle age Elderly	Disc injuries, spondylolisthesis Sprain/strain, herniated disc, degenerative disc disease Spinal stenosis, herniated disc, degenerative disc disease, arthritis
2. PAIN		
a. Character	Radiating (shooting) Diffuse, dull, non-radiating	Radiculopathy (Herniated disc, spondylosis) Cervical or lumbar strain (soft tissue injury)
b. Location	Unilateral vs. bilateral Neck Arms (+/- radiating) Lower back Legs (+/- radiation)	Unilateral: herniated disc; Bilateral: systemic or metabolic disease;space occupying lesion Cervical spondylosis, neck sprain or muscle strain Cervical spondylosis (+/- myelopathy), herniated disc Degenerative Disc Disease, back sprain or muscle strain, spondylolisthesis, tumor Herniated disc, spinal stenosis
c. Occurrence	Night pain With activity	Tumor Usually mechanical etiology
d. Alleviating	Arms elevated Sit down	Herniated cervical disc Spinal stenosis (stenosis relieved)
e. Exacerbating	Back extension	Spinal stenosis (e.g. going down stairs)
3. TRAUMA	MVA (seatbelt?)	Cervical strain (whiplash), cervical fractures, ligamentous injury
4. ACTIVITY	Sports (stretching injury)	“Burners/stingers” (especially in football)
5. NEUROLOGIC SYMPTOMS	Pain, numbness, tingling Spasticity, clumsiness Bowel or bladder symptoms	Radiculopathy, neuropathy Myelopathy Cauda equina syndrome
6. SYSTEMIC	Fever, weight	

6. SYSTEMIC COMPLAINTS	Fever, weight loss	Infection, tumor

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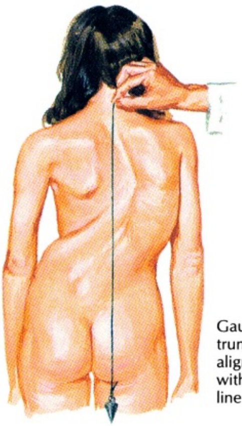
PHYSICAL EXAM

Scoliosis



Gauging trunk alignment with plumb line

Malalignment of spine

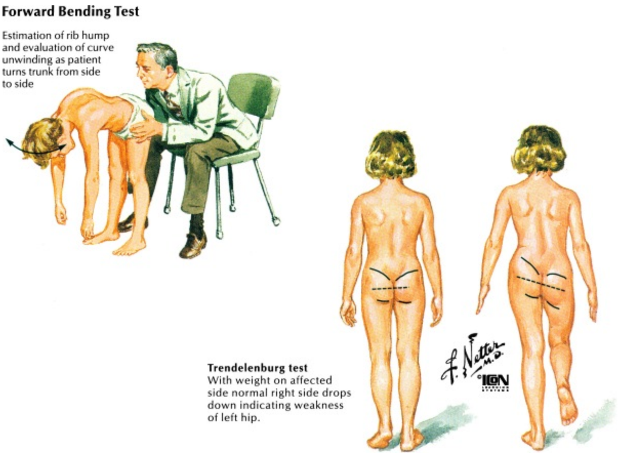
EXAM		TECHNIQUE	CLINICAL APPLICATION
		INSPECTION	
Gait		Leaning forward Wide-based	Spinal stenosis Myelopathy
Alignment		Malalignment	Dislocation, scoliosis, lordosis, kyphosis
Posture		Head tilted Pelvis tilted	Dislocation, spasm, spondylosis, torticollis Loss of lordosis: spasm
Skin		Disrobe patient	Cafe-au-lait spots, growths: possibly neurofibromatosis Port wine spots, soft masses: possibly spina bifida
		PALPATION	
Bony structures		Spinous processes	Focal/point tenderness: fracture. Step-off: dislocation/spondylolisthesis
Soft tissues		Cervical facet joints Coccyx-via rectal exam Paraspinal muscles Supraclavicular fossa Skin	Tenderness: osteoarthritis, dislocation Tenderness: fracture or contusion Diffuse tenderness indicates sprain/muscle strain. Trigger point: spasm Swelling suggests clavicle fracture Fatty masses: possibly spina bifida
		RANGE OF MOTION	
Flexion/extension:	Cervical Lumbar	Chin to chest/occiput back Touch toes with straight legs	Normal: Flexion: chin within 3-4cm of chest; Extension 70 degrees Normal: 45-60 degrees in flexion, 20-30 degrees in extension
Lateral flexion:	Cervical Lumbar	Ear to shoulder Bend to each side	Normal: 30-40 degrees in each direction Normal: 10-20 degrees in each direction
		Stabilize	

Rotation:	Cervical Lumbar	shoulders: rotate Stabilize hip: rotate	Normal: 75 degrees each direction Normal: 5-15 degrees in each direction
NEUROVASCULAR			
A complete neurologic examination should be performed			
Sensory			
CERVICAL			
Supraclavicular (C2-3) Axillary nerve (C5) Musculocutaneous nerve (C6) Radial Nerve (C6) Median Nerve (C7) Ulnar Nerve (C8) Medial Cutaneous nerve forearm(T1)		Anterior neck clavicle area Lateral shoulder Lateral forearm Dorsal thumb web space Radial border mid finger Ulnar border small finger Medial forearm	Deficit indicates corresponding nerve/root lesion Deficit indicates corresponding nerve/root lesion Deficit indicates corresponding nerve/root lesion Deficit indicates corresponding nerve/root lesion Deficit indicates corresponding nerve/root lesion Deficit indicates corresponding nerve/root lesion Deficit indicates corresponding nerve/root lesion

Straight Leg Test

EXAM		TECHNIQUE	CLINICAL APPLICATION
LUMBAR			
Femoral/Saphenous nerve (L4) Superficial/Deep Peroneal Nerve (L5) Tibial/sural nerve (S1) Sacral nerves (S 2, 3, 4)		Medial leg ankle Dorsal foot 1^{st}-2^{nd} toe web space Lateral foot Perianal sensation	Deficit indicates corresponding nerve/root lesion Deficit indicates corresponding nerve/root lesion Deficit indicates corresponding nerve/root lesion Deficit indicates corresponding nerve/root lesion
Motor			
CERVICAL			
Spinal accessory (CN11) Axillary nerve (C5) Musculocutaneous nerve (C5-6) Radial nerve (PIN) (C7) Median nerve (C8) Ulnar nerve (Deep branch) (T1)		Neck flexion rotation Resisted shoulder abduction Resisted elbow flexion Finger extension Thumb flexion, opposition, abduction Finger cross (abduct/adduct)	Weakness = Sternocleidomastoid or nerve/root lesion Weakness = Deltoid or nerve/root lesion Weakness = Brachialis or nerve/root lesion Weakness = EDC, EIP, EDM or nerve/root lesion Weakness = FPL/thenar muscles or corresponding nerve/root lesion Weakness = DIO/VIO or nerve/root lesion
LUMBAR			
Deep Peroneal nerve (L4) Deep Peroneal nerve (L5) Superficial Peroneal		Foot inversion dorsiflexion Great toe extension Foot eversion	Weakness = Tibialis anterior or nerve/root lesion Weakness = Extensor hallucis longus or nerve/root lesion Weakness = Peroneus longus/brevis or

Superficial Peroneal (S1) Tibial nerve (S1)		Great toe flexion	nerve/root lesion Weakness = Flexor hallucis longus or nerve/root lesion
Reflexes			
C5 C6 C7 L4 S1 S1, 2, 3		Biceps Brachioradialis Triceps Patellar Achilles reflex Bulbocavernosus	Hypoactive/absence indicates C5 radiculopathy Hypoactive/absence indicates C6 radiculopathy Hypoactive/absence indicates C7 radiculopathy Hypoactive/absence indicates L4 radiculopathy Hypoactive/absence indicates S1 radiculopathy Finger in rectum, squeeze/pull penis (Foley), anal sphincter contracts
UMN		Babinski/clonus	Upgoing toe is consistent with upper motor neuron lesion
Pulses			
Upper extremity Lower extremity		Brachial, radial, ulnar Femoral, popliteal, dorsalis pedis, posterior tibial	Diminished/absent = vascular injury or compromise Diminished/absent = vascular injury or compromise



Forward Bending Test

EXAM	TECHNIQUE	CLINICAL APPLICATION
	SPECIAL TESTS	
<u>CERVICAL</u>		
Spurling	Axial load, then laterally flex rotate neck	Radiating pain indicates nerve root compression
Distraction	Upward distracting force	Relief of symptoms indicates foraminal compression of nerve root
<u>LUMBAR</u>		
Straight leg	Flex hip to pain, dorsiflex foot	Symptoms reproduced (pain below knee) indicative of radicular etiology
Straight leg 90/90	Supine: flex hip knee 90°, extend knee	20° of flexion = tight hamstrings: source of pain
Bowstring	Raise leg, flex knee,	Radicular pain with popliteal pressure indicates sciatic

Bowstring	apply popliteal pressure	nerve etiology
Sitting root (flip sign)	Sit: distract patient, passively extend knee	Patient with sciatic pain will arch or flip backward on knee extension
Kernig	Supine: flex neck	Pain in or radiating to legs indicates meningeal irritation or infection
Brudzinski	Supine: flex neck, flex hip	Pain reduction with knee flexion indicates meningeal irritation.
Forward Bending	Standing, bend at waist	Asymmetry of back (scapula/ribs) is indicative of scoliosis
Trendelenburg	Stand on one leg	Drooping pelvis on elevated leg side: gluteus medius weakness
Hoover	Supine: hands under heels, patient then raises one leg	Pressure should be felt under opposite heel (not being raised). No pressure indicates lack of effort, not true weakness
Waddell signs	Presence indicates non-organic pathology: **1**) exaggerated response or overreaction, **2)** pain to light touch, **3)** non-anatomic pain localization, **4)** negative flip sign with positive straight leg test.	

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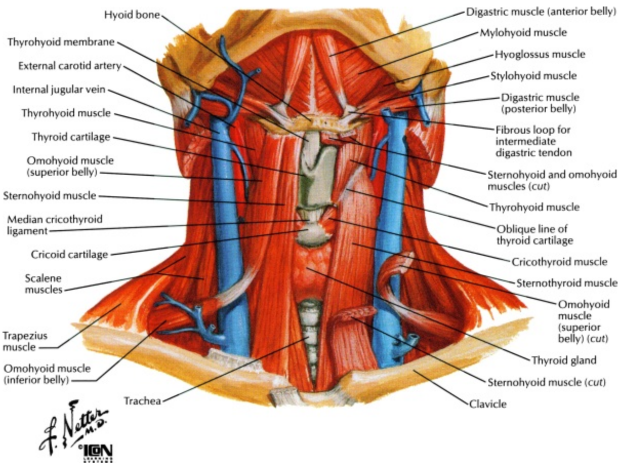
MUSCLES: ANTERIOR NECK



MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
ANTERIOR NECK				
Platysma	Fascia: Deltoid/pectoralis major	Mandible; skin	Depress jaw	CN 7
SUPRAHYOID MUSCLES				
Digastric	Anterior: Mandible Posterior: Mastoid notch	Hyoid body	Elevate hyoid, depress mandible	Anterior: Mylohyoid (CN 5) Posterior: Facial (CN 7)
Mylohyoid	Mandible	Raphe on hyoid	Same as above	Mylohyoid (CN 5)
Stylohyoid	Styloid process	Body of hyoid	Elevate hyoid	Facial nerve (CN 7)
Geniohyoid	Genial tubercle of mandible	Body of hyoid	Elevate hyoid	C1 Via CN 12
INFRAHYOID MUSCLES [STRAP MUSCLES INCLUDES THE SCM]				
SUPERFICIAL				
Sternohyoid	Manubrium clavicle	Body of hyoid	Depress hyoid	Ansa cervicalis (C1-3)
Omohyoid	Suprascapular notch	Body of hyoid	Depress hyoid	Ansa cervicalis (C1-3)
DEEP				
Thyrohyoid	Thyroid cartilage	Greater horn of hyoid	Depress/retract hyoid/larynx	C1 via CN 12
Sternothyroid	Manubrium	Thyroid cartilage	Depress/retract hyoid/larynx	Ansa cervicalis (C1-3)
Sternocleidomastoid	Manubrium clavicle	Mastoid process	Turn head opposite side	CN 11

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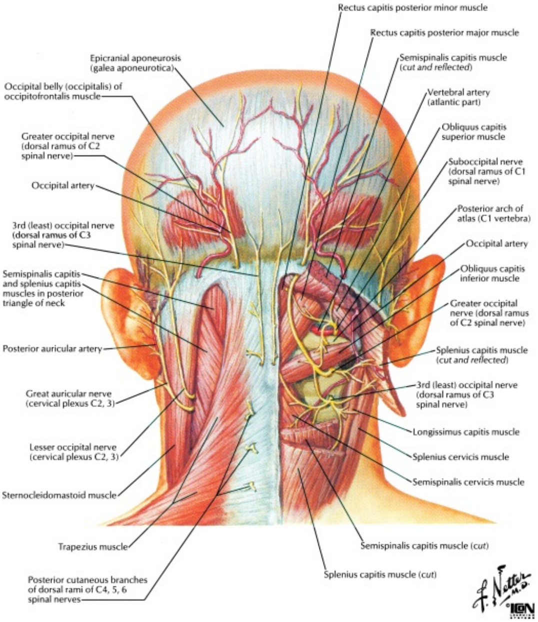
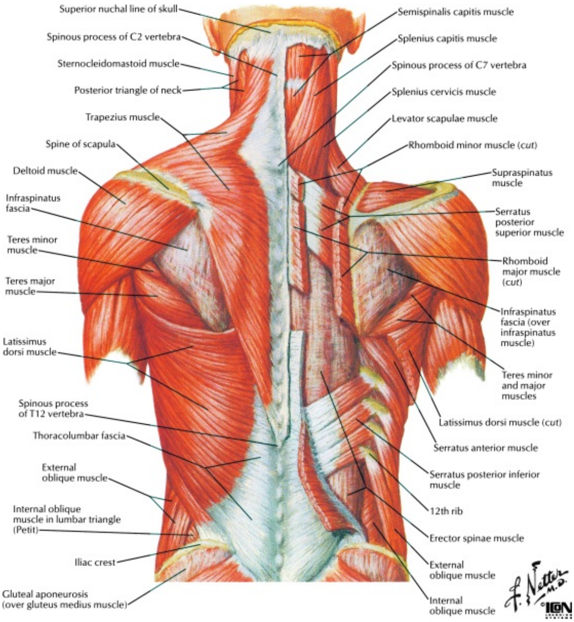
MUSCLES: POSTERIOR NECK



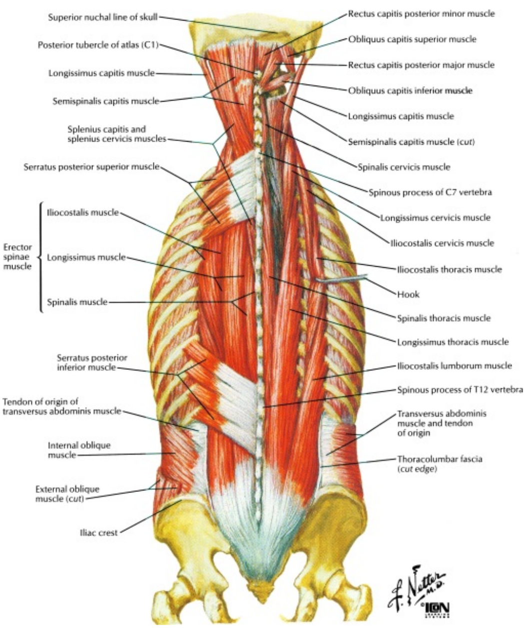
MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
POSTERIOR NECK: SUBOCCIPITAL TRIANGLE				
Rectus capitis posterior: major	Spine of axis	Inferior nuchal line	Extend, rotate, laterally flex	Suboccipital nerve
Rectus capitis posterior: minor	Posterior tubercle of atlas	Occipital bone	Extend, laterally flex	Suboccipital nerve
Obliquus capitis superior	Atlas transverse process	Occipital bone	Extend, rotate, laterally flex	Suboccipital nerve
Obliquus capitis inferior	Spine of axis	Atlas transverse process	Extend, laterally rotate	Suboccipital nerve

SUPERFICIAL MUSCLES: POSTERIOR NECK AND BACK

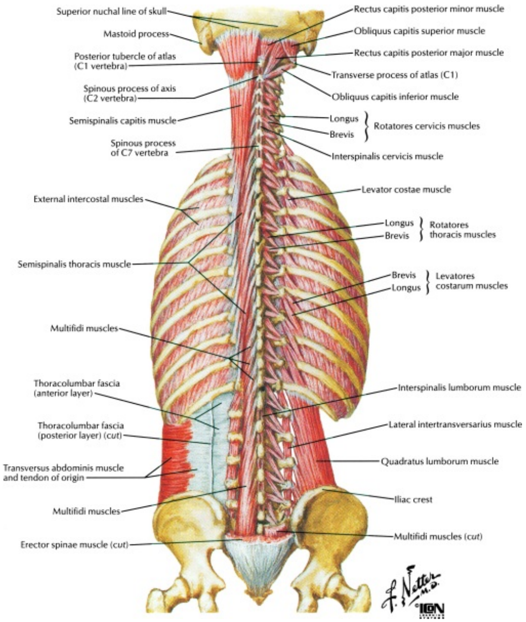


MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
SUPERFICIAL (EXTRINSIC)				
Trapezius	Spinous process C7-T12	Clavicle; Scapula (AC, SP)	Rotate scapula	CN 11
Latissimus dorsi	Spinous process T6-S5	Humerus	Extend, adduct, IR arm	Thoracodorsal
Levator scapulae	Transverse process C1-4	Scapula (medial)	Elevate scapula	C3, 4, Dorsal scapular
Rhomboid minor	Spinous process C7-T1	Scapula (spine)	Adduct scapula	Dorsal scapular
Rhomboid major	Spinous process T2-T5	Scapula (medial border)	Adduct scapula	Dorsal scapular
Serratus posterior superior	Spinous process C7-T3	Ribs 2-5 (upper border)	Elevate ribs	Intercostal nerve (T1-4)
Serratus posterior inferior	Spinous process T11-L3	Ribs 9-12 (lower border)	Depress ribs	Intercostal nerve (T9-12)

DEEP MUSCLES: POSTERIOR NECK AND BACK

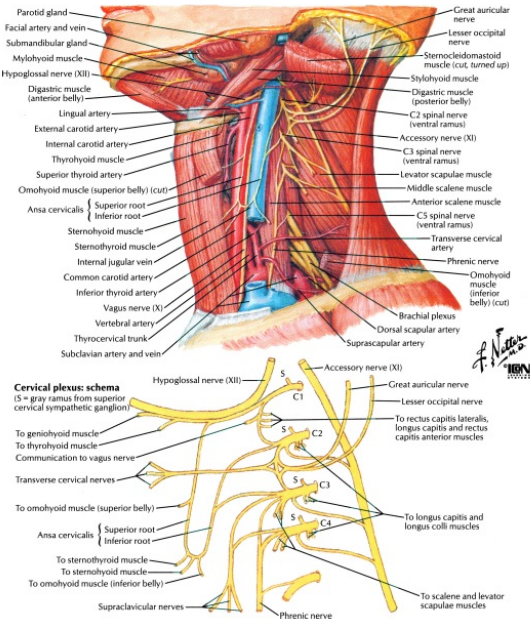


MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
DEEP (INTRINSIC)				
SUPERFICIAL LAYER: SPINOTRANSVERSE GROUP				
Splenius capitis	Ligamentum nuchae	Mastoid nuchal line	Both: laterally flex rotate neck to same side	Dorsal rami of inferior cervical nerves
Splenius cervicus	Spinous process T1-6	Transverse process C1-4		
INTERMEDIATE LAYER: SACROSPINALIS GROUP (Erector spinae) All have 3 parts: thoracis, cervicis and capitis				
Iliocostalis Longissimus Spinalis	Common origin: Sacrum, iliac crest, and lumbar spinous process.	Ribs TC spinous process, mastoid process T-spine: spinous process	Laterally flex, extend, rotate head (to same side) and vertebral column	Dorsal rami of spinal nerves



MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
DEEP (INTRINSIC)				
DEEP LAYERS: TRANSVERSOSPINALIS GROUP				
Semispinalis (CT)	Transverse process	Spinous process	Extend, rotate opposite side	Dorsal primary rami
Semispinalis capitis	Transverse process T1-6	Nuchal ridge		Dorsal primary rami
Multifidi [C2-S4]	Transverse process	Spinous process	Flex laterally, rotate opposite	Dorsal primary rami
Rotatores	Transverse process	Spinous process +1	Rotate superior vertebrae opposite	Dorsal primary rami
Interspinales	Spinous process	Spinous process +1	Extend column	Dorsal primary rami
Intertransversarii	Transverse process	Transverse process +1	Laterally flex column	Dorsal primary rami

NERVES OF THE UPPER EXTREMITY: CERVICAL PLEXUS



CERVICAL PLEXUS (C1-C4 ventral rami) Behind IJ and SCM

Lesser Occipital Nerve(C2-3): arises from posterior border of SCM

Sensory:	Superior region behind auricle
Motor:	NONE

Great Auricular Nerve (C2-3): exits inferior to Lesser Occipital nerve, then ascends on SCM

Sensory:	Over parotid gland and below ear
Motor:	NONE

Transverse Cervical Nerve (C2-3): exits inferior to Greater Auricular nerve, then to anterior neck

Sensory:	Anterior triangle of the neck
Motor:	NONE

Supraclavicular (C2-3): splits into 3 branches: anterior, middle, posterior

Sensory:	Over clavicle, outer trapezius deltoid
Motor:	NONE

1.

Ansa Cervicalis (C1-3): superior (C1-2) inferior (C2-3) roots form loop

2.

Sensory:	NONE

3.

Motor:	Omohyoid Sternohyoid Sternothyroid

4.

5.

6.

Phrenic Nerve (C3-5): On anterior scalene, into thorax between subclavian artery and vein

Sensory:	Pericardium and mediastinal pleura
Motor:	Diaphragm

NERVES: BRACHIAL PLEXUS

BRACHIAL PLEXUS (C5-T1 ventral rami) [variations: C4-T2] (also see Shoulder)

SUPRACLAVICULAR [approach through posterior triangle]

ROOTS

Dorsal Scapular (C5): pierces middle scalene, deep to Levator Scapulae Rhomboids.

Sensory:	NONE
Motor:	Levator scapulae Rhomboid Minor and Major

Long Thoracic (C5-7): on anterior surface of Serratus Anterior with Lateral Thoracic artery.

Sensory:	NONE
Motor:	Serratus Anterior (wing scapula with nerve dysfunction)

UPPER TRUNK

Suprascapular (C5-6): through scapular notch, under superior transverse scapular ligament.

Sensory:	Shoulder joint
Motor:	Supraspinatus Infraspinatus

Nerve to Subclavius (C5-6): descends anterior to plexus, posterior to clavicle

Sensory:	NONE
Motor:	Subclavius

INFRACLAVICULAR [approach through axilla]

LATERAL CORD

- Lateral root to Median nerve

Lateral *Pectoral* (C5-7): named for lateral cord, is medial to Medial Pectoral nerve runs with pectoral artery.

Sensory:	NONE
Motor:	Pectoralis Major Pectoralis Minor (via loop to MPN]

Musculocutaneous (C5-7): pierces coracobrachialis, runs between biceps brachialis.

Sensory:	Lateral forearm [via Lateral cutaneous nerve]
Motor:	ANTERIOR COMPARTMENT OF ARM Coracobrachialis Biceps brachialis Brachialis

INFRACLAVICULAR [approach through axilla]

MEDIAL CORD

- Medial root to Median nerve

Medial Pectoral (C8-T1): named for medial cord, is lateral to Lateral Pectoral nerve

Sensory:	NONE
Motor:	Pectoralis Minor Pectoralis Major (overlying muscle]

Medial Cutaneous Nerve of Arm (Brachial, C8-T1): joins Intercostalbrachial

Sensory:	Medial (inner) arm
Motor:	NONE

Medial Cutaneous Nerve of Forearm (Antibrachial, (C8- T1): runs with basilic vein.

Sensory:	Medial forearm anterior arm
Motor:	NONE

Ulnar (C (7) 8-T1): runs behind medial epicondyle in groove. Multiple sites of possible compr

	Sensory:	Medial palm 1 1/2 digits via: palmar palmar digital branches Medial dorsal hand 1 1/2 digits via: dorsal, dorsal digital, proper palmar digital bra
10.	Motor:	FOREARM [runs between the two muscles] Flexor carpi ulnaris Flexor digitorum profundus [digits 4,5] HAND [divides at hypothenar eminence] **Superficial Branch** [lateral to pisiform] Palmaris brevis **Deep (Motor) Branch** [around hook of hamate] Adductor pollicis THENAR MUSCLES Flexor pollicis brevis[FPB][with median] HYPOTHENAR MUSCLES Abductor digiti minimi [ADM] Flexor digiti minimi brevis [FDMB] Opponens digiti minimi [ODM] INTRINSIC MUSCLES Dorsal interossei [DIO] [abduct DAB] Volar interossei [VIO] [adduct PAD] Lumbricals [medial two (3,4)]

BRACHIAL PLEXUS (C5-T1 ventral rami) [variations: C4-T2] (also see Shoulde

INFRACLAVICULAR [approach through axilla]

MEDIAL AND LATERAL CORDS

Median (C (5) 6-T1): runs anteromedial, no branches in arm Multiple sites of possible com

Sensory:	Dorsal distal phalanges of lateral 3 1/2 digits via: proper palmar digital branche Volar 3 1/2 digits and lateral palm via: palmar palmar digital branches
Motor:	ANTERIOR COMPARTMENT OF FOREARM Superficial Flexors Pronator Teres [PT] Flexor Carpi Radialis [FCR] Palmaris longus [PL] Flexor digitorum superficialis [FDS] [sometimes considered a “middle” flexor] Deep Flexors: **AIN** (Anterior Interosseous Nerve) Flexor digitorum profundus [digits 2,3] Flexor pollicis longus [FPL] Pronator Quadratus [PQ] HAND: **Motor Recurrent** (Thenar motor) Thenar Abductor pollicis brevis [APB] Opponens pollicis Flexor pollicis brevis [FPB][with ulnar] Intrinsic Lumbricals [lateral two (1,2)]

1.

2.

3.

4.

POSTERIOR CORD

Upper *Subscapular* (C5-6)

Sensory:	NONE
Motor:	Subscapularis [upper portion]

5.

6.

Lower *Subscapular* (C5-6)

Sensory:	NONE
Motor:	Subscapularis [lower portion] Teres major

Thoracodorsal (C7-8): runs with Thoracodorsal artery

Sensory:	NONE
Motor:	Latissimus dorsi

7.

8.

9.

Axillary (C5-6): runs with Posterior Circumflex Humeral ar
space

Sensory:	Lateral upper arm: via Superior lateral cutaneo
Motor:	Deltoid (Deep branch) Teres minor (Superficial branch)

Radial (C5-T1): runs with Deep Artery of Arm in Tr

Sensory:	Lateral arm: via Inferior lateral cutaneo Posterior arm: via Posterior cutaneous Posterior forearm: via Posterior cutane Dorsal 3 1/2 digits and hand: via super branches)
Motor:	POSTERIOR COMPARTMENT OF AR Triceps [medial, long, lateral heads] Anaconeus MOBILE WAD: (Radial nerve-Deep bra Brachioradialis [BR] Extensor carpi radialis longus [ECRL Extensor carpi radialis brevis [ECRB] POSTERIOR COMPARTMENT OF FO **PIN** Multiple possible compression si (see Forearm) Superficial Extensors Extensor carpi ulnaris [ECU] Extensor digiti minimi [EDM] Extensor digitorum [ED] Deep Extensors Supinator Abductor pollicis longus Extensor pollicis longus Extensor pollicis brevis Extensor indicis proprius

11.

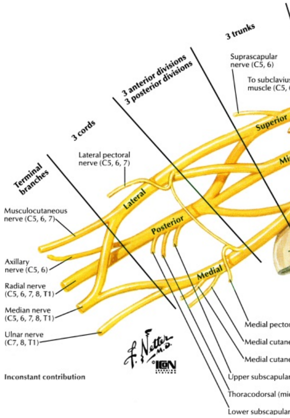
16.

12.

13.

14.

15.


3 trunks
Suprascapular nerve (C5, 6)
3 anterior divisions
3 posterior divisions
Superior
3 cords
Lateral pectoral nerve (C5, 6, 7)
Terminal branches
Lateral
Posterior
Musculocutaneous nerve (C5, 6, 7)
Axillary nerve (C5, 6)
Radial nerve (C5, 6, 7, 8, T1)
Median nerve (C5, 6, 7, 8, T1)
Ulnar nerve (C7, 8, T1)
Medial
Inconstant contribution

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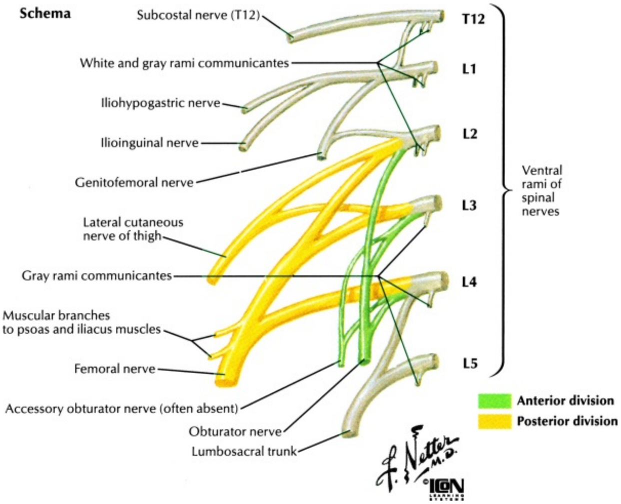
NERVES: LUMBAR PLEXUS



LUMBAR PLEXUS (Deep to Psoas muscle)

ANTERIOR DIVISION

Subcostal (T12):

Sensory:	Subxiphoid region
Motor:	NONE

Iliohypogastric (L1):

Sensory:	Above pubis Posterolateral buttocks
Motor:	Transversus abdominus Internal Oblique

Ilioinguinal (L1):

Sensory:	Inguinal region
Motor:	NONE

Genitofemoral (L1-2): pierces Psoas, lies on anteromedial surface.

Sensory:	Scrotum/mons
Motor:	Cremaster

Obturator (L2-4): exits via obturator canal, splits into anterior posterior divisions. Can be injured by retractors placed behind the transverse acetabular ligament.

Sensory:	Inferomedial thigh via cutaneous branch of Obturator nerve
	External oblique Adductor longus (anterior division)

Motor:	Adductor brevis (ant post division) Adductor magnus (posterior division) Gracilis (anterior division) Obturator externus (posterior division)

Accessory *Obturator* (L2-4): inconsistent

Sensory:	NONE
Motor:	Psoas

POSTERIOR DIVISION

1.

2.

Lateral Femoral Cutaneous [LFCN](L2-3): crosses ASIS, can be compressed at ASIS

Sensory:	Lateral thigh
Motor:	NONE

3.

4.

Femoral (L2-4): lies between psoas major and iliacus

5.

6.

7. 8.

Sensory:	Anteromedial thigh via anterior intermediate cutaneous nerves Medial leg foot via medial cutaneous nerves *(Saphenous Nerve)*
Motor:	Psoas Iliacus Pecineus Quadriceps Rectus femoris Vastus lateralis Vastus intermedialis Vastus Medialis Sartorius Articularis genu

NERVES: SACRAL PLEXUS

SACRAL PLEXUS

ANTERIOR DIVISION

Tibial (L4-S3): descends between heads of Gastrocnemius to medial malleolus

Sensory:	Posterolateral proximal calf: via Medial sural Posterolateral distal calf: via Sural Medial plantar heel: via Medial calcaneal Medial plantar foot: via Medial plantar Lateral plantar foot: via Lateral plantar
Motor:	POSTERIOR THIGH Biceps femoris [long head] Semitendinosus Semimembranosus SUPERFICIAL POST. COMPARTMENT OF LEG Soleus: via nerve to Soleus Gastrocnemius Plantaris DEEP POSTERIOR COMPARTMENT OF LEG Popliteus: via nerve to Popliteus Tibialis posterior [TP] (Tom) Flexor digitorum longus [FDL] (Dick) Flexor hallucis longus [FHL] (Harry) FIRST PLANTAR LAYER of FOOT Abductor hallucis: Medial plantar Flexor digitorum brevis [FDB]: Medial plantar Abductor digiti minimi: Lateral plantar SECOND PLANTAR LAYER of FOOT Quadratus plantae: Lateral plantar Lumbricals: Medial lateral plantar THIRD PLANTAR LAYER of FOOT Flexor hallucis brevis [FHB]: Medial plantar Adductor hallucis: Lateral plantar Flexor digitorum minimus brevis [FDMB]: Lateral plantar FOURTH PLANTAR LAYER of FOOT Dorsal interosseous: Lateral plantar Plantar interosseous: Lateral plantar

Nerve to Quadratus femoris (L4-S1):

Sensory:	NONE
Motor:	Quadratus femoris Inferior gemelli

Nerve to Obturator internus (L5-S2): exits greater sciatic foramen

Sensory:	NONE
Motor:	Obturator internus Superior gemelli

Pudendal (S2-4): exit greater then re-enters lesser sciatic foramen

Sensory:	Perineum: via Perineal (scrotal/labial branches) via Inferior rectal nerve via Dorsal nerve to penis/clitoris
Motor:	Bulbospongiosus: Perineal nerve Ischiocavernosus: Perineal nerve Urethral sphincter: Perineal nerve Urogenital diaphragm: Perineal nerve Sphincter ani externus: Inferior rectal nerve

Nerve to Coccygeus (S3-4)

Sensory:	NONE
Motor:	Coccygeus

Motor:	Levator ani

POSTERIOR DIVISION

1. Common Peroneal (L4-S2): in groove between biceps lateral head of Gastrocnemius. Wraps around fibular head, deep to peroneus longus; the divides

Sensory:	Proximal lateral leg: via Lateral sural nerve Distal lateral leg dorsal foot: via Superficial peroneal Lateral foot: via Sural (lateral calcaneal dorsal cutaneous branches) 1st/2nd interdigital space: Deep peroneal
Motor:	POSTERIOR THIGH Biceps femoris [short head] ANTERIOR COMPARTMENT of LEG: **Deep Peroneal** Tibialis anterior [TA] Extensor hallucis longus [EHL] Extensor digitorum longus [EDL] Peroneus tertius LATERAL COMPARTMENT of LEG: **Superficial Peroneal** Peroneus longus Peroneus brevis FOOT: **Deep Peroneal** Extensor hallucis brevis [EHB] Extensor digitorum brevis [EDB]

2. Superior Gluteal (L4-S1):

Sensory:	NONE
Motor:	Gluteus medius Gluteus minimus Tensor fascia lata

3. **Inferior Gluteal** (L5-S2):

Sensory:	NONE
Motor:	Gluteus maximus

4. **Nerve to piriformis** (S2):

Sensory:	NONE
Motor:	Piriformis

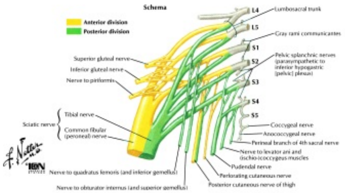
5. **Posterior Femoral Cutaneous Nerve** [PFCN] (S1-3)

6.

10.

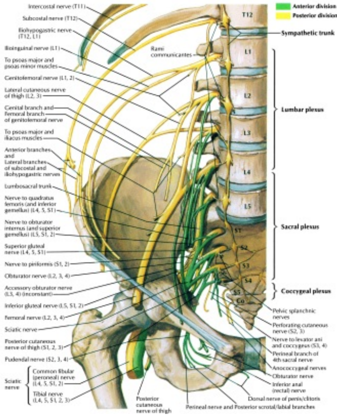
Sensory:	Posterior thigh
Motor:	NONE

7.

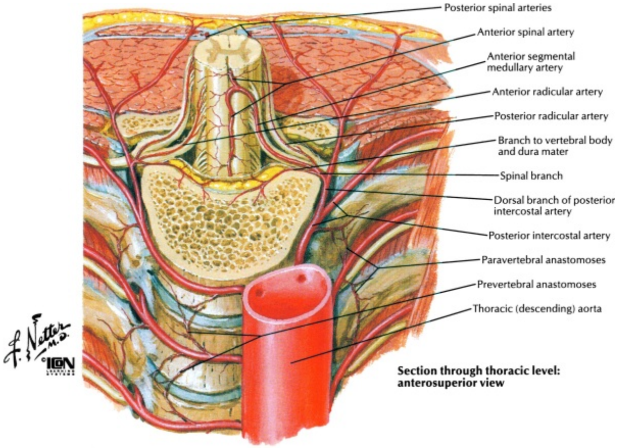

Schema
Anterior division
Posterior division
L4
L5
S1
S2
S3
S4
S5
Lumbosacral trunk
Gray rami communicantes
Pelvic splanchnic nerves (parasympathetic to inferior hypogastric [pelvic] plexus)
Superior gluteal nerve
Inferior gluteal nerve
Nerve to piriformis
Sciatic nerve
Tibial nerve
Common fibular (peroneal) nerve
Coccygeal nerve
Anococcygeal nerve
Perineal branch of 4th sacral nerve
Nerve to levator ani and ischiococcygeus muscles
Pudendal nerve
Perforating cutaneous nerve
Posterior cutaneous nerve of thigh
Nerve to quadratus femoris (and inferior gemellus)
Nerve to obturator internus (and superior gemellus)

8.

9.

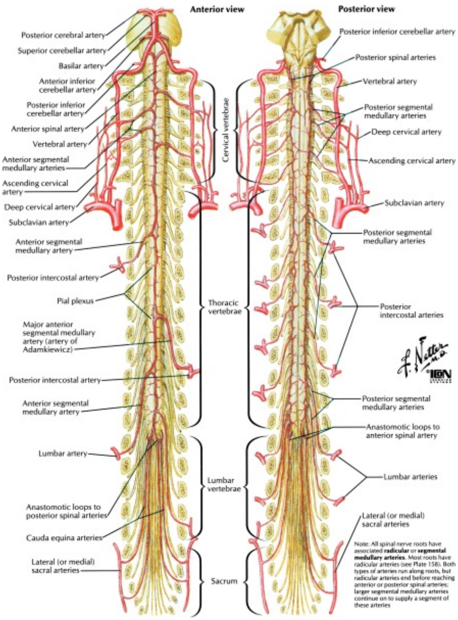

Anterior division
Posterior division
Intercostal nerve (T11)
Subcostal nerve (T12)
Iliohypogastric nerve (T12, L1)
Ilioinguinal nerve (L1)
To psoas major and psoas minor muscles
Genitofemoral nerve (L1, 2)
Lateral cutaneous nerve of thigh (L2, 3)
Genital branch and Femoral branch of genitofemoral nerve
To psoas major and iliacus muscles
Anterior branches and Lateral branches of subcostal and iliohypogastric nerves
Lumbosacral trunk
Nerve to quadratus femoris (and inferior gemellus) (L4, 5, S1)
Nerve to obturator internus (and superior gemellus) (L5, S1, 2)
Superior gluteal nerve (L4, 5, S1)
Nerve to piriformis (S1, 2)
Obturator nerve (L2, 3, 4)
Accessory obturator nerve (L3, 4) (inconstant)
Inferior gluteal nerve (L5, S1, 2)
Femoral nerve (L2, 3, 4)
Sciatic nerve
Posterior cutaneous nerve of thigh (S1, 2, 3)
Pudendal nerve (S2, 3, 4)
Sciatic nerve
Common fibular (peroneal) nerve (L4, 5, S1, 2)
Tibial nerve (L4, 5, S1, 2, 3)
Posterior cutaneous nerve of thigh
Rami communicantes
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4
S5
Co
Sympathetic trunk
Lumbar plexus
Sacral plexus
Coccygeal plexus
Pelvic splanchnic nerves
Perforating cutaneous nerve (S2, 3)
Nerve to levator ani and coccygeus (S3, 4)
Perineal branch of 4th sacral nerve
Anococcygeal nerves
Obturator nerve
Inferior anal (rectal) nerve
Dorsal nerve of penis/clitoris
Perineal nerve and Posterior scrotal/labial branches

ARTERIES



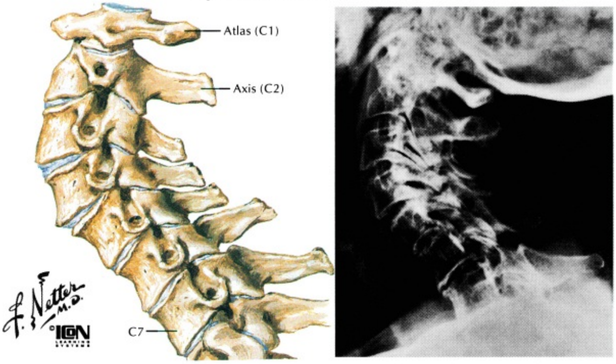
ARTERY	COURSE	BRANCHES	COMMENT
Vertebral	**Major arterial supply of cervical spine and cord.**		
	Off both subclavian through transverse foramen of C1-6	Anterior and posterior segmental medullary	Feed Anterior Posterior spinal arteries respectively
		Anterior spinal	Forms superiorly from both vertebrals
		Posterior spinal	Each branch superiorly from vertebrals
Ascending cervical	From Thyrocervical	Contributes to Anterior Posterior spinal arteries via segmental medullary arteries	
Deep cervical	From Costocervical	Contributes to Anterior Posterior spinal arteries via segmental medullary arteries	
Segmental/Intercostal	Branch from aorta	Dorsal branch Dorsal branch Spinal branch Ventral branch Major anterior segmental medullary (Adamkiewicz Artery)	Supplies dura, posterior elementsSupplies cord and bodies Supplies vertebral bodies Supplies inferior thoracic superior, L-spine, feeds anterior spinal artery in L-spine
Spinal branch	Along vertebral bodies	Anterior segmental medullary Posterior segmental medullary Radicular arteries (Anterior Posterior)	On ventral root; feeds anterior spinal artery Feeds posterior spinal arteries Along nerve roots, do not feed spinals
		Anterior segmental medullary On Posterior	On ventral root; feeds anterior

Lumbar arteries	Branch from aorta	segmental medullary Radicular arteries (Anterior Posterior)	spinal artery Feeds Posterior spinal arteries
Anterior segmental medullary	Along nerve roots	Anterior spinal artery Anterior radicular arteries	Single artery, runs midline Do not feed spinal arteries
Posterior segmental medullary	Along nerve roots	Posterior spinal artery Posterior radicular arteries	Paired arteries (left/right) Do not feed spinal arteries
Anterior spinal	Midline anterior surface of cord	Supplies anterior 2/3 of cord; has multiple contributions from segmental arteries	
		Sulcal branches Pial arterial plexus	Supplies center of cord Supplies cord peripheries
Posterior spinal	Off midline (L R)	Supplies post 1/3 of cord; has multiple contributions from segmental arteries	
Each nerve root has either a segmental medullary or a radicular artery associated with it.			



DISORDERS

Spine Involvement in Osteoarthritis

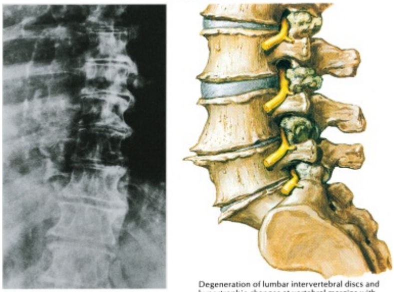


Extensive thinning of cervical discs and hyperextension deformity with narrowing of intervertebral foramina. Lateral radiograph reveals similar changes

DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
CAUDA EQUINA SYNDROME			
• Compression of cauda equina • Etiology: usually a large midline disc herniation • A surgical emergency	HxPE: Back, buttock, leg pain. Bladder (#1) and bowel dysfunction. Leg numbness paralysis	XR: no emergent need MR (or myelography): to show compression	Immediate surgical decompression (when diagnosis is confirmed)
CERVICAL SPONDYLOSIS			
• Disc degeneration with vertebral and facet arthritis • 3 pain sources: disc, ligament, root (HNP) • C5-6 #1 site • PLL ossifies, results in stenosis (most common in Asians)	Hx: Older, men. Neck UE pain, stiffness or grinding. PE: Decreased ROM, midline neck TTP. Radicular or myelopathic signs if HNP or cord compressed	XR: AP, lateral: 1. Osteophytes 2. Spinal stenosis 3. Disc space narrowed 4. Facet osteoarthritis 5. Instability	1. Discogenic: soft collar, NSAID, Physical therapy, +/- traction 2. Persistent radiculopathy or myelopathy: decompression and fusion (not for discogenic pain)
CERVICAL STRAIN/MUSCLE STRAIN (Whiplash)			
• Not a sprain. Soft tissue (muscle/ligament) strain • Etiology: trauma or some minor movement	Hx: Stiffness, pain (dull/nonradiating) in neck traps PE: Paraspinal muscles tender to palpation (+/- spasm). Spurling test	XR: if history of trauma or neurologic or persistent symptoms	1. Soft collar immobilization (Philadelphia collar) 2. NSAID, muscle relaxant 3. +/- Ice, heat, massage
DEGENERATIVE DISC DISEASE (DDD)			

• Aging process: disc desicates and tears. Facet degeneration and sclerosis • Associated with tobacco use	Hx: Chronic LBP (+/- buttock), stiffness (worse with activity) PE: Back tender to palpation +/- Waddell's signs.	XR: AP, lateral: aging, osteophytes, disc space narrowed, "vacuum sign"	**1.** NSAIDs (no narcotics) **2.** Antidepressants if indicated **3.** Physical therapy, exercise, weight control
HERNIATED CERVICAL DISC (Herniated nucleus pulposus)			
• Nucleus pulposus protrudes presses on root. • Usually posterolateral at C5-6 or C6-7.	Hx: Young or middle age. Numbness radiating pain. PE: 1weakness, decreased sensation reflexes, 1 Spurling test	XR: AP, lateral: spondylosis MR: bulging nucleus pulposus	**1.** Soft collar, rest **2.** Physical therapy, NSAIDs **3.** Surgical decompression

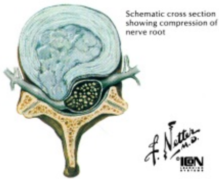
Degenerative Disc Disease



Radiograph of thoracic spine shows narrowing of intervertebral spaces and spur formation

Degeneration of lumbar intervertebral discs and hypertrophic changes at vertebral margins with spur formation. Osteophytic encroachment on intervertebral foramina compresses spinal nerves

Lumbar Disc Herniation

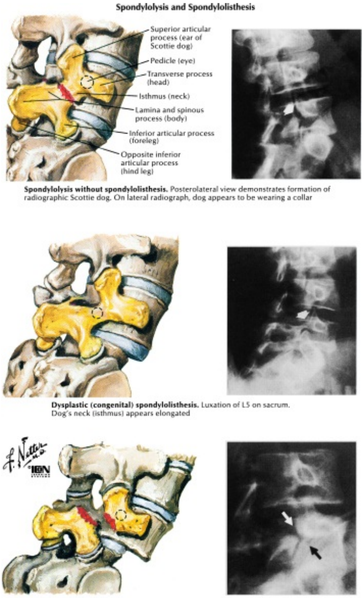


DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
HERNIATED LUMBAR DISC (HNP)			
• DDD annulus tear: nucleus herniates, +/- root or cauda compression. • Can be Asymptomatic • L4-5 most common • Most posterolateral (PLL weak)	Hx: DDD sx (+/- radicular sx). Increased with sneeze, decreased with hip flexion PE: Root weakness, decreased sensation reflexes, 1straight leg bowstring tests.	XR: AP, lateral: age changes EMG/NCS: + after 3 weeks MR: shows herniation	**1.** Bed rest, NSAIDs **2.** Physical therapy, fitness program **3.** Discectomy **4.** Cauda Equina Syndrome: a surgical emergency

DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
LUMBAR BACK SPRAIN/MUSCLE STRAIN			
• Strain or lifting injury • Soft tissue injury (muscle spasm, ligament or tendon injury, disc tear-without bulge)	Hx: LBP (+/- radiation to buttock, not leg), paraspinous spasm tenderness PE: Normal neurologic exam	XR: if neurologic symptoms present or refractory to treatment	**1.** Rest (1-2 day bed rest), NSAIDs (no narcotics) **2.** Physical therapy **3.** Increase fitness
SCHEUERMANN'S DISEASE			
• Increased thoracic kyphosis (Cobb angle 45°) with 3 vertebrae with anterior wedging • Unknown etiology • Schmorl nodes (cartilage) in the vertebral body	Hx: Adolescent with poor posture, +/-back pain PE: "rounded back" on examination, usually nontender to palpation	XR: AP, lateral T-spine: **1.** Increased kyphosis **2.** Anterior wedging (3) **3.** Schmorl nodes	Immature: exercise, brace or orthosis Mature: Anterior release and posterior fusion
SCOLIOSIS			
• Lateral spine curve (+/- rotation) • Multiple etiologies: #1 idiopathic • Girls.boys (needing tx) • Find on school screening • Progression: based on skeletal maturity, curve angle	Hx: +/-pain, fatigue, visible physical deformity. PE: Neurologic exam usually normal. 1forward bend test. Determine plumb line (hang string from C7)	XR: Full length AP, lateral: Lateral curve on AP. Measure Cobb angle: angle between lines drawn perpendicular to most superior inferior affected vertebrae	Curves: **1.** 30° observation **2.** 30-40° bracing **3.** 40° surgery: spinal fusion.
SPINAL STENOSIS			
• Congenital vs. acquired (most common) • Canal narrowing with symptoms • Etiology: DDD or facet osteoarthritis ligament laxity	Hx: Neurogenic claudication (fatigue), +/-pain; Back extension reproduces sx. PE: Weakness, decreased pin prick reflexes	XR: AP, lateral: age changes CT/MR: better to evaluate canal, shows stenosis	**1.** Physical Therapy: abdominal strength back flexion exercises **2.** NSAIDs (+/- steroids) **3.** Laminectomy
SPONDYLOLISTHESIS			
• Forward slipped vertebrae • 6 Types (common sites): **1.** Congenital: facet defect (S1) Isthmic (most common): pars	Hx: Type: I (peds), II (young), III (elderly). Mechanical back pain, +/-radicular symptoms	XR: AP, lateral: measure forward slippage for grade (I-V, 0-100°) Type: **1.** Scottie dog: long	**1.** Activity modification, rest, NSAIDs **2.** Flexion exercises Surgical

2. defect (L5-S1; associated with hyperextention); 3. Degenerative: facet arthropathy (L4-5) 4. Traumatic 5. Pathologic 6. Post-surgical	PE: +/-palpable step-off spasm. +/-radicular signs (e.g. weakness, decreased sensation reflexes)	neck 2. Scottie dog: broken neck 3. Facet arthritis	Surgical decompression and fusion for 3. progressive slippage or radicular symptoms
SPONDYLOLYSIS			
• Defect or stress fracture (without slippage) in pars interarticularis • Leads to spondylolisthesis • L5 most common site	Hx: Young, athlete (football, gymnast). Low back pain, worse with activity (#1 cause in pediatrics)	XR: Oblique L-spine "Scottie dog has a collar"	1. Symptomatic treatment 2. Activity restriction, +/- brace 3. Back muscle strengthening
TUMORS			
Metastatic are most common. Most common primary: Multiple Myeloma (malignant)			

Spondylolysis and Spondylolisthesis



Spondylolysis without spondylolisthesis. Posterolateral view demonstrates formation of radiographic Scottie dog. On lateral radiograph, dog appears to be wearing a collar

Dysplastic (congenital) spondylolisthesis. Luxation of L5 on sacrum. Dog's neck (isthmus) appears elongated

Isthmic type spondylolisthesis. Anterior luxation of L5 on sacrum due to fracture of isthmus. Note that gap is wider and dog appears decapitated

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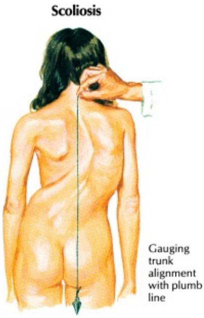
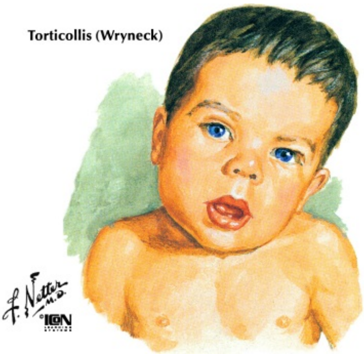
PEDIATRIC DISORDERS





DESCRIPTION	EVALUATION	TREATMENT/COMPLICATIONS
	MYELODYSPLASIA	
• Neural tube (closure) defect; • No function below level of lesion; level determines function (L1 paraplegic/S1 near normal) • Associated with increased AFP • Associated with many deformities	Hx: Some have family history PE/XR: Depends on type of defect: 1. Spina bifida occulta 2. Meningocele 3. Myelomeningocele 4. Rachischisis	Must individualize for each patient: Most need ambulation assistance, orthoses, surgical releases, etc.Common problems requiring treatment: Deformities and/or contractures of spine, hips, knees, ankles, and feet
	SCOLIOSIS	
• Lateral spine curve +/- rotation • Multiple etiologies: #1 idiopathic • Cases needing tx: girls boys • Curve progression predicted: 1. Angle of curve 2. Skeletal maturity (Risser stages: iliac Apophysis)	Hx: +/- pain fatigue, visible deformity, found in school screening PE: + forward bend test (asymmetric). Neurologic exam usually normal. Determine plumb line from C7 XR: AP full length: measure Cobb angle. (See Disorder Table)	Based on curves and Risser stage; 1. 30°: observation (most) 2. 30-40°:bracing (Boston, for apex below T8 vs. Milwaukee brace) 3. 40°: spinal fusion
	TORTICOLLIS	
• Contracture of SCM • Associated with other disorders • Associated with intrauterine position	Hx: Parents note deformity PE: Head tilted to one side, chin to opposite side, 1/2facial asymmetry XR: Spine hips: rule out	1. Physical therapy/stretching of the sternocleidomastoid 2. Surgical release if persistent Complication: poor eye

intrauterine position • Etiology: several theories	XR: Spine hips: rule out other anomalies	development

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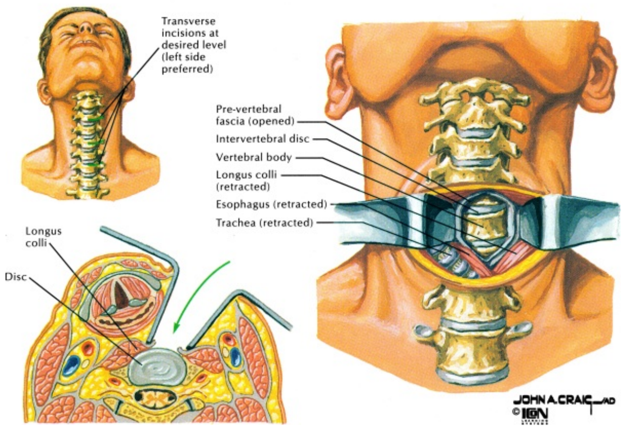
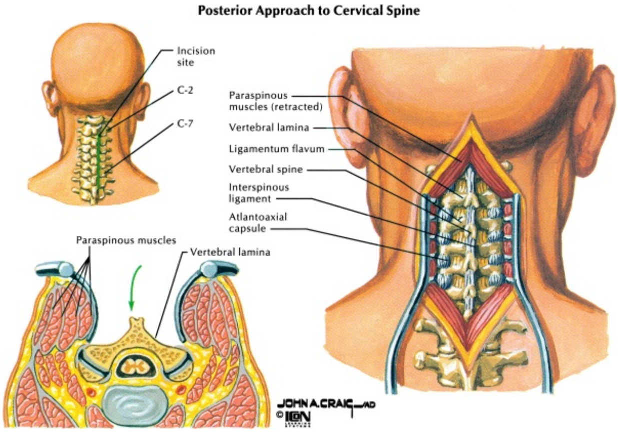
SURGICAL APPROACHES

Anterior Approach to Cervical Spine



USES	INTERNERVOUS PLANE	DANGERS	COMMENT
ANTERIOR APPROACH			
1. Herniated disc removal 2. Vertebral fusion 3. Osteophyte removal 4. Tumor or biopsy	Superficial: 1. SCM (CN 11) 2. Strap muscles (C1-3) Deep: Between left and right Longus colli muscles	1. Recurrent laryngeal nerve 2. Sympathetic nerve 3. Carotid artery 4. Internal jugular 5. Vagus nerve 6. Inferior thyroid artery	• Access C3 to T1 • Right recurrent laryngeal nerve more susceptible to injury-most choose approach on left side. • Thyroid arteries limit extension of the approach

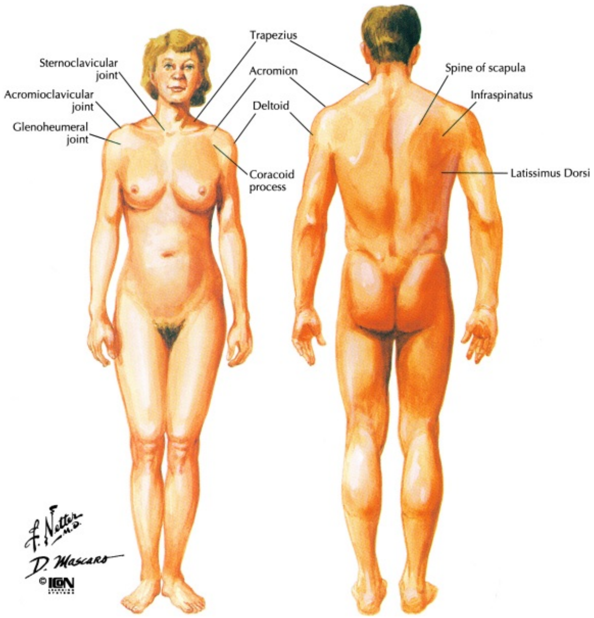


USES	INTERNERVOUS PLANE	DANGERS	COMMENT
POSTERIOR APPROACH			
CERVICAL 1. Posterior fusion 2. Herniated disc 3. Facet dislocation	Left and Right paracervical muscles (posterior cervical rami)	1. Spinal cord 2. Nerve roots 3. Posterior rami 4. Vertebral artery 5. Segmental vessels	1. Most common c-spine approach 2. Mark the level of pathology with a radiopaque marker pre-op to assist finding the appropriate level intraoperatively
LUMBAR 1. Herniated disc 2. Explore nerve roots	Left and Right paraspinal muscles (dorsal rami)	Segmental vessels to paraspinals	Incision is along the spinous processes.

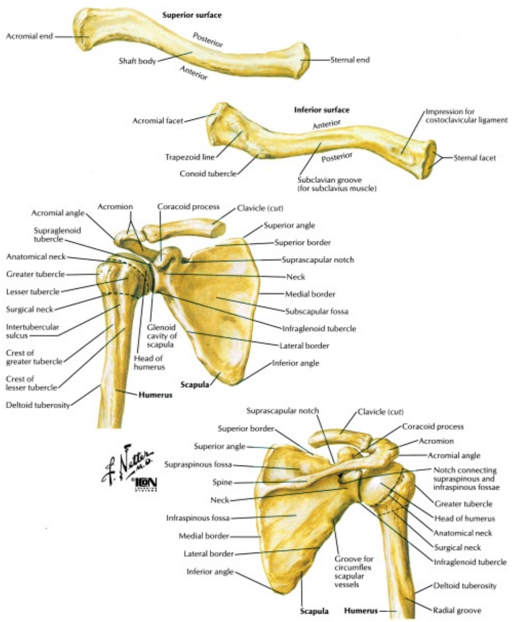
CHAPTER 2 - SHOULDER

CHAPTER 2 – SHOULDER

TOPOGRAPHIC ANATOMY



OSTEOLOGY



CHARACTERISTICS	OSSIFY		FUSE	COMMENT
CLAVICLE				
• Cylindrical; S shaped • Middle: narrowest, no ligament attachments	Primary (2) (medial/lateral) Secondary (sternal/acromial)	7 weeks fetal 18-20 years	9 weeks fetal 25 years (sternal) 19-20 yrs (acromial)	• Clavicle is first to ossify, last to fuse • It starts as intramembranous ossification, ends as membranous.
SCAPULA				
• Flat, triangular shape • Only attachments to axial skeleton are muscular.	**1.** Body **2.** Coracoid **3.** Coracoid/glenoid **4.** Acromion **5.** Inferior angle	8 weeks (fetal) 1 year 15 yrs 15 yrs 16 yrs	All fuse between 15-20 years	Blood supply: **1.** Subscapular (and circumflex scapular arteries) **2.** Suprascapular artery

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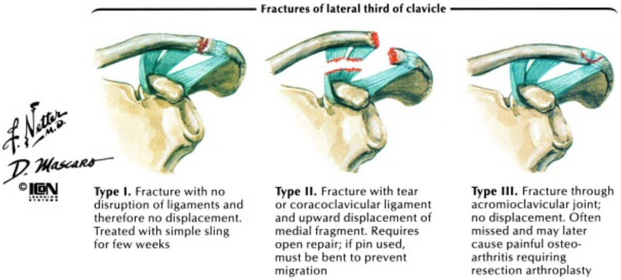
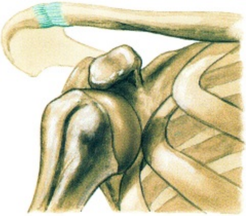
TRAUMA



DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
CLAVICLE FRACTURE			
• Most common fracture • Fall on shoulder or direct blow. • Football, hockey • Rare neurovascular damage (subclavians)	HX: Trauma. Cannot raise arm. Pain. PE: Gross deformity at fracture site with ttp. Must do neurological and vascular exams. XR: AP and 45° cephalad Group II: stress views	I. Middle 1/3: 80% II Distal 1/3: 15% Type I: minimally displaced; between ligaments. Type II: Displaced, fracture medial to CC ligament. Type IIA: CC ligaments both attached to distal fragment Type IIB: Conoid ruptured Trapezoid ligament attached. Type III: Fracture through AC joint. Ligaments intact. III Proximal 1/3: 5%	Closed treatment (no reduction) with figure of eight brace or sling for mid/ proximal 1/3, distal 1/3 (Types I and III) (3-4 weeks; ROM) Open treatment for Type II to prevent nonunion. (also open fracture, vascular injury)
COMPLICATIONS: Nonunion: esp. with distal 1/3: type II injury; Brachial plexus (medial cord/ulnar nerve) or subclavian injury; Pneumothorax.			
SCAPULAR FRACTURE			
• Relatively uncommon • Males-young • High-energy trauma • 85% w/associated injuries (including	HX: Trauma. Pain in back and/or shoulder. PE: Swelling and tenderness to palpation XR: AP/Axillary	Anatomic classification: A-G Idleberg (glenoid fracture) Type I: Anterior avulsion fracture Type II: Tranverse/oblique fracture thru glenoid; exits inferiorly Type III: Oblique	Closed treatment with a sling for 2 weeks for most fractures. Then early ROM. ORIF for intraarticular fx

• (including severe) • Dx often delayed due to associated injuries (esp pulmonary great vessels).	XR: AP/Axillary lateral/ scapular Y; CXR CT: intraarticular glenoid	fracture through glenoid, exits superiorly Type IV: Transverse fracture exits through the scapula body Type V: Types II + IV	ORIF for intraarticular fx and/or large displaced (25%) fragments
COMPLICATIONS: Associated injuries: Rib fracture #1, pneumothorax, pulmonary contusion, vascular injury, brachial plexus inury; AC injury (esp w/type III; acromion fx); Suprascapular nerve injury			



Subcoracoid dislocation (most common)

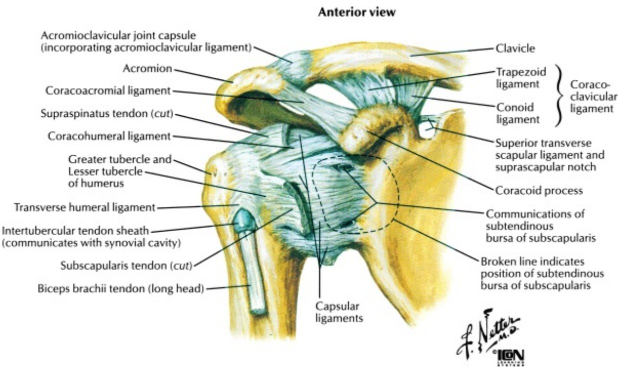
Anteroposterior radiograph. Subcoracoid dislocation

F. Netter M.D.
D. Mascaro
©ICON

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
ACROMIOCLAVICULAR (AC) SEPARATION			
• Separation is subluxation or dislocation of AC joint • Fall onto acromion • Contact sports: hockey football, wrestling • Males	HX: Trauma. Range of pain: minimal to severe. PE: AC joint TTP, gross deformity with grade III up. XR: AP, stress view: grade II vs. grade III I: normal, II: minimal separation, III and up: clavicle displaced.	6 Grades: (based on ligament tear clavicle position) Grade I: Sprain, AC ligament intact Grade II: AC tear, CC sprain Grade III: AC/CC (both) torn AC joint is dislocated. Grade IV: III with clavicle posterior into/thru trapezius muscle Grade V: III with clavicle elevated 100% superiorly Grade VI: III with clavicle inferior	Grade I, II: sling until pain subsides (+/- injection/pain medication) for 1-2 wks, then increase ROM Grade III: nonoperative for most; operative for laborers/athletes Grade IV-VI: Open reduction and repair.
COMPLICATIONS: Permanent deformity; Stiffness, early OA; Distal clavicle osteolysis (pain); Associated injuries: Fracture, pneumothorax.			

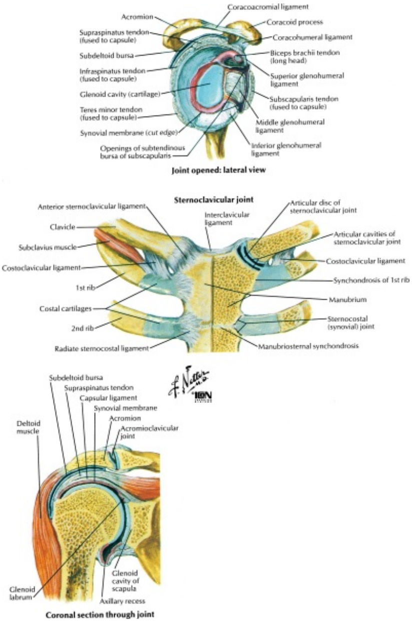
GLENOHUMERAL DISLOCATION			
• Anterior: Abd/ER injury 2 mechanisms 1. TUBS [Traumatic Unilateral, Bankart lesion, Surgery] 2. AMBRI [Atraumatic Multi-directional, Bilat- eral, responds to Rehab, Inferior capsule repair) 20 yo: 80% recur Hill Sachs Bankart lesions predisposed to recurrence • Posterior: after seizure often missed	HX: Trauma or hx of shoulder slipping out. Intense pain. PE: Deformity, flattened shoulder silhouette. Exquisitely tender. Do full neurovascular PE XR: AP/axillary lateral (also Stryker notch) Anterior: Hill Sacks Lesion Posterior: Rev Hill Sachs, “empty glenoid” MRI: Bankart lesion (anterior/inferior labral tear)	Anatomic Classification: where humeral head is: • Anterior (90%) • Posterior (5%) • Inferior (luxatio erecta) very rare • Superior: very, very rare	Reduce dislocation: Pre and Post neurological exam Conscious sedation (IV benzo + narcotic) Methods: 1. Traction/counter-traction 2. Hippocratic 3. Stimson 4. Milch Immobilize (2-6 weeks), rehabilitation Surgery for recurrent/TUBS, posterior dislocation 3 wks
COMPLICATIONS: Recurrence rate (young age predicts it, decreases w/increased age); Axillary nerve injury; Rotator cuff tear; Glenoid/Greater tuberosity fracture; Dead arm syndrome			

JOINTS



JOINT	TYPE	LIGAMENTS	COMMENTS
Glenohumoral	Spheroidal Ball and Socket	Highly mobile, decreased stability (needs Rotator cuff); #1 dislocated joint (anterior 90%)	
		Capsule	Loose, redundant, with gaps; minimal support
		Coracohumoral	Provides anterior support
		Glenohumoral	Discrete capsular thickenings; 3 ligaments: superior, middle, inferior-strongest
		Glenoid labrum	Increases surface area depth of glenoid. Injuries: SLAP lesion/Bankart lesion
		Transverse humeral	Holds biceps (LH) tendon in groove
Sternoclavicular	Double sliding	Capsule	
		Anterior and Posterior SC ligaments	Posterior stronger; Anterior dislocation more common
		Interclavicular	
		Costoclavicular	Strongest SC ligament
Acromioclavicular [AC joint]	Plane/Gliding	Capsule has a disc in joint;	
		Acromioclavicular	Horizontal stability; torn in Grade II AC injury
		Coracoacromial	Can cause impingement
		Coracoclavicular	Vertical stability; torn in Grade III AC injury
		Trapezoid	Anterior/lateral position
		Conoid	Posterior/medial position; stronger
Scapulothoracic	not an articulation	Allows scapula to move along the posterior rib cage.	
Other ligaments		Superior transverse	Separates Suprascapular Artery

Other ligaments		transverse scapular	and Nerve



STRUCTURE	FUNCTION
	MUSCLES
ROTATOR CUFF	Holds humeral head in glenoid
Supraspinatus	Most commonly torn tendon
Infraspinatus	
Teres Minor	
Subscapularis	Anterior support
	LIGAMENTS
Capsule	Rotator cuff tendons fused to it
Glenohumeral	Superior: resists inferior translation
	Middle: resists anterior translation
	Inferior: resists ant/inf translation
Coracohumeral	Resists post/inferior translation
Labrum	Deepens glenoid

MINOR PROCEDURES

STEPS

INJECTION OF THE ACROMIOCLAVICULAR (AC) JOINT

1. Ask patient about allergies
2. Palpate clavicle distally to AC joint (sulcus)
3. Prepare skin over AC joint (iodine/antiseptic soap)
4. Anesthetize skin with local (quarter size spot)
5. Use 21 gauge or smaller, insert needle into joint vertically. Aspirate to ensure not in a vessel, then inject 2ml of 1:1 local/ corticosteroid preparation into AC joint. (You will feel the needle "pop/give" into the joint)
6. Dress injection site

INJECTION OF SUBACROMIAL SPACE

1. Ask patient about allergies
2. Palpate the acromion: define it's borders
3. Prepare skin over shoulder (iodine/antiseptic soap)
4. Anesthetize skin with local (quarter size spot)
5. Hold finger (sterile glove) on acromion, insert needle under posterior acromion w/cephalad tilt. Aspirate to ensure not in a vessel, then inject 5-10cc of preparation-will flow easily if in joint). Use:
   a. diagnostic injection: local only
   b. therapeutic injection: local/corticosteroid 5:1
6. Dress injection site

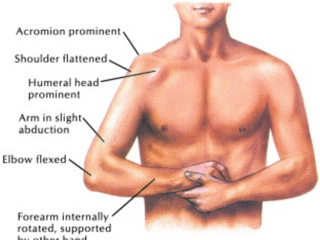
GLENOHUMERAL ARTHROCENTESIS

1. Palpate the coracoid process/humeral head
2. Prepare skin over shoulder (iodine/antiseptic soap)
3. Anesthetize skin (quarter size spot)
4. Abduct arm/downward traction (by an assistant)
5. Insert needle between humeral head and coracoid process
6. Synovial fluid should aspirate easily
7. Dress insertion site

Thompson: Netter's Concise Atlas of Orthopaedic Anatomy, 1st ed.

HISTORY

Injury to acromioclavicular joint. Usually caused by fall on tip of shoulder, depressing acromion (shoulder separation)



Clinical appearance

Rupture of Biceps Brachii Muscle

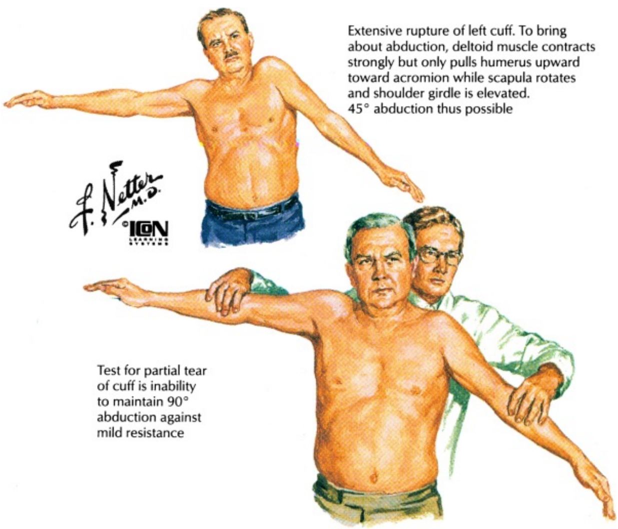
QUESTION	ANSWER	CLINICAL APPLICATION
1. AGE	OLD YOUNG	Rotator cuff tear/impingement, arthritis (OA), adhesive capsulitis (frozen shoulder), humerus fracture (after trauma) Instability, AC injury, osteolysis, impingement in athletes
2. PAIN **a.** Onset **b.** Location **c.** Occurrence **d.** Exacerbating /relieving	Acute Chronic On top/AC joint Night pain Overhead worse Overhead better	Fracture, rotator cuff tear, acromioclavicular injury, dislocation Impingement, arthritis AC joint arthrosis Classic for Rotator Cuff tear, tumor Rotator Cuff tear Cervical radiculopathy
3. STIFFNESS	Yes	Osteoarthritis, adhesive capsulitis
4. INSTABILITY	“Slips in and out”	Dislocation: 90% anterior - occurs with abduction external rotation (e.g. throwing motion)
5. TRAUMA	Direct blow Fall on outstretched hand	Acromioclavicular injury Glenohumeral dislocation
	Overhead usage	Osteolysis (distal clavicle)

6. WORK/ACTIVITY	Weight lifting Athlete: throwing type Long term manual labor	Osteolysis (distal clavicle) Rotator cuff tear/impingement Arthritis (OA)
7. Neurologic Symptoms	Numbness/tingling/ “heavy”	Thoracic outlet syndrome, brachial plexus injury
8. PMHx	Cardiopulmonary/GI	Referred pain to shoulder

PHYSICAL EXAM

EXAM	TECHNIQUE/FINDINGS	CLINICAL APPLICATION
INSPECTION		
Symmetry	Compare both sides	
Wasting	Loss of contour/muscle mass	Rotator Cuff tear
Gross deformity	Superior displacement	Acromioclavicular injury (separation)
Gross deformity	Anterior displacement	Anterior dislocation (glenohumeral joint)
Gross deformity	"Popeye" arm	Biceps tendon rupture (usually proximal end of long head)
PALPATION		
AC joint	Feel for end of clavicle	Pain indicates Acromioclavicular pathology
Subacromial bursa	Feel acromion-down to acromiohumeral sulcus	Pain: bursitis and/or supraspinatus tendon rupture
Coracoclavicular ligament	Feel between acromion coracoid	Pain indicates impingement
Greater tuberosity	Prominence on lateral humeral head	Pain indicates Rotator Cuff tendinitis
Biceps tendon	Feel proximal insertion on humerus	Pain indicates biceps tendinitis
RANGE OF MOTION		
Forward flexion	Arms from sides forward	0-160° normal
Abduction	Arms from sides outward	0-160/180° normal
Internal rotation	Reach thumb up back-note level	Mid thoracic normal-compare sides
External rotation	**1.** Elbow at side, rotate forearms lateral **2.** Abduct arm to 90°, externally rotate up	30-60° normal External rotation decreased in adhesive capsulitis
Rotator Cuff tear: AROM decreased, PROM ok, Adhesive Capulitis: both are decreased		
NEUROVASCULAR		
Sensory	Light touch, pin prick, 2 pt	
Supraclavicular nerve (C4)	Superior shoulder/ clavicular area	Deficit indicates corresponding nerve/root lesion
Axillary nerve (C5)	Lateral shoulder	Deficit indicates corresponding nerve/root lesion
T2 segmental nerve	Axilla	Deficit indicates corresponding nerve/root lesion
Motor		
Spinal accessory (CN11)	Resisted shoulder shrug	Weakness = Trapezius or corresponding nerve lesion.
Suprascapular (C5-6)	Resisted abduction	Weakness = Supraspinatus or corresponding nerve/root lesion.
	Resisted external rotation	Weakness = Infraspinatus or corresponding nerve/root lesion.
Axillary nerve (C5)	Resisted abduction	Weakness = Deltoid or corresponding nerve/root lesion.
	Resisted external rotation	Weakness = Teres minor or corresponding nerve/root lesion.
Dorsal scapular	Shoulder shrug	Weakness = Lev Scap/Rhomboid or

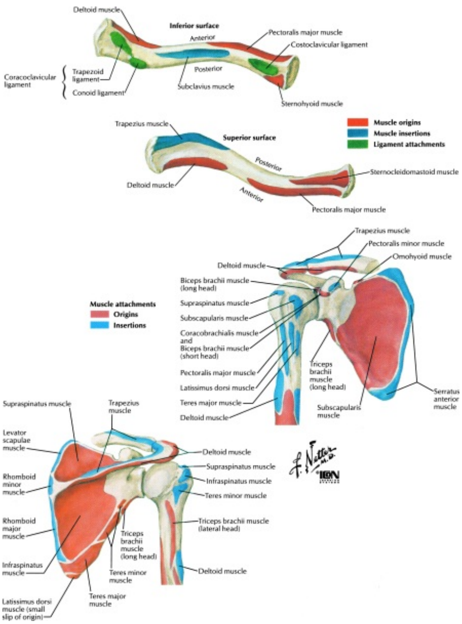
nerve (C5)	Shoulder shrug	nerve/root lesion.
Thoracodorsal nerve (C7-8)	Resisted adduction	Weakness = Latissimus dorsi or nerve/root lesion.
Lateral pectoral nerve (C5-7)	Resisted adduction	Weakness = Pectoralis major or corresponding nerve/root lesion.
U/L subscabular nerve (C5-6)	Resisted internal rotation	Weakness = Teres min or subscapularis or nerve/root lesion.
Long thoracic nerve (C5-7)	Scapular protraction /reach	Weakness = Serratus anterior or nerve/root lesion



EXAM	TECHNIQUE/FINDINGS	CLINICAL APPLICATION
	SPECIAL TESTS	
Supraspinatus (empty can)	Bilateral:30°add,90°FF,IR,resist down force	Weakness indicates Rotator cuff (supraspinatus) tear, impingement
Drop Arm	Passively abduct 90°, lower slowly	Weakness or arm drop indicates rotator cuff tear
Liftoff	Hand behind back, push posteriorly	Weakness or inability indicates subscapularis rupture
Speed	Resist forward flexion of arm	Pain indicates biceps tendinitis
Yergason	Hold hand, resist supination	Pain indicates biceps tendinitis, biceps tendon subluxation
Impingement sign (Neer)	Forward flex greater than 90°	Pain indicates Impingement Syndrome
Hawkins sign	Forward flex 90°, elbow @ 90°, then IR	Pain indicates Impingement Syndrome
Cross Body Adduction	90°Forward flex then adduct arm across body	Pain indicates Acromioclavicular pathology, Decreased ROM indicates tight posterior capsule
AC Shear	Cup hands over clavicle/scapula: then squeeze	Pain/movement indicates AC pathology

Active Compression **(O'Brien's)**	90°FF, max IR, then adduct/flex	Pain or pop indicates a SLAPlesion
Load and shift	Push into glenoid, translate ant/post	Motion indicates instability in that direction (anterior vs. posterior)
Apprehension sign	Throwing position- continue to externally rotate	Apprehension indicates anterior instability
Relocation (Jobe)	90°abd, full ER, posterior force on humeral head	Relief of pain/apprehension, or increased externalrotation indicates anterior instability
Posterior Apprehension sign	FF 90°,internally rotate, posterior force	Apprehension indicates posterior instability
Inferior instability	Abd 90°, downward force on mid- humerus	Slippage of humeral head or apprehension: inferior instability or Multidirectional instability
Sulcus sign	Arm to side, downward traction	Increased acromiohumeral sulcus: inferior instability or **Multidirectional instability**
Adson	Palpate radial pulse, rotate neck to ipsilateral side	Reproduction of symptoms indicates thoracic outlet syndrome
Roo (EAST)	Bilateral arm: abduct/ER, open and close fist 3 minutes	Reproduction of symptoms indicates thoracic outlet syndrome
Spurling	Lateral flex/axial compression of neck	Reproduction of symptoms indicates cervical disc pathology

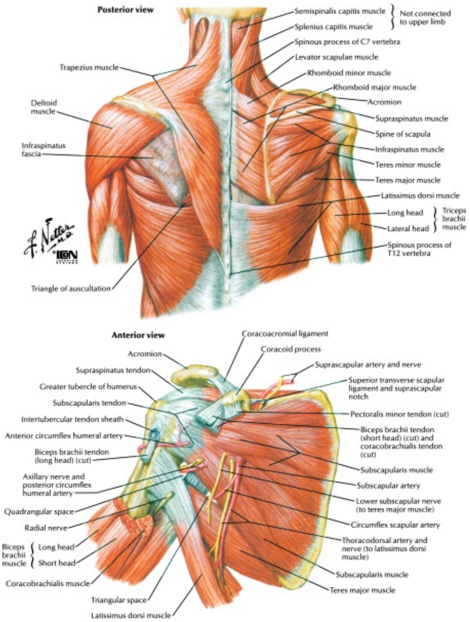
MUSCLES: INSERTIONS AND ORIGINS



CORACOID PROCESS	GREATER TUBERCLE	ANTERIOR PROXIMAL	MEDIAL EPICONDYLE	LATERAL EPICONDYLE
ORIGINS	**INSERTIONS**	**INSERTIONS**	**ORIGINS**	**ORIGINS**
Biceps (SH)	Supraspinatus	Pectoralis major	Pronator Teres	Anaconeus
Corcobrachialis	Infraspinatus	Latissimus dorsi	Common Flexor	Common. Extensor
INSERTIONS	Teres minor	Teres major	Tendon [FCR, PL,	Tendon [ECRB,ED,
Pectoralis minor			FCU, FDS]	EDM, ECU]

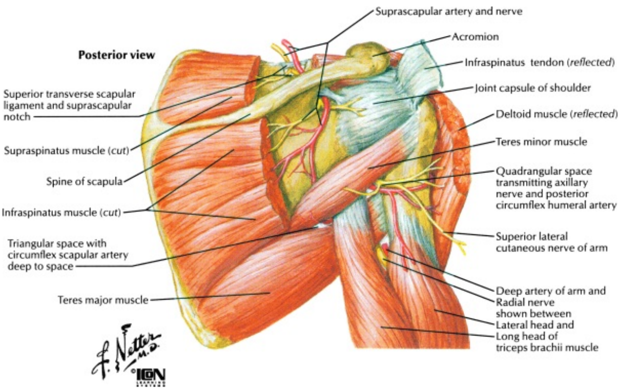
Thompson: Netter's Concise Atlas of Orthopaedic Anatomy, 1st ed.

MUSCLES: BACK/SCAPULA REGION



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Trapezius	C7-T12 spinous process	Clavicle, Acromion spine of scapula	Cranial nerve XI	Elevate rotate scapula	Connect UE to spine
Latissimus dorsi	T7-T12, iliac crest	Humerus (intertubercular groove)	Thoracodorsal	Adduct, extend arm, IR humerus	Connect UE to spine
Levator scapulae	C1-C4 transverse process	Superior medial scapula	Dorsal scapular/ C3-4	Elevates scapula	Connect UE to spine
Rhomboid minor	C7-T1 spinous process	Medial scapula (at the spine)	Dorsal scapular	Adduct scapula	Connect UE to spine
Rhomboid major	T2-T5 spinous process	Medial scapula	Dorsal scapular	Adduct scapula	Connect UE to spine

MUSCLES: ROTATOR CUFF



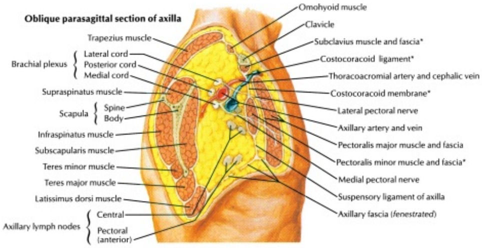
SPACE	BORDERS	STRUCTURES
Triangular Space	Teres Minor	Circumflex Scapular Artery
	Teres Major	
	Triceps (Long Head)	
Quadrangular Space	Teres Minor	Axillary Nerve
	Teres Major	Posterior Circumflex Artery
	Triceps (Long Head)	Humeral Artery
	Triceps (Lateral Head)	
Triangular Interval	Teres Major	Radial Nerve
	Triceps (Long Head)	Deep Artery of Arm
	Triceps (Lateral Head)	

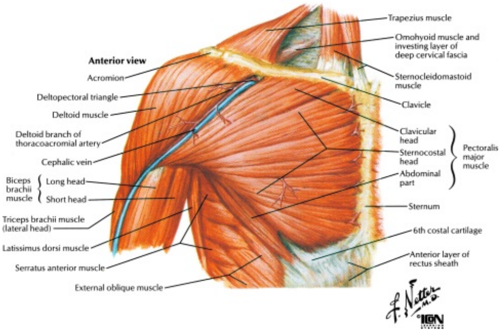
MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Deltoid	Clavicle, Acromion spine of scapula	Humerus (Deltoid tuberosity)	Axillary	Abduct arm	Atrophy: Axillary nerve damage
Teres major	Inferior angle of the scapula	Humerus (intertubercular groove)	Lower subscapular	IR, adduct arm	Protects radial nerve in posterior approach
Rotator Cuff(4)					
1.Supraspinatus	Supraspinatus fossa (scapula)	Greater tuberosity (superior)	Suprascapular	Abduct arm (initiate),	Trapped in impingement #1 torn tendon (RC tear)
2.Infraspinatus	Infraspinatus fossa (scapula)	Greater tuberosity (middle)	Suprascapular	ER arm, stability	Weak ER: damage to nerve. lesion in notch
					Dissection

3.Teres Minor	Lateral scapular	Greater tuberosity (inferior)	Axillary	ER arm, stability	Dissection can damage circum-flex vessels
4.Subscapularis	Subscapular fossa (scapula)	Lesser tuberosity	Upper Lower Subscapular	IR, adduct arm, stability	**Can rupture in anterior dislocation**

Thompson: Netter's Concise Atlas of Orthopaedic Anatomy, 1st ed.

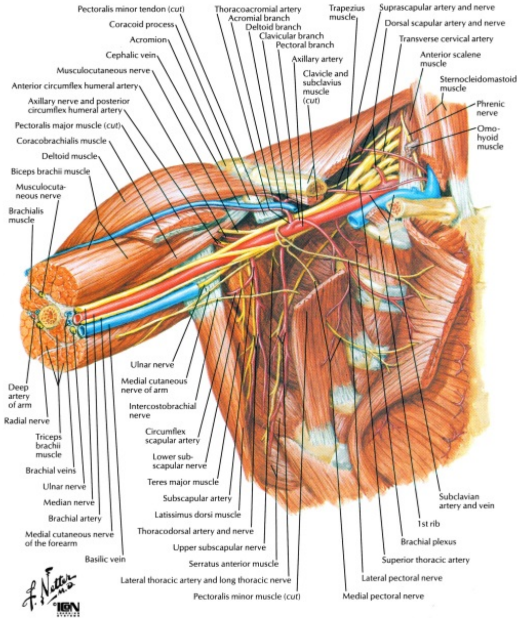
MUSCLES: DELTOID/PECTORAL REGION



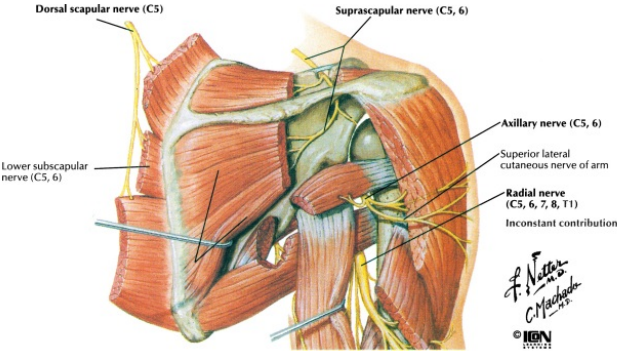


MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Deltoid	Clavicle, Acromion, spine of scapula	Humerus (Deltoid tuberosity)	Axillary	Abduct arm	**Atrophy: Axillary nerve damage**
Pectoralis major	1.Clavicle 2.Sternum	Humerus (intertubercular groove)	Lateral/medial pectoral	Adducts arm, IR humerus	**Can rupture during weight lifting**
Pectoralis minor	Ribs 3-5	Coracoid process (scapula)	Medial pectoral	Stabilizes scapula	Divides Axillary artery into 3 parts
Serratus anterior	Ribs 1-8 (lateral)	Scapula (antero-medial border)	Long thoracic	Holds scapula to chest wall	Paralysis indicates wing scapula
Subclavius	Rib 1 (and costal cartilage)	Clavicle (inferior border/mid 3rd)	Nerve to subclavius	Depresses clavicle	Cushions sub- clavian vessels

NERVES

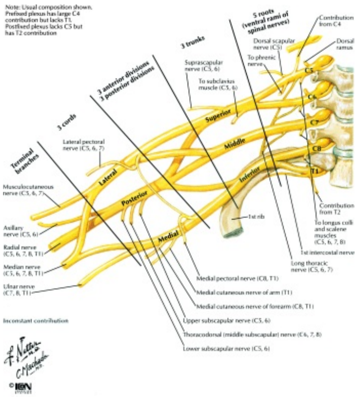


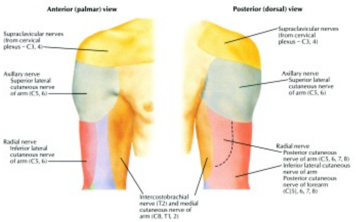
BRACHIAL PLEXUS
• C5-T1 ventral rami Variations: C4 (prefixed) T2 (post-fixed) • Rami (Roots), Trunks, Divisions, Cords, Branches (**R**ob **T**aylor **D**rinks **C**old **B**eer) • Supraclavicular (rami trunks) portion in posterior triangle of neck **Rami exit between Anterior Medial Scalene**, then travel with Subclavian artery in axillary sheath • Divisions occur under (posterior) to clavicle and subclavius muscle Anterior Divisions: Flexors Posterior Divisions: Extensors • Infraclavicular (cords branches) portion in the axilla



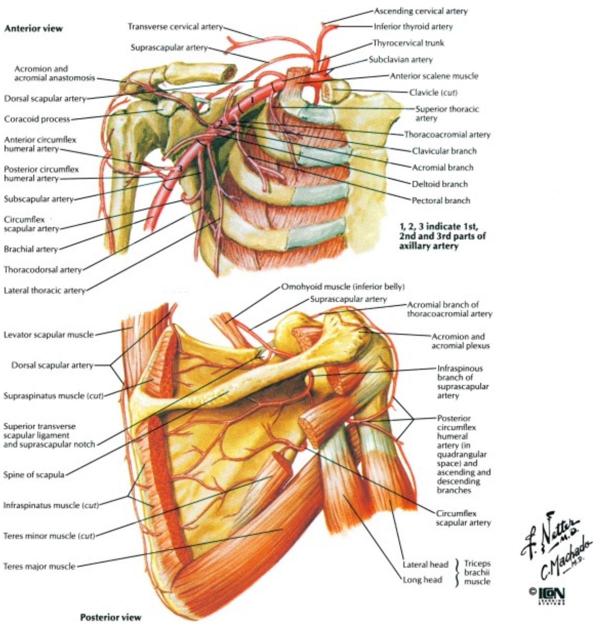
1. **Spinal Accessory** (CN11,C1-C6): in posterior cervical triangle on levator scapulae			
Sensory: NONE			Motor: Trapezius, Sternocleidomastoid
CERVICAL PLEXUS			
2. **Supraclavicular**(C2-3): splits into 3: anterior middle, posterior branches			
Sensory: over clavicle, outer trap, deltoid			Motor: NONE
BRACHIAL PLEXUS			
SUPRACLAVICULAR [approach through posterior triangle]		INFRACLAVICULAR [approach through axilla]	
		LATERAL CORD	
ROOTS		•Lateral root to Median nerve	
3.**Dorsal Scapular** (C3, 4, 5): pierces middle scalene, deep to Levator		7. **LateralPectoral**(C5-7):named for cord,runs with pectoral artery	
		Sensory:	NONE
	Scapulae	Motor:	Pectoralis Major
Sensory:	NONE		Pectoralis Minor
Motor:	Levator scapulae	**MEDIAL CORD**	
	Rhomboid Minor and Major	•Medial root to Median nerve	
4.**Long Thoracic**(C5-7): on anterior surface of Serratus Anterior. Runs with lateral thoracicartery		8. **MedialPectoral**(C8-T1): named for cord	
		Sensory:	NONE
		Motor:	Pectoralis Minor
Sensory:	NONE		Pectoralis Major (overlying muscle]
Motor:	Serratus Anterior	**POSTERIOR CORD**	
UPPER TRUNK		9. **UpperSubscapular**(C5-6)	
5.**Suprascapular**(C5-6): **thru scapular notch, under ligament**		Sensory:	NONE
		Motor:	Subscapularis [upper portion]
Sensory:	Shoulder joint	10. **LowerSubscapular**(C5-6)	

Motor:	Supraspinatus	Sensory:	NONE
	Infraspinatus	Motor:	Subscapularis [lower portion]
6.**Nerve to Subclavius** (C5-6): descends anterior to plexus, posterior to clavicle			Teres major
		11. **Thoracodorsal**(C7-8): runs with thoracodorsal artery	
		Sensory:	NONE
Sensory:	NONE	Motor:	Latissimus dorsi
Motor:	Subclavius	12. **Axillary**(C5-6):**with posterior circumflex humeral arterythrough Quadranglar space. Injured in Anterior dislocations, or proximal humerus fractures**	
		Sensory:	Lateral upper arm: via Superior Lateral Cutaneous Nerve of arm
		Motor:	Deltoid: via deep branch
			Teres minor: via superficial branch





ARTERIES



TRUNK	BRANCH	COURSE/COMMENT
Thyrocervical Trunk	Suprascapular	Over superior transverse scapular ligament.
	Infraspinatous branch	Bends around spine of scapula
Subclavian artery comes off: Left - aorta, Right - brachiocephalic. Then goes between anterior and middle scalene muscles with brachial plexus		
Subclavian Artery	Dorsal Scapular	Splits around levator scapulae; descends medial to scapula
Parts determined by pectoralis minor. Part I of the axillaryartery has 1 branch, Part II has 2 branches, Part III has 3 branches		
Axillary (Part I)	Superior thoracic	To serratus anterior and pectoralis muscles
Axillary (Part II)	Thoracoacromial	
	Clavicular branch	
	Acromial branch	
	Deltoid branch	Courses with basilic vein
	Pectoral branch	
	Lateral thoracic	To serratus anterior with Long Thoracic nerve.
Axillary (Part III)	Subscapular	

	Circumflex scapular	Seen posteriorly in Triangular space
	Thoracodorsal	Follows Thoracodorsalnerve
	Anterior circumflex	Supplies humeral head (anterior humerus)
	Posterior circumflex	**Seen posteriorly in Quadrangular space. Injury in proximal humeral fracture.**

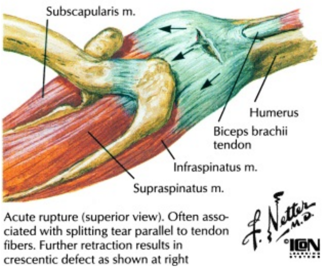
Thompson: Netter's Concise Atlas of Orthopaedic Anatomy, 1st ed.

DISORDERS

DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
ADHESIVE CAPSULITIS (FROZEN SHOULDER)			
•Inflammatoryprocess; leads to joint fibrosis	Hx: Middle age women, DM Slow onset: pain/stiffness	XR: Usually normal	1.NSAIDs
		Arthrogram: **decreased joint volume**.	2.Physical therapy and home therapy program (3 month minimum)
•3 stages: 1. Pain, 2. Stiffness3. Resolving;	PE: **Decreased active ROM passive ROM**		
•Associated with old Colles fracture			
ARTHRITIS:ACROMIOCLAVICULAR (AC) JOINT			
•Usually osteoarthritis	Hx: Pain at AC, esp. with motion	XR: Osteophytes, joint narrowing	1.NSAIDs, rest
			2.Distal clavicle resection (Mumford)
	PE: Tender to palpation		
ARTHRITIS:GLENOHUMORAL JOINT			
•Multiple etiologies: OA, RA, post-traumatic	Hx: Older, pain increases with activity	XR: True AP,axillary lateral: joint space narrowed	1. NSAIDs, ice/heat, ROM steroid inject controversial
•Often overuse condition	PE:+/- wasting, crepitus, decreased AROM		2.Refractory: hemi vs.total joint arthroscopy
BICEPS TENDINITIS			
•Associated with impinge- ment or subluxation/transverse humeral ligament tear	Hx : Pain in shoulder	XR: Normal views: usually normal	1.Treat the impingement
	PE: Tenderness along groove		2.Biceps strengthening
	+Speed, + Yergason		3.Tenodesis (rare procedure)
BICEPS TENDON RUPTURE			
•Long Head of biceps rupture	Hx: Old, or young weight lifter, sudden pain	XR: Normal; rule out fracture	1.Old: conservative treatment
		Arthrogram: rule out RC tear	2.Young/laborer: surgery
•Due to impingement, micro- trauma or trauma	PE: Proximal arm bulge (Popeye arm)		
•Associated with RC tear			
BRACHIAL PLEXUS INJURY			
•Traction of brachial plexus	Hx: Football players, parathesias in	XR: Shoulder series: normal	Most resolve with rest

	arm		
BURSITIS:SUBACROMIAL			
•Often from impingement	Hx/PE: Pain at shoulder		Treat the impingement
IMPINGEMENT			
•RC (supraspinatus), Biceps tendon trapped under acromion or coracoacromial ligament	Hx: Older, or athlete. Pain/inability to do overhead activity.	XR: Normal views +**outlet view**: type III acromion or subacromial spur	**1.** Decrease/modify activity **2.** NSAID, ROM, strengthen **3.** Corticosteroid injection **4.** Subacromial decompression
•Associated with Type III acromion	PE: +Neer,+Hawkins		
INSTABILITY/DISLOCATION: GLENOHUMORAL JOINT TWO TYPES			
1. TUBS [Trauma Unilateral Bankart lesion, Surgery]	Hx:Pain, "arm slips out" TUBS history	XR: Trauma (+/- Stryker) Bankart/Hill Sachs lesion	1. Reduce (if dislocated): 3 ways. Immobilize in IR for 4 weeks, RC strengthening, then ROM
•90% anterior (posterior after seizure)	PE: +PE for unilateral instability (e.g. +	Axillary nerve injury (esp. with anterior)	
•Pts 20yrs: 80% recur	Apprehension, relocation)		2. Surgical repair for recurrence (notin posterior)
2. AMBRI **A**traumatic **M**ulti- directional, **B**ilateral, **R**ehab responsive, **I**nferior capsule repair	Hx: Pain, "arms slip out" + AMBRI history	XR: Trauma series	1. Reduce if dislocated: 3 ways2. Long term conservative treatment
	PE: +sulcus, general joint laxity in MDI		3. Life style modifications

Rotator Cuff Tear



Acute rupture (superior view). Often associated with splitting tear parallel to tendon fibers. Further retraction results in crescentic defect as shown at right

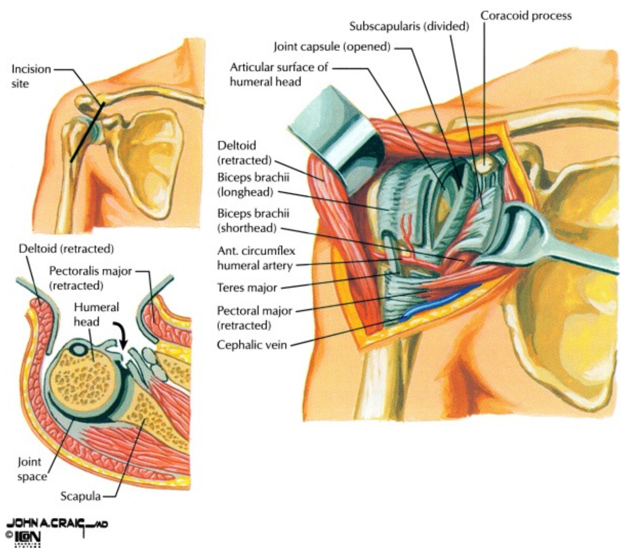
Communication between shoulder joint and subdeltoid bursa is pathognomonic of cuff tear

DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
INSTABILITY/DISLOCATION:STERNOCLAVICULAR JOINT			
•Tear of capsule	Hx: Large force: sports/MVA, pain (anterior: ant prominence, posterior: +/- pulm,	XR: May not show injury	Anterior: sling/closed reduction

	GI)		
•Most anterior; Posterior rare, has increased Complications (great vessels)		CT: Helpful in diagnosis	Posterior: early closed reduction immobilize, PT
LABRUM INJURY (SLAP LESION)			
Bicep tendon attachment injury I. Bicep fraying/anchor intact II.Tear in anchor (labrum) III. Bucket handle tear IV.III 1tear in bicep	Hx: Pain, 1/2instability symptoms PE: 1 O'Brien test	XR: Shoulder series MR/Arthroscopy to diagnose SLAP lesion	By type: I . Debridement II. Reattachment III.Debridement IV.Repair vs. tenodesis
LONG THORACIC NERVE INJURY			
•Nerve injuryresults in serratus anterior dysfunction	Hx: Usually trauma PE: Winged scapula	NONE	Conservative treatment, most resolve within weeks/ months
OSTEOLYSIS			
•Often in weight-lifters	Hx: Pain in shoulder	XR: Distal clavicle lucency	1.Activity modification.
			2.Mumford
PECTORALIS MAJOR RUPTURE			
•Maximal eccentric contraction	Hx/PE: Sudden, pain, palpable defect	NONE	Surgical repair
ROTATAR CUFF TEAR			
•Due to poor vascularity, overuse, micro or macro trauma, degeneration, or abnormal acromion	Hx: Older; pain is deep at night, worse with overhead activity	XR: Trauma series: high-riding humerus	1.Conservative: NSAID, rest, activity modification, ROM, RC strengthening
•Supraspinatus most common	PE: Atrophy,decreased AROM, normal PROM, + drop arm/empty can, +lift off (subscapular tear)	Arthrogram (or MR/Arthrogram): Gold standard: shows communication with subdeltoid bursa	2.Surgical repair with subacromial decompression for complete tears
THORACIC OUTLET SYNDROME			
•Compression of neuro- vascular structure (vein, artery, or plexus) between first rib and scalene muscle•Also seen with cervical ribs	Hx: Women 20-50 yo. Worse with overhead activity Vein: edema, discolor,stiff Artery: cool, claudication Plexus: parathesias	XR: Shoulder usually normalC-spine: Rule out massCXR: Rule out mass	1. Activity modification (until symptoms resolve)2. Posture training3. Surgery: especially for a cervical rib
	PE: +Adson, +Roos tests		

SURGICAL APPROACHES

Deltopectoral Approach to Shoulder Joint



USES	INTERNERVOUS PLANE	DANGERS	COMMENT
ANTERIOR (DELTOPECTORAL) APPROACH (HENRY)			
1.Shoulder reconstruction	1.Deltoid [Axillary]	1.Musculocutaneous nerve	1.Keep arm adducted to avoid bringing brachial plexus into the field.
2.Biceps tendon repair.	2.Pectoralis major [lat/med pectoral]	2.Cephalic vein	
3.Arthroplasty		3.Axillary nerve	
			2.Keep dissection to lateral side of coracobrachialis: protect MC nerve.
ARTHROSCOPY PORTALS			
1.Anterior	“Soft spot” between biceps tendon, anterior glenoid, superior edge of subscapular tendon	1.Musculocutaneous nerve	1.Usually placed AFTER the posterior portal
		2.Cephalic vein	
		3.Axillary nerve	
2.Posterior	“Soft spot”between teres minor and infraspinatus	1.Superior AC ligament	1.Primary portal for shoulder
		2.RC tendons	2.Aim to coracoid when placing

3.Lateral	Through deltoid	1.Axillary nerve	1.To access subacromial space

CHAPTER 3 - ARM

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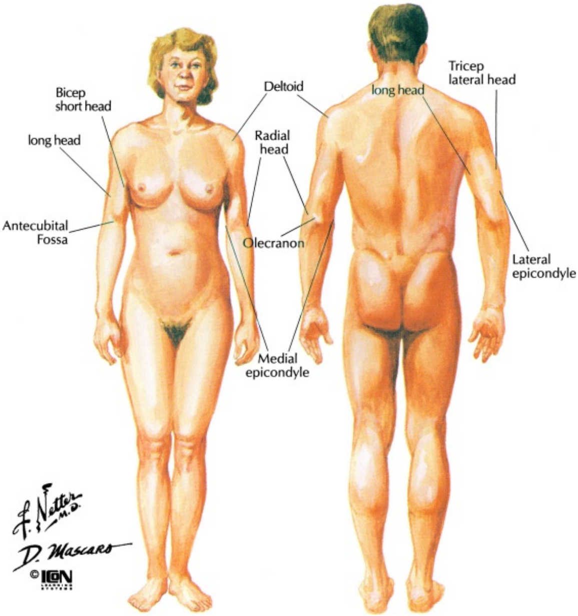
CHAPTER 3 – ARM

TOPOGRAPHIC ANATOMY



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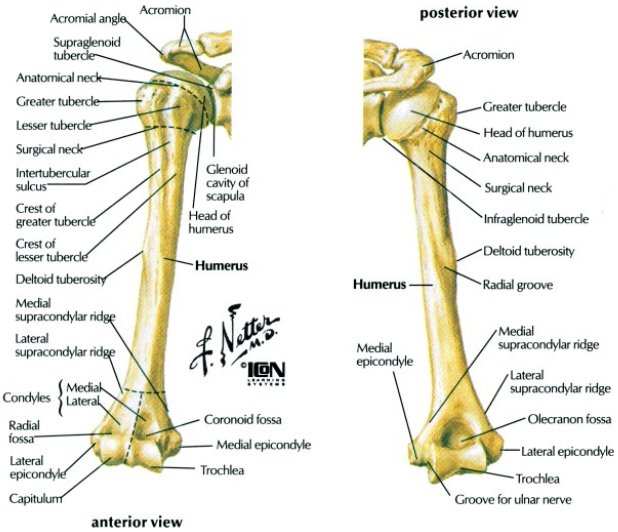
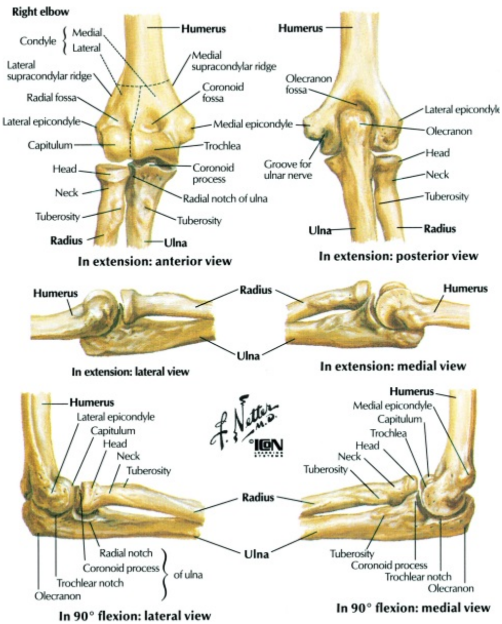
OSTEOLOGY





CHARACTERISTICS	OSSIFY		FUSE	COMMENT
		HUMERUS		
• Long bone characteristics	Primary: Shaft	8-9th wk (fetal)	By birth	• Surgical neck: common fracture site
• Lateral condyle				• Blood supply
1. Epicondyle: non-articular	Secondary Proximal (3):			Proximal: Anterior/Posterior circumflex
2. Capitellum: articular	1. Head		17-20 yrs	Middle: Nutrient artery (from Deep artery)
• Medial condyle	2. Tuberosities (2)	Birth		
1. Epicondyle: non-articular		3-5 yrs		Distal: Branches from anastomosis
2. Trochlea: articular				• Elbow ossification order: Capitellum, Radial head, Medial epicondyle, Trochlea, Olecranon, Lateral epicondyle (**C**aptain **R**oy **M**akes **T**rouble **O**n **L**eave)
3. Cubital tunnel: covered with Osbourne's fascia.	Distal (4):			
	1. Capitellum	1 yr		
	2. Medial epicondyle	4-6 yr	13-14 yrs	
	3. Trochlea	9-10 yr		
	4. Lateral epicondyle	12 yr	15-20 yrs	

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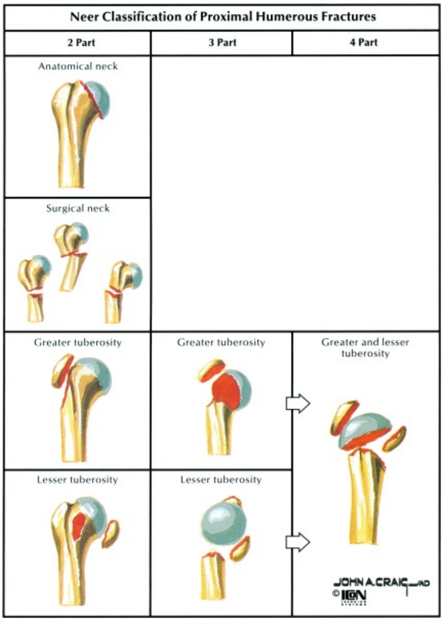
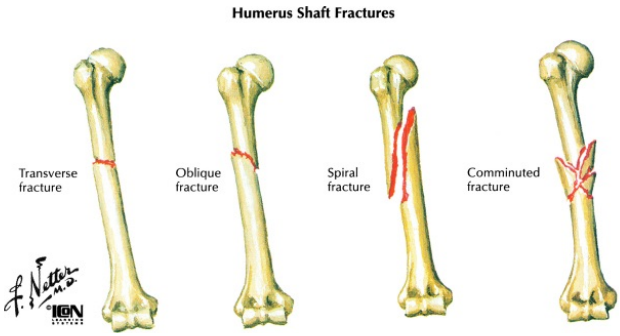
TRAUMA



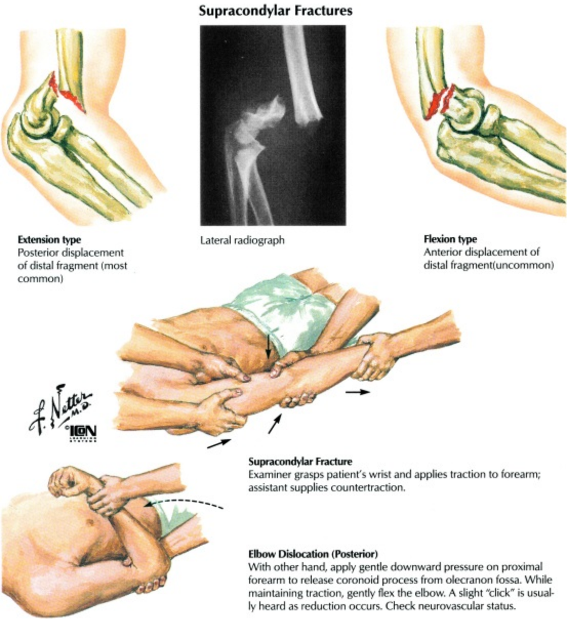
DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
PROXIMAL HUMERUS FRACTURE			
• Common fracture	HX: Fall/trauma. Pain worse with movement	Neer: based on number of fragments(parts) 1-4	1 part: sling, early motion.
• Osteoporosis, elderly, female	PE: Swelling, ecchymosis, good neurovascular exam	Multiple combinations of fractures possible	2 part: closed reduction splint. Irreducible, intraarticular anatomic neck fx: ORIF. Greater tuberosity fx: ORIF and Rotator Cuff repair
• Mechanism:			
1. Elderly: fall on outstretched hand	XR: Trauma series	Also fracture dislocation, and intraarticular fx	3 4 part : ORIF or hemiarthroplasty (elderly)
	CT: shows intraarticular glenoid involvement		
2. Young: high energy trauma (e.g. MVA, fall)	MR: sensitive for AVN	4 parts: head, shaft, greater and lesser tuberosities	Fracture/Dislocation:
• 80% non or minimally displaced (1 part fx)		Each part: 1cm displaced or 45° angulated	2 part: closed treatment except when displaced
• Most heal well			3-4 part: ORIF or hemiarthorplasty

• Early pendulum motion is key for full ROM		Fragment displacement due to attached muscle	Intraarticular: ORIF or hemiarthroplasty
COMPLICATIONS: Stiffness/adhesive capsulitis; Avascular necrosis (AVN):4 part anatomic neck, axillary nerve and brachial plexus injury; axillary artery injury, nonunion			



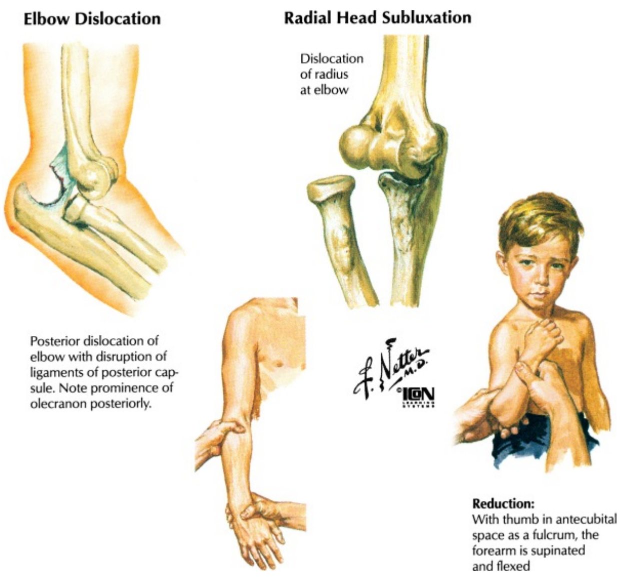
DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
HUMERUS SHAFT FRACTURE			
• Common fracture	HX: Trauma, fall. Severe pain, swelling	Descriptive:	Closed: Most fractures: coaptation splint or fracture brace for 6-8 weeks
• Mechanism: direct blow or fall on outstretched arm	PE: Swelling, deformity + / - radial nerve findings	Location: level of humerus	Open Neurovascular injury, multitrauma, pathologic fracture. Severe comminution requires plates/screws or intermedullary (IM) nail
• Displacement based on fracture site relation to deltoid pectoralis major insertion	XR: AP lateral arm, shoulder and elbow series	Pattern: oblique, spiral, transverse	
• Almost 100% union		Displacement or comminution	
• Site of pathologic fx			
COMPLICATIONS: Radial nerve injury (esp. Holstein/Lewis fracture, spiral fracture of distal third) most resolve. Malunion is rare.			
DISTAL HUMERUS FRACTURE			
• Uncommon	HX: Pain, deformity, discoloration, swelling	Displaced vs. nondisplaced	Early motion important to avoid loss of motion
• High morbidity	PE: Swelling, ecchymosis crepitus, tenderness, good neurovascular exam	Multiple types:	Intercondylar: ORIF or total joint arthroplasty (closed treatment if comminuted or elderly)
• Often intraarticular	XR: AP lateral: posterior fat pad/sail sign	Intercondylar	Transcondylar: reduce, percutaneous pinning
• Mechanism: fall onto hand, ulna forced into humerus	CT: Optional: useful in pre-operative planning	Transcondylar	Others:

• Intercondylar most common in adults		Supracondylar	Nondisplaced: closed treatment; 10-14 days and early motion.
• Condylar, capitellum, Trochlea, Epicondylar all rare		Condylar	Displaced or comminuted (or elderly) require ORIF
		Capitellum	
		Trochlea	
		Epicondylar (medial or lateral)	
COMPLICATIONS: Stiffness/arthritis; Compartment syndrome; Median/Ulnar nerve injury; Brachial artery injury; Nonunion			



DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
SUPRACONDYLAR FRACTURE			
• Common childhood fracture	HX: Fall. Pain, swelling, will not use arm.	Extension (common): Undisplaced Partially displaced Fully displaced	Neurovascularly intact: closed reduction and percutaneous pinning under general anesthesia (fluoroscopy)
•Occurs at metaphysis, above growth plate	PE: Swelling, point tenderness, + / - neurovascular signs: check distal pulses do neurologic exam	Flexion (rare)	Pulseless/Perfused: same
• Extension type			

most common(90%): shaft is anterior, distal fragment is posterior	XR: AP lateral (note capitellum position to anterior humeral line)		Pulseless/Unperfused: open reduction exploration
• Associated with signifcant morbidity; prompt treatment essential.	Arteriogram: if pulseless		
COMPLICATIONS: Neurovascular injury: brachial artery; AIN injury; Compartment syndrome can lead to Volkmann's ischemic contracture; Deformity: cubitus varus			



DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
ELBOW DISLOCATION			
• Common in children and young adults	HX: Fall/trauma. Pain, inability to flex elbow	Location of ulna (radius) Posterior (common) Posterolateral (90%) Anterior Lateral Medial	Closed reduction: + / - local anesthesia and/or conscious sedation
• Younger, sports related fall on hand	PE: Deformity, tenderness, + / - neurovascular signs. Check distal pulses neurologic exam		Splint 7days for comfort, then early ROM
• Associated with radial head fracture, brachial artery, median	XR: AP lateral: rule out fracture		Open: if unstable or with entrapped

artery, median nerve injury			bone or soft tissue
• Both collateral ligaments ruptured			
		Divergent (ulna and radius opposite)	
COMPLICATIONS Neurovascular injury: brachial artery; median or ulnar nerve; Loss of extension; Instability/redislocation; Heterotopic ossification			
RADIAL HEAD SUBLUXATION (NURSEMAID'S ELBOW)			
• Common in children Usually ages 2-4, 7 rare	Hx: Pulled by hand, child will not use arm.	NONE	Reduce: with gentle, full supination and flexion (should feel it “pop” in).
• Mechanism: child pulled or swung by hand or forearm	PE: Arm held pronated/flexed. Radial head supination tender.		Immobilize a recurrence
• Annular ligament stretches, radial head lodges within it.	XR: only if suspect fracture		
COMPLICATIONS: Recurrence			

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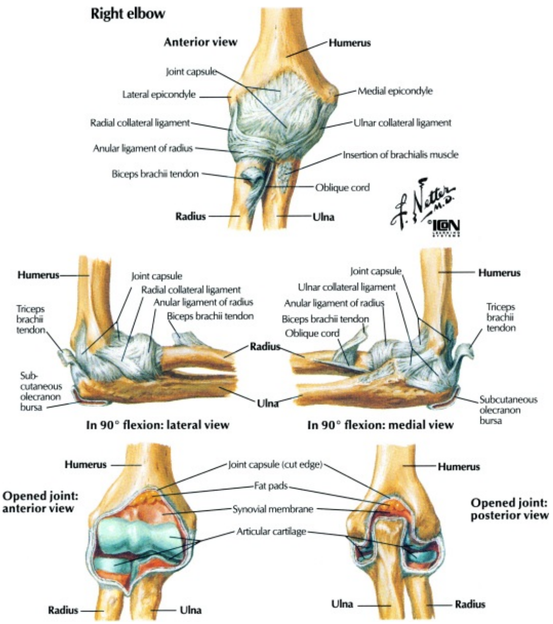
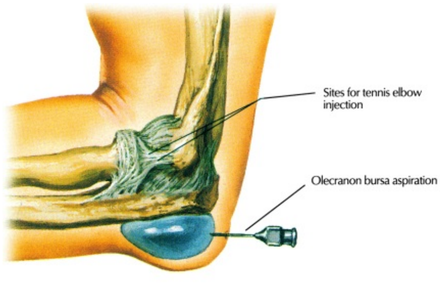
ELBOW JOINTS



JOINT	TYPE	ARTICULATION	LIGAMENTS	COMMENTS
ELBOW		Includes 3 joints	Capsule (common to all 3)	Carrying angle: 10-15°valgus
Ulnohumeral "Trochlear joint"	Ginglymus [Hinge]	Trochlea and trochlear notch	Ulnar(medial) collateral: 1. Anterior band 2. Posterior band 3. Transverse band	Torn in posterior dislocation Strongest: resists valgus stress
Radiohumeral	Trochoid [Pivot]	Capitellum radial head	Radial (lateral) collateral 1. Ulnar part 2. Radial part	Weak Gives posterolateral stability
Proximal radioulnar		Radial head radial notch	Annular	Keeps head in radial notch
			Oblique cord	
			Quadrate	Supports rotary movements

MINOR PROCEDURES



STEPS

ELBOW ARTHROCENTESIS

1. Extend elbow, palpate lateral condyle, radial head and olecranon laterally; feel triangular sulcus between all three
2. Prepare skin over sulcus (iodine/antiseptic soap)
3. Anesthetize skin locally (quarter size spot)
4. May keep arm in extension or flex it. Insert needle in the “triangle” between bony landmarks
5. Fluid should aspirate easily
6. Dress injection site

OLECRANON BURSA ASPIRATION

1. Prepare skin over olecranon (iodine/antiseptic soap)
2. Anesthetize skin locally (quarter size spot)
3. Insert 18 gauge needle into bursa and aspirate fluid.
4. If suspicious of infection, send fluid for Gram stain and culture
5. Dress injection site

TENNIS ELBOW INJECTION

1. Ask patient about allergies
2. Flex elbow 90°, palpate ERCB distal to lateral epicondyle.
3. Prepare skin over lateral elbow (iodine/antiseptic soap)
4. Anesthetize skin locally (quarter size spot)

5. Insert 22 gauge or smaller needle into ERCB tendon at its insertion just distal to the lateral epicondyle. Aspirate to ensure needle is not in a vessel, then inject 2-3ml of 1:1 local/corticosteroid preparation.
6. Dress insertion site
7. Annotate improvement in symptoms

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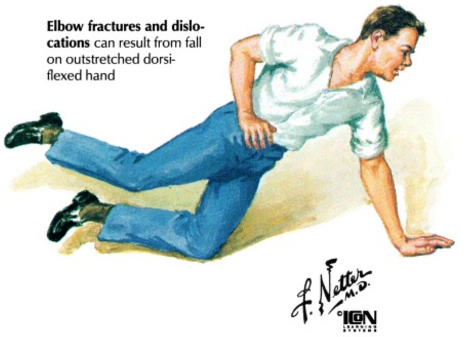
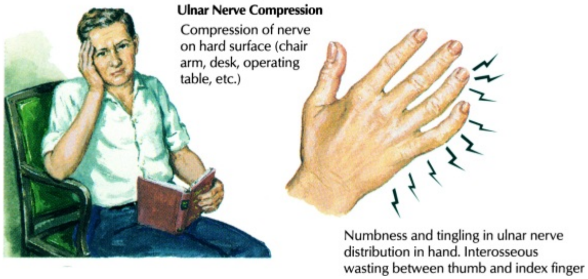
HISTORY





QUESTION	ANSWER	CLINICAL APPLICATION
1. AGE	Young	Dislocation, fracture
	Middle age, elderly	Tennis elbow (epicondylitis), arthritis
2. PAIN		
a. Onset	Acute	Dislocation, fracture, tendon avulsion/rupture, ligament injury
	Chronic	Cervical spine pathology
b. Location	Anterior	Biceps tendon rupture, arthritis
	Posterior	Olecranon bursitis
	Lateral	Lateral epicondylitis, fracture (especially radial head-hard to see on x-ray)
	Medial	Medial epicondylitis, nerve entrapment, fracture, MCL strain
c. Occurrence	Night pain/at rest	Infection, tumor
	With activity	Ligamentous and/or tendinous etiology
3. STIFFNESS	Without locking	Arthritis, effusions (trauma)
	With locking	Loose body, Lateral collateral ligament injury
4. SWELLING	Over olecranon	Olecranon bursitis. Other: dislocation, fracture, gout

5. TRAUMA	Fall on elbow, hand	Dislocation, fracture
6. ACTIVITY	Sports, repetitive motion	Epicondylitis, ulnar nerve palsy
7. NEUROLOGIC SYMPTOMS	Pain, numbness, tingling	Nerve entrapments (multiple possible sites), cervical spine pathology, thoracic outlet syndrome
8. HISTORY OF ARTHRITIDES	Multiple joints involved	Lupus, rheumatoid arthritis, psoriasis

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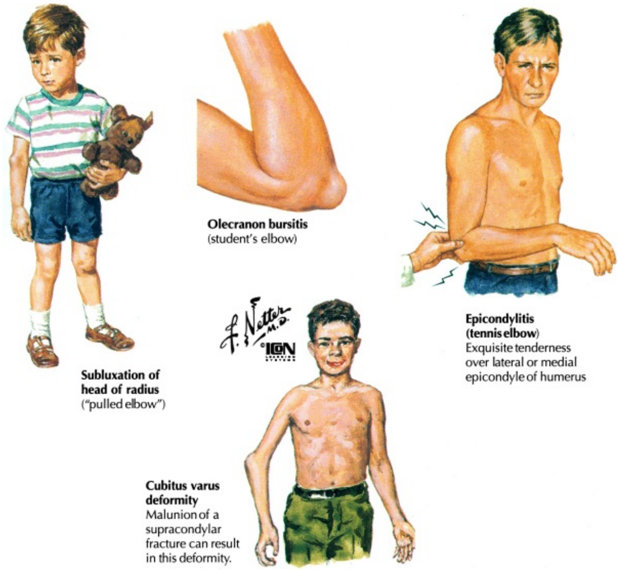
PHYSICAL EXAM



EXAM/OBSERVATION	TECHNIQUE	CLINICAL APPLICATION
	INSPECTION	
Gross deformity, swelling	Compare both sides	Dislocation, fracture, bursitis
Carrying angle (normal 5-15°)	Negative (5 degrees)	Cubitus varus: physeal damage (e.g. malunion supracondylar fracture)
	Positive (15 degrees)	Cubitus valgus: physeal damage (e.g. lateral epicondyle fracture)
	PALPATION	
Medial	Epicondyle supracondylar line	Pain: medial epicondylitis (Golfer's elbow), fracture, MCL rupture
	Ulnar nerve in ulnar groove	Parathesias indicate ulnar nerve entrapment
Lateral	Epicondyle supracondylar line	Pain: lateral epicondylitis (Tennis elbow), fracture
	Radial head	Pain: arthritis, fracture, synovitis
Anterior	Biceps tendon in antecubital fossa	Pain can indicate biceps tendon rupture
Posterior	Flex elbow: olecranon olecranon fossa	Olecranon bursitis, triceps tendon rupture

EXAM/OBSERVATION	TECHNIQUE	CLINICAL APPLICATION
	RANGE OF MOTION	
	Elbow at side, flex extend	Normal: 0-5° to 140-150°:

Flex and extend	Elbow at side, flex extend at elbow	Normal: 0-5° to 140-150°, note if PROM AROM
Pronate and supinate	Tuck elbows, pencils in fists, rotate wrist	Normal: supinate 90 degrees, pronate 80-90 degrees
NEUROVASCULAR		
Sensory	(LT, PP, 2 pt)	
Axillary nerve (C5)	Superolateral arm	Deficit indicates corresponding nerve/root lesion
Radial nerve (C5)	Inferolateral and posterior arm	Deficit indicates corresponding nerve/root lesion
Medial Cutaneous nerve of the Arm (T1)	Medial arm	Deficit indicates corresponding nerve/root lesion
Motor		
Musculocutaneous n. (C5-6)	Resisted elbow flexion	Weakness = Brachialis/biceps or corresponding nerve/root lesion.
Musculocutaneous n. (C6)	Resisted supination	Weakness = Biceps or corresponding nerve/root lesion.
Median nerve (C6)	Resisted pronation	Weakness = Pronator Teres or corresponding nerve/root lesion.
Median nerve (C7)	Resisted wrist flexion	Weakness = FCR or corresponding nerve/root lesion.
Radial nerve (C7)	Resisted elbow extension	Weakness = Triceps or corresponding nerve/root lesion.
Radial nerve/PIN (C6-7)	Resisted wrist extension	Weakness = ECRL-B/ECU or corresponding nerve/root lesion.
Ulnar nerve (C8)	Resisted wrist flexion	Weakness = FCU or corresponding nerve/root lesion.
Reflexes		
C5	Biceps	Hypoactive/absence indicates corresponding radiculopathy
C6	Brachioradialis	Hypoactive/absence indicates corresponding radiculopathy
C7	Triceps	Hypoactive/absence indicates corresponding radiculopathy
Pulses	Brachial, Radial, Ulnar	
SPECIAL TESTS		
Tennis Elbow	Make fist, pronate, extend wrist and fingers against resistance	Pain at lateral epicondyle suggests lateral epicondylitis
Golfer's Elbow	Supinate arm, extend wrist Elbow	Pain at medial epicondyle suggests medial epicondylitis
Ligament Instability	25° flexion, apply varus/valgus stress	Pain or laxity indicates LCL/MCL damage
Tinel's Sign (at the elbow)	Tap on ulnar groove (nerve)	Tingling in ulnar distribution indicates entrapment
Elbow Flexion	Maximal elbow flexion for	Tingling in ulnar distribution

Elbow Flexion	3-5min	indicates entrapment
Pinch Grip	Pinch tips of thumb and index finger	Inability (or pinching of pads, not tips) indicates AIN pathology

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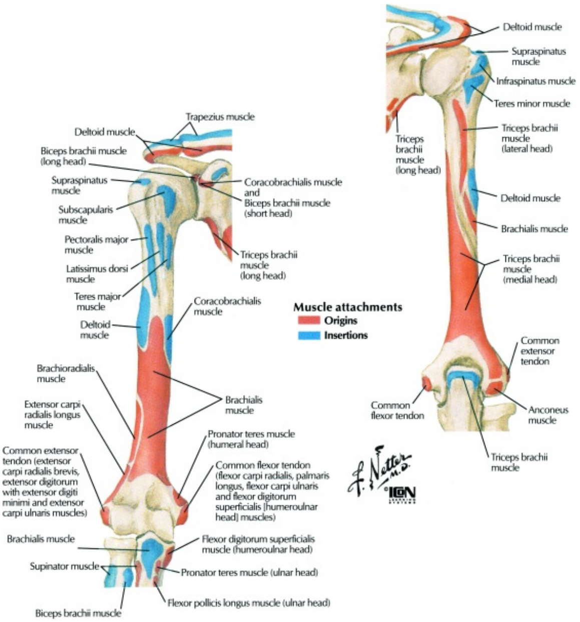
MUSCLES: INSERTIONS AND ORIGINS



CORACOID PROCESS	GREATER TUBEROSITY	ANTERIOR PROXIMAL HUMERUS	MEDIAL EPICONDYLE	LATERAL EPICONDYLE
ORIGINS	INSERTIONS	INSERTIONS	ORIGINS	ORIGINS
Biceps (SH)	Supraspinatus	Pectoralis major	Pronator Teres	Anconeus
Coracobrachialis	Infraspinatus	Latissimus dorsi	Common Flexor Tendon	Common Extensor Tendon
INSERTIONS	Teres minor	Teres major	[FCR, PL, FCU, FDS]	[ECRB, ED, EDM, ECU]
Pectoralis minor				

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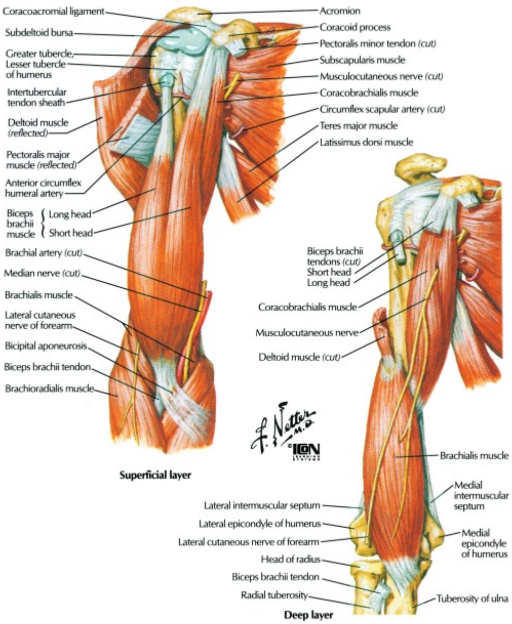
ANTERIOR MUSCLES



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Coracobrachialis	Coracoid process	Middle humerus	Musculocutaneous	Flex and adduct arm	
Brachialis	Distal anterior humerus	Ulnar tuberosity	Musculocutaneous	Flex forearm	Often split in anterior surgical approach
Biceps brachii					
Long Head	Supraglenoid tubercle	Radial tuberosity (proximal radius)	Musculocutaneous	Flex supinate forearm	Can rupture proximally-results in Popeye arm
Short Head	Coracoid process	Radial tuberosity (proximal radius)	Musculocutaneous	Flex supinate forearm	Covers brachial artery

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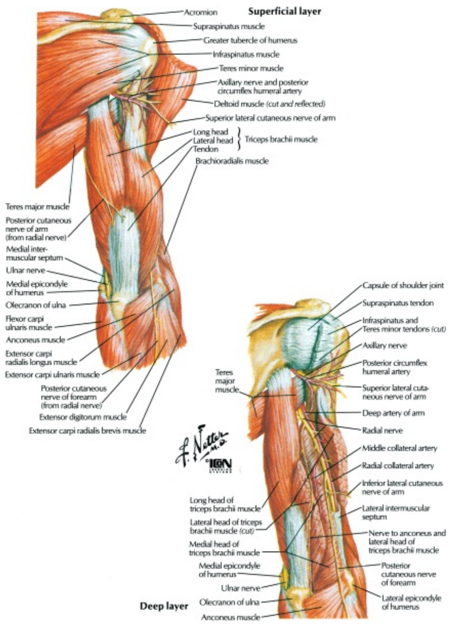
POSTERIOR MUSCLES



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Triceps Brachii					
Long Head	Infraglenoid tubercle	Olecranon (proximal)	Radial n.	Extends forearm	Border of quadrangular triangular space interval
Lateral Head	Posterior humerus (proximal)	Olecranon (proximal)	Radial n.	Extends forearm	Border in lateral approach
Medial Head	Posterior humerus (distal)	Olecranon (proximal)	Radial n.	Extends forearm	One muscular plane in posterior approach

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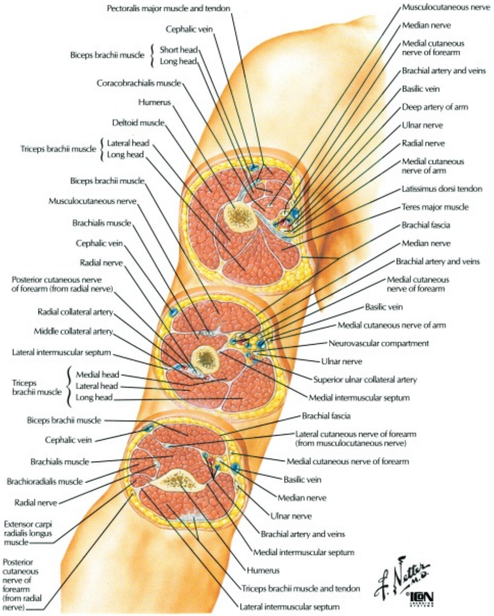
MUSCLES: CROSS SECTION



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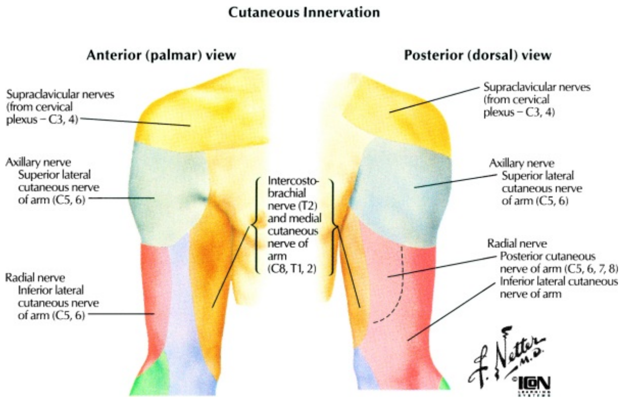
NERVES



INFRACLAVICULAR [approach through axilla]

LATERAL CORD

1. Musculocutaneous (C5-7): pierces coracobrachialis between bicep and brachialis. At risk for injury during anterior approach to shoulder.

Sensory:	NONE (in arm)
Motor:	ANTERIOR COMPARTMENT OF ARM
	Coracobrachialis
	Biceps brachii
	Brachialis

MEDIAL CORD

2. Medial Cutaneous Nerve of Arm (C8-T1): joins intercostal-brachial nerve

Sensory:	Medial (inner) arm
Motor:	NONE

3.*Ulnar* (C(7)8-T1): travels from anterior to posterior compartment via arcade of Struthers [*], then to cubital tunnel [*].

Sensory:	NONE (in arm)
Motor:	NONE (in arm)

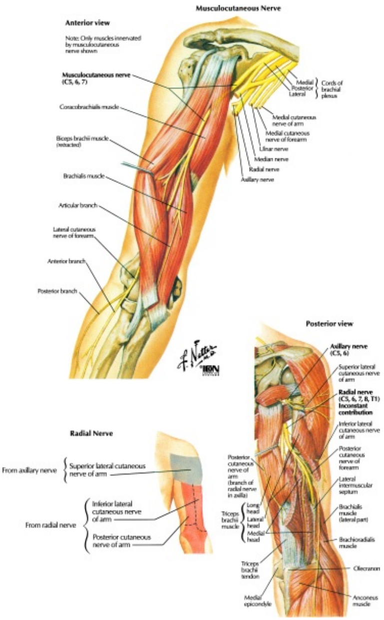
POSTERIOR CORD

4.*Radial* (C5-T1): runs with deep artery of arm in triangular interval, then spiral groove 15cm from elbow (injured in shaft fx; at risk in surgery), then it divides at the elbow: 1. PIN (motor), 2. superficial radial nerve (sensory)

Sensory:	Lateral arm: via Inferior Lateral Cutaneous Nerve of arm
	Posterior arm: via Posterior Cutaneous Nerve of arm
Motor:	POSTERIOR COMPARTMENT OF ARM
	Triceps [medial, long, lateral heads]

	Anconeus

* possible compression site



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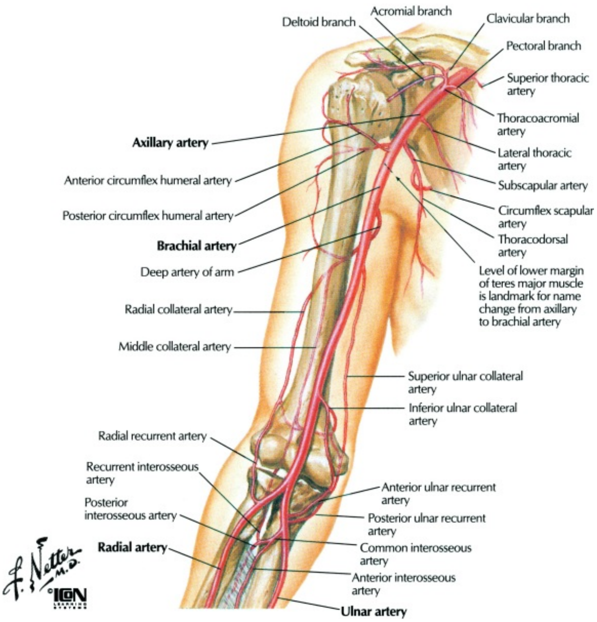
ARTERIES



ANASTOMOSES AROUND THE ELBOW	
SUPERIOR	INFERIOR
Superior Ulnar Collateral	Posterior Ulnar Recurrent
Inferior Ulnar Collateral	Anterior Ulnar Recurrent
Middle Collateral (branch of Deep Artery)	Interosseous Recurrent
Radial Collateral (branch of Deep Artery)	Radial Recurrent

TRUNK	BRANCH	COURSE/COMMENT
Brachial Artery	Continuation of axillary artery	Medial to biceps, runs with median nerve
	1. Deep artery of arm	Runs with radial nerve in radial groove (posterior humerus)
	2. Nutrient humeral artery	Enters nutrient canal
	3. Superior ulnar collateral	Branches in middle of arm, runs with ulnar nerve
		*Anastomosis with posterior ulnar collateral at elbow
	4. Inferior ulnar collateral	*Anastomosis with anterior ulnar collateral at elbow Brachial artery can be clamped below this branch: collateral circulation is usually sufficient.
	5. Muscular	

	5. Muscular branches	Variable, usually branch laterally
	6. Radial artery	These are the two terminal branches of Brachial artery, it divides in the cubital fossa.
	7. Ulnar artery	
Deep Artery of arm	Radial collateral	*Anastomosis with Radial recurrent artery at elbow
	Middle collateral	*Anastomosis with Recurrent interosseous artery at elbow
***Radial* Artery**	Radial Recurrent	*Anastomosis with radial collateral artery at elbow
***Ulnar* Artery**	Anterior ulnar recurrent	*Anastomosis with inferior ulnar collateral artery at elbow
	Posterior ulnar recurrent	*Anastomosis with superior ulnar collateral artery at elbow
	Common interosseous artery Recurrent interosseous artery	
		*Anastomosis with middle collateral artery at elbow
Collateral branches are all superior branches, recurrent branches are all inferior branches of the anastomosis at the elbow		

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DISORDERS

DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
ARTHRITIS			
• Uncommon condition	Hx: Chronic pain stiffness	XR: OA vs. inflammatory	1. Conservative (rest, NSAID)
• Osteoarthritis seen in athletes	PE: Decreased ROM tenderness	Blood: RF, ESR, ANA	2. Debridement
• Site for arthritides		Joint fluid: crystals, cells, culture	3. Joint replacement
BICEPS TENDON RUPTURE			
• Trauma: forced elbow flexion against resistance	Hx: Acute onset of pain	XR: usually normal	Surgical reattachment
• Rare (proximal distal)	PE: Decreased or absent elbow flexion		
CUBITAL TUNNEL SYNDROME			
• Trauma or stretching of ulnar nerve in cubital tunnel	Hx: Numbness/tingling (+ / - pain) in ulnar distribution	XR: Usually negative	1. Rest, ice, NSAID
• Occurs near FCU origin	PE: + / - decreased grip strength, Tinel's and/or elbow flexion test	Nerve conduction: gives objective data, but often not necessary	2. Splints (day and/or night)
• Can also be trapped at arcade of Struthers			3. Casting
			4. Nerve decompression and transposition
LATERAL EPICONDYLITIS (Tennis Elbow)			
• Degeneration of common extensor tendons (esp. ECRB)	Hx: Age 30-60, chronic pain at lateral elbow, worse with wrist finger extension	XR: Rule out fracture OA. Calcification of tendons can occur (esp. ECRB)	1. Activity modification, ice, NSAIDs
• Due to overuse (e.g. tennis) or injury (microtrauma)	PE: +Tennis elbow test		2. Use of brace or strap
			3. Stretching/strengthening
			4. Corticosteroid injection
			5. Surgical release of tendon
LCL SPRAIN			
• Rare condition	Hx: + / - catching and locking	XR: Usually negative	Conservative unless recurrent subluxation, then surgical reconstruction
	PE: + instability with varus stress, + posterolateral (pivot shift) drawer		

MCL SPRAIN			
• Due to single traumatic or repetitive valgus stress	Hx: Young, throwing athletes, chronic pain or acute onset of pain at MCL, + / - “pop”	XR: occasional spur; rule out fracture (+ / - stress view)	Grade I II: conservative (rest, ice, NSAID)
• Usual mechanism: throwing	PE: + / - instability with valgus stress	MRI: before surgery	Grade III (complete tear): surgical repair (use PL)
• Anterior Band is affected			
MEDIAL EPICONDYLITIS (Golfer's Elbow)			
• Degeneration of pronator/ flexor group (PT FCR)	Hx: Medial elbow pain	XR: Rule out fracture OA. Calcification of tendons can occur	Same as Tennis elbow
• Due to injury or overuse	PE: Focal medial epicondyle tenderness, + Golfer's elbow test		Surgery is less effective than for lateral epicondylitis
OLECRANON BURSITIS			
• Inflammation of bursa (Infection/trauma/other)	Hx: Swelling, acute or chronic	Aspirate bursa: send purulent fluid for culture and Gram stain	1. Compressive dressing
	PE: Palpable mass at olecranon		2. Reaspirate if recurs
			3. Corticosteroid injection
OSTEOCHONDRITIS DISSECANS OF ELBOW: OCD			
• Repetitive valgus stresses (e.g. throwing or gymnastics)	Hx: Young, active (thrower or gymnast), lateral elbow pain	XR: lucency and/or loose body	Type I (fragment stable): Ice, discontinue activity, NSAID
• Vascular compromise and microtrauma of capitellum	PE: + / - catching and/or locking, crepitus with pronation and supination	CT/MRI: determine articular and subchondral involvement	Type II-III (loose fragment): Drill or curette fragment
TRICEPS TENDON RUPTURE			
• Trauma: forced elbow extension against resistance	Hx: Pain in posterior elbow	XR: usually normal	Surgical reattachment
	PE: Loss of active elbow extension		

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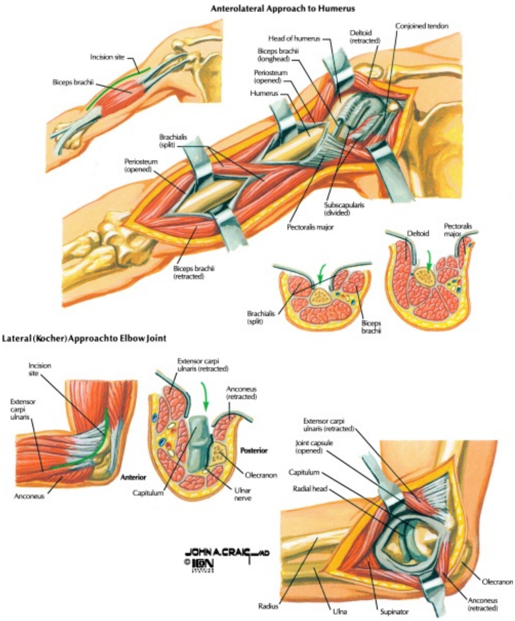
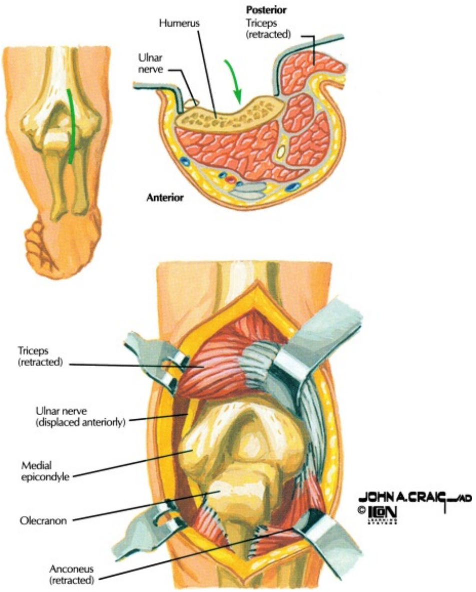
SURGICAL APPROACHES



USES	INTERNERVOUS PLANES	DANGERS	COMMENT
HUMERUS: ANTERIOR APPROACH			
1. ORIF of fractures	Proximal 1. Deltoid [Axillary] 2. Pectoralis Major [Pectoral]	Proximal 1. Axillary nerve 2. Humeral circumflex artery	• Anterior humeral circumflex artery may need ligation.
2. Bone biopsy or tumor removal.			• The brachialis has a split innervation which can be used for an internervous plane.
	Distal 1. Brachialis splitting Lateral [Radial] Medial [MC]	Distal 1. Radial nerve	
ELBOW: LATERAL APPROACH (KOCHER)			
Most radial head procedures	1. Anconeus [Radial]	1. PIN	• Protect PIN: stay above annular ligament; keep forearm pronated
	2. ECU [PIN]	2. Radial nerve	

Posterior Approach to Elbow Joint



USES	INTERNERVOUS PLANES	DANGERS	COMMENT
ELBOW: POSTERIOR APPROACH (BRYAN/MORREY)			
1. Arthroplasty 2. Distal humerus and olecranon fractures 3. Loose body removal	No planes	Ulnar nerve	• Triceps is detached from the olecranon. • MCL release may be necessary.

CHAPTER 4 - FOREARM

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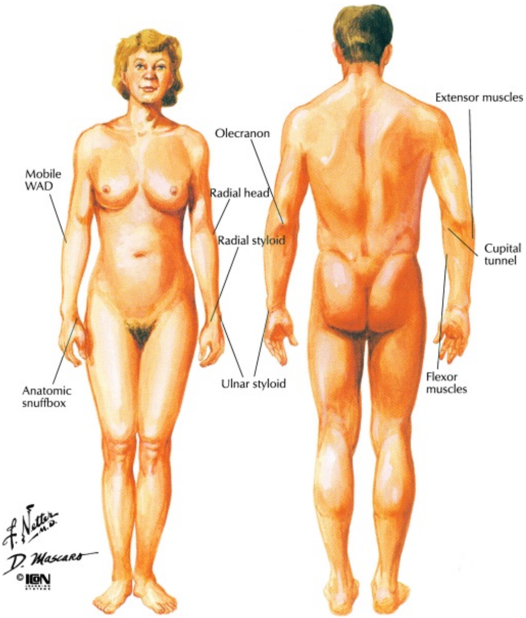
CHAPTER 4 – FOREARM

TOPOGRAPHIC ANATOMY



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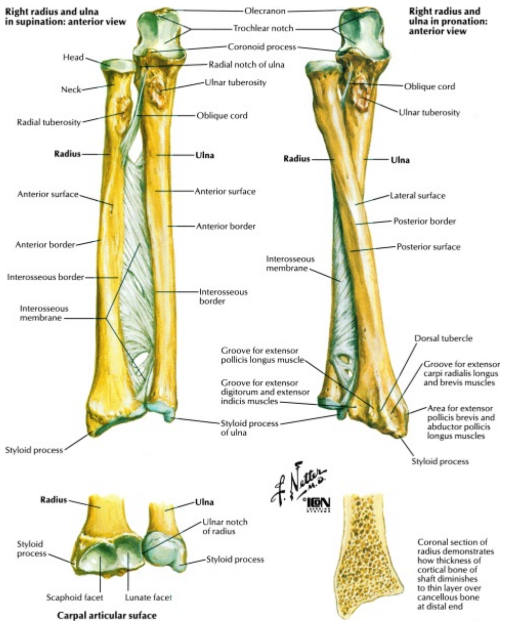
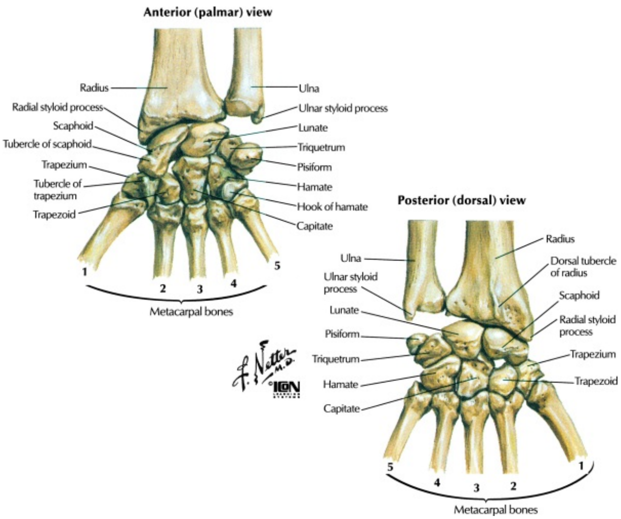
OSTEOLOGY OF THE FOREARM



CHARACTERISTICS	OSSIFY		FUSE	COMMENT
RADIUS				
• Cylindrical long bone • Head within elbow joint • Tuberosity outside joint • Palpate head laterally • Styloid is distal	Primary: Shaft Secondary 1. Proximal epiphysis 2. Distal epiphysis	8-9 weeks (fetal) 1-9 years	14-21 years	• Elbow ossification: used to determine bone age in peds • Elbow ossification order: Capitellum, Radial head, Medial epicondyle, Trochlea, Olecranon, Lateral Epicondyle (**Captain Roy Makes Trouble On Leave**)
ULNA				
• Cylindrical long bone Olecranon	Primary: Shaft	8-9 weeks		Olecranon

• Olecranon palpable posteriorly at elbow • Styloid process distally	Secondary **1.** Olecranon **2.** Distal epiphysis	(fetal) 10 years 5-6 yrs	16-20 years	• Olecranon and coronoid give the elbow bony stabilization.

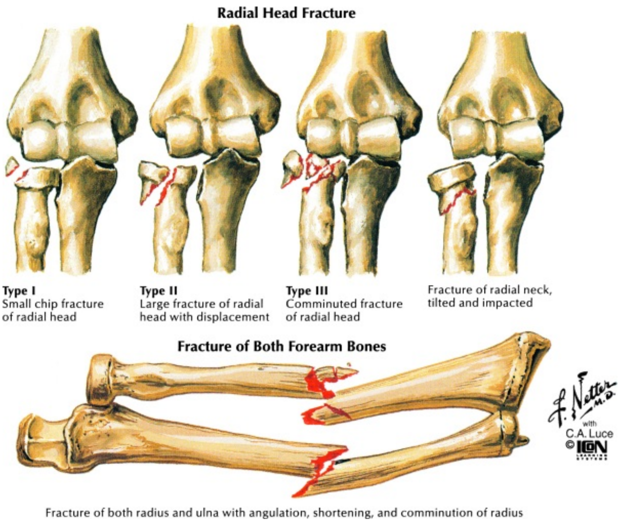
OSTEOLOGY OF THE WRIST



CHARACTERISTICS	OSSIFY	FUSE	COMMENT
		PROXIMAL ROW	
Scaphoid: boat shaped, 80% of surface is articular (not the waist)	5th 5 years	14-16 yrs	• Lies beneath the anatomic snuffbox • Distal (to waist) blood supply (radial artery); proximal pole is susceptible to necrosis if injured
Lunate: moon shaped	4th 4 years	14-16 yrs	• Dislocations often missed • Blood supply is palmar: palmar fractures need ORIF to protect against osteonecrosis; dorsal fractures treated nonsurgically
Triquetrum: pyramid shaped	3rd 3 years	14-16 yrs	
Pisiform: large sesamoid bone	8th 9-12 years	14-16 yrs	• In the FCU tendon; TCL attaches
		DISTAL ROW	
Trapezium: most radial	6th 5-6 years	14-16 yrs	• Articulates with 1st metacarpal; TCL attaches, FCR
Trapezoid: wedge shape	7th 5-6 years	14-16 yrs	• Articulates with 2nd metacarpal
Capitate: largest carpal bone	1st 1 year	14-16 yrs	• First to ossify
Hamate: has a hook	2nd 1-2	14-16	• TCL, FCU attach to the hook

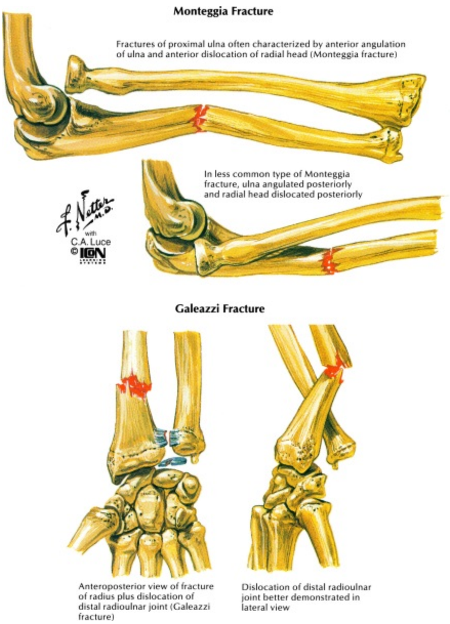
Hamate: has a hook	years	16 yrs	- TCL, FCU attach to the hook
Ossification: each from a single center: counterclockwise (anatomic position) starting with capitate			
Carpal tunnel borders: Roof: Transverse carpal ligament; Lateral wall: scaphoid trapezium; Medial wall: pisiform hamate Contents: Median nerve, flexor tendons			
Guyon's canal: Roof: volar carpal ligament; Floor: TCL; Lateral wall: hamate (hook); Medial wall: pisiform Contents: Ulnar nerve and artery			
Anatomic snuffbox: Between tendons of EPL and EPB; Contents: Radial artery (scaphoid directly deep to snuffbox)			

TRAUMA



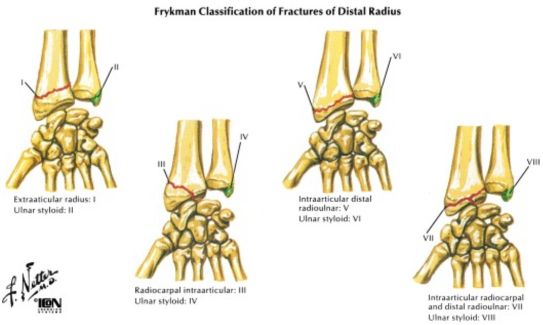
DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
OLECRANON FRACTURE			
• Mechanism: fall directly on elbow; fall on hand • Articular surface always involved • Triceps tendon pulls fragment	HX: Fall/trauma. Swelling, pain, +/- numbness. PE: Effusion, tenderness +/- decreased elbow extension. Good neurovascular exam (esp. ulnar nerve) XR: AP/lateral	Colton: Undisplaced: 2mm Displaced -avulsion -transverse/oblique -comminuted -fracture/dislocation	Undisplaced: Cast at 45-90° for 3 weeks, then gentle ROM Displaced: ORIF with tension band wires or bicortical screw. (comminuted fracture: excise bone then reattach triceps)
COMPLICATIONS: Ulnar nerve injury (most resolve); Decreased ROM; Arthritis			
RADIAL HEAD FRACTURE			
• Common • Fall on outstretched arm radius pushed into capitellum • Intraarticular fracture • Can be associated with elbow dislocation	HX: Fall. Pain, swelling, decreased function. PE: Tenderness of radial head, decreased ROM especially pronation/supination. Test MCL stability XR: AP/lateral: +fat pad	Mason: 4 Types I: Undisplaced II: Displaced III: Comminuted (head) IV: Fracture with elbow dislocation	Type I: Splint for 3 days, then early ROM Type II: If motion intact-splint, then early ROM. If 1/3 of head involved or 3mm displaced-ORIF or excision

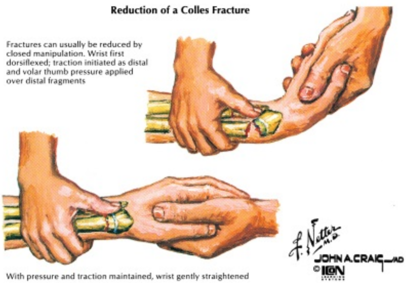
			Type III: Radial head excision
COMPLICATIONS: Decreased ROM; Instability			
BOTH BONE FRACTURE			
• Mechanism: high energy injuries • Fractures in shaft of single bone shorten, resulting forces cause fracture in other bone • Nightstick fracture: ulnar shaft fracture only	HX: Trauma. Pain, swelling. PE: Tenderness, deformity. Check compartments and do neurovascular PE XR:AP/lateral: including wrist and elbow	Descriptive: • Undisplaced • Displaced • Comminuted	ORIF (usually plates and screws) through two separate incisions. Nightstick: Undisplaced-closed treatment; Displaced-ORIF Peds: closed, LAC 6-8wks
COMPLICATIONS: Loss of Pronation and supination; Nonunion			



DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
MONTEGGIA FRACTURE			
• Proximal ulna fracture, shortening forces result in radial head dislocation.	HX: Fall. Pain, swelling. PE: Tenderness, deformity. Check compartments and	Bado (based on radial head location): I: Anterior (common) II: Posterior	Ulna: ORIF (plates/screws) Radial head: closed reduction (open if irreducible or

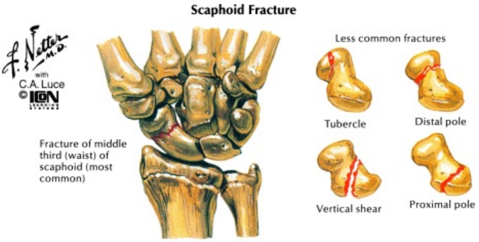
dislocation. • Mechanism: direct blow or fall on outstretched hand.	neurovascular exam. XR: AP/lateral: including wrist and elbow series.	III: Lateral IV: Anterior with associated both bone fracture.	irreducible or unstable). Peds: closed reduction cast.
COMPLICATIONS: Radial nerve/PIN injury (most resolve); Decreased ROM; Compartment Syndrome; Nonunion			
GALEAZZI/PIEDMONT FRACTURE			
• Mechanism: fall on outstretched hand. • Distal radial shaft fracture, shortening forces result in distal radioulnar dislocation.	HX: Fall. Pain, swelling. PE Tenderness, deformity. Check compartments and do neurovascular exam. XR: AP/lateral: including wrist and elbow	By mechanism: Pronation: Galeazzi Supination: Reverse Galeazzi (ulna shaft fracture with DRUJ dislocation)	Radius: ORIF (plate/screws) DRUJ: closed reduction, +/- percutaneous pins. (open treatment if unstable) Cast immobilization for 4-6wks. Peds: closed reduction, cast.
COMPLICATIONS: Nerve injury; Decreased ROM; Nonunion; Distal radioulnar joint (DRUJ) arthrosis			

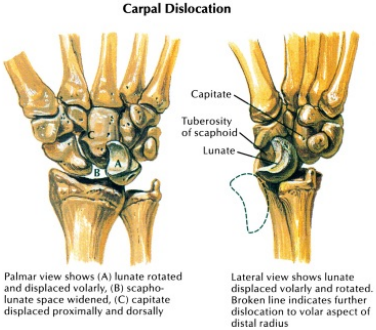




DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
DISTAL RADIUS FRACTURE			
• Very common (Colles#1) • Fall on outstretched arm	HX: Fall. Pain, swelling. PE: Swelling,	Frykman (for Colles): Type I, II: extraarticular	Close reduce, immobilize with WELL molded cast. (volar flexion ulnar

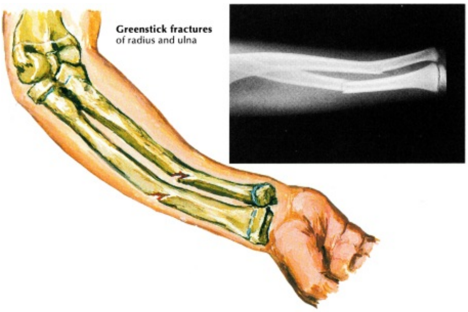
• Colles fracture: dorsal displacement (apex volar), radial shortening, dorsal angulation. • Smith fracture: volar displacement (apex dorsal) • Barton fracture: radial rim carpus displace together • Radial styloid (chauffeur fracture)	deformity, tenderness to palpation.Good neurovascular exam. XR: AP/lateral: normal radius: 1. 23° radial inclination 2. 13 mm radial height 3. 11° volar tilt	Type III, IV: radiocarpal joint. Type V, VI: radioulnar joint Type VII, VIII: radiocarpal and radioulnar joints involved (even numbers also have ulna styloid fx) Barton: 1. Dorsal 2. Volar (most common)	deviation). If unstable add percutaneous pins, ORIF or external fixation. Smith: closed treatment +/- percutaneous pinning (often unstable needs ORIF) Barton fracture: Most need ORIF Styloid fracture: ORIF
COMPLICATIONS: Loss of motion; Deformity; Median nerve injury; Malunion; Scapholunate dislocation			

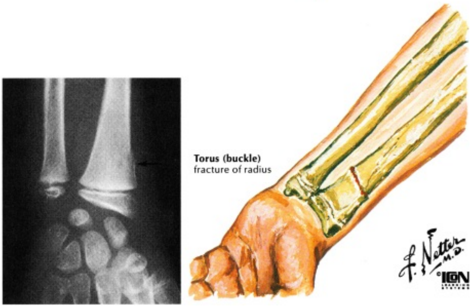




DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
SCAPHOID FRACTURE			
• Most common carpal fracture • Fall on outstretched arm • High complication rate	HX: Fall. Pain worse with gripping, swelling. PE: “Snuffbox” tenderness, swelling on radial wrist XR: AP/lateral:	By location: Proximal pole Middle (“waist”) most common Distal pole	If clinical symptoms with negative xray: thumb spica for 10-14days then re-evaluate. Nondisplaced: cast 6-12 wks Displaced:

• Proximal pole with tenuous blood supply	also PA with ulnar deviation/oblique		Displaced: ORIF (K-wire or Herbert screw)
COMPLICATIONS: Nonunion/malunion; Osteonecrosis: especially of proximal pole; Degenerative Joint Disease (DJD)			
CARPAL DISLOCATION: PERILUNATE INSTABILITY			
• Uncommon: hyperextension supination injury • Injury determined by a progression of ligament disruption (see joint chart) • Space of Poirer is weak (Capitate-lunate joint)	HX: Fall. Pain. PE: Wrist pain, + Watson sign. XR: AP/lateral: 3mm SL gap is Terry Thomas sign.+/-2 Scaphoid ring sign Cinearthrogram: definitive diagnosis	Mayfield (4 stages): **I:** Scapholunate diastasis **II:** Perilunate dislocation **III:** Lunotriquetral diastasis **IV:** Volar lunate dislocation.	Closed reduction and cast simple cases. Open reduction, pin fixation, and primary ligament repair usually required.
COMPLICATIONS: Wrist instability and/or pain; SLAC wrist			

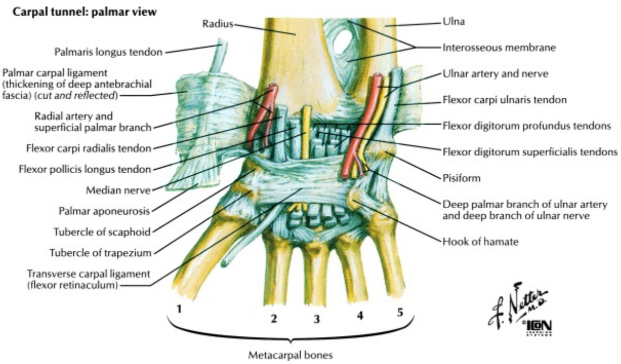




DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
INCOMPLETE FRACTURE: TORUS GREENSTICK FRACTURE			
• Common in children (usually ages 6-12) Mechanism:	Hx: Trauma. Pain, inability to use arm	Torus(Buckle):concave cortex compresses	Torus: reduction rarely needed

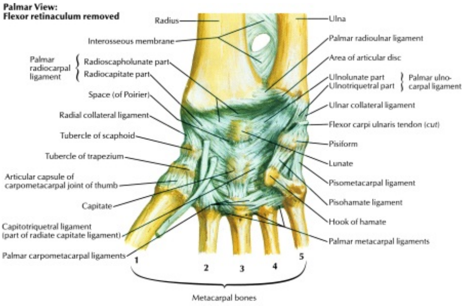
• Mechanism: fall on hand most common • Distal radius most common • Increased flexibility of pediatric bone allows only one cortex to be involved	use arm. PE:+/- deformity. Point tenderness swelling. XR: AP and lateral: only one cortex involved.	(buckles), convex/tension side: intact Greenstick: concave cortex intact, convex/tension side fracture/plastic deformity	needed, splint 2-4 weeks Greenstick: reduce if 10° of angulation. Long arm cast for 6 weeks.
COMPLICATIONS: Deformity; Malunion; Neurovascular injury (rare)			

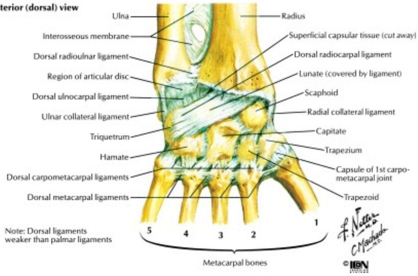
JOINTS: WRIST

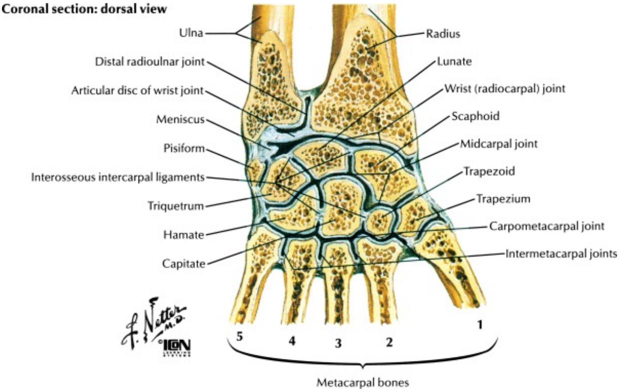


LIGAMENTS	ATTACHMENTS	COMMENTS
RADIOCARPAL (Ellipsoid type)		
Bones: radius, scaphoid, lunate, triquetrum		
Capsule	Surrounds joint	Loose, provides little support
Volar radiocarpal [VRC]	Multiple intracapsular ligaments	Strong; space of Poirier (lunocapitate) is weak. Injury leads to instability.
Radioscaphocapitate [RCL]	Radial styloid to capitate	Stabilizes radial wrist, distal row, midcarpal joint. Disrupted in perilunate instability stage II.
Radioscapholunate [RSL]	Radial styloid to lunate	Stabilizes radial wrist, scapholunate joint; Disrupted in DISI, perilunate instability stage I.
Radiolunotriquetral [RTL]	Radial styloid to triquetrum	Largest, volar sling for lunate, lunotriquetral joint stabilizer. Disrupted in perilunate instability stage III.
Dorsal radiocarpal [DRC]	Radius, scaphoid, lunate, triquetrum	Weak; stabilizes proximal row, radiolunate joint. Disrupted in perilunate instability stage IV.
Radial collateral	Radius, scaphoid, trapezium, TCL	Stabilizes proximal row. Radial artery runs adjacent to it.
RADIOULNAR (Pivot type)		
Triangular Fibrocartilage Complex (TFCC): Multiple components stabilize joint, absorbs axial load; any tear or injury results in pain		
COMPONENT	ORIGIN	INSERTION
Dorsal Volar Radioulnar	Ulnar radius	Caput ulna
Triangular fibrocartilage (disc)	Radius/ulna	Triquetrum
Meniscus homologue	Ulna/disc	Triquetrum
Ulnar collateral/ECU	Ulna	Fifth metacarpal
OTHER LIGAMENTS		
Ulnocarpal:	Often considered part of TFCC; Stabilizes proximal row of carpus	
Ulnolunate	Ulna	Lunate

Ulnotriquetral	Ulna	Triquetrum



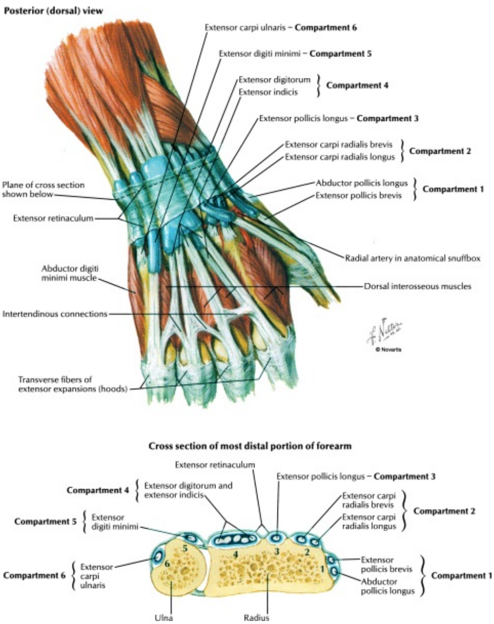




JOINT TYPE		LIGAMENTS	ATTACHMENTS	COMMENTS
		INTERCARPAL		
				Dorsal stronger

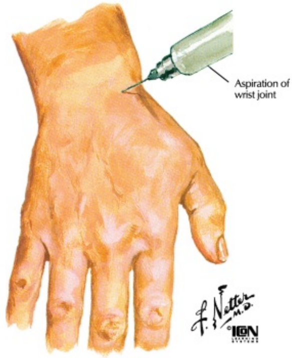
Proximal Row	Gliding	2 Dorsal intercarpal 2 Palmar intercarpal 2 Interosseous	Scapholunate, lunotriquetral Scapholunate, lunotriquetral Scapholunate, lunotriquetral.	Stabilize SL or LT joints DISI: SL ligament injury VISI: LT ligament injury
Pisiform Articulation		Capsule Ulnar collateral Volar radiocarpal Pisohamate Pisometacarpal	Pisiform triquetrum Ulna to pisiform RCL to pisifrom Pisiform to hamate Pisiform to 5 th metacarpal	Holds it proximally Holds it proximally Assists FCU; roof of Guyon's canal Assists FCU flexion
Distal Row	Gliding	3 Dorsal intercarpal 3 Palmar intercarpal 2 interosseous	All four bones in distal row All four bones in distal row Trapezoid to capitate to hamate	Thicker than proximal
MIDCARPAL				
	Ellipsoid	Palmar (Volar) intercarpal Carpal collaterals Capitotriquetral (CTL)	Proximal distal carpal rows Capitate to triquetrum	1/3 of wrist extension, 2/3 of wrist flexion occurs here Radial stronger than ulnar Stabilizes distal row

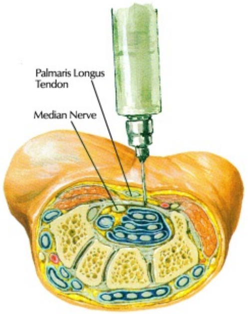
OTHER WRIST STRUCTURES



STRUCTURE	FUNCTION	COMMENT
Extensor Retinaculum Dorsal Compartments	Covers dorsum of the wrist I: APL, EPB II: ECRL, ECRB III: EPL IV: EDC, EIP V: EDM VI: ECU	Forms six fibroosseous dorsal compartments DeQuervain's tenosynovitis can develop here Tendinitis (carpal bossing) Around Lister's tubercle: tendon can rupture Tenosynovitis, ganglions Jackson-Vaughn syndrome (rupture from RA) Tendon can "snap" over ulnar styloid
Transverse Carpal Ligament (TCL, Flexor Retinaculum)	Covers volar wrist Attaches to: Medial: pisoform hook of hamate Lateral: scaphoid trapezium	Roof of carpal tunnel, floor of Guyon's canal (ulnar nerve can entrap here)

MINOR PROCEDURES





STEPS

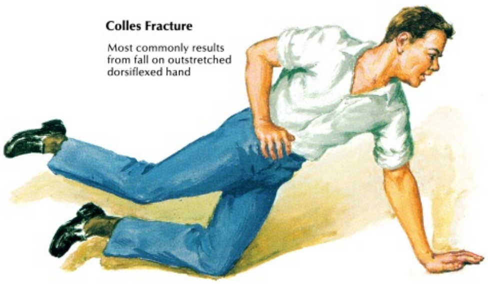
WRIST ASPIRATION/INJECTION

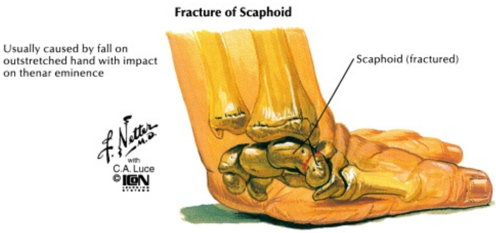
1. Ask patient about allergies
2. Palpate radiocarpal joint dorsally for EPL,ECRB, Lister's tubercle and the space ulnar to them
3. Prepare skin over dorsal wrist (iodine/antiseptic soap)
4. Anesthetize skin locally (quarter size spot)
5. Aspiration: Insert 20 gauge needle into space ulnar to Lister's tubercle/ECRB and radial to EDC, aspirate.
   Injection: Insert 22 gauge needle into same space,aspirate to ensure not in vessel, then inject 1-2ml of local or local/steroid preparation into RC joint.
6. Dress injection site
7. If suspicious for infection, send fluid for Gram stain culture

CARPAL TUNNEL INJECTION/MEDIAN NERVE BLOCK

1. Ask patient about allergies
2. Ask patient to pinch thumb and small finger tips, Palmaris longus (PL) tendon will protrude (10-20% do not have one) median nerve is directly beneath PL, just ulnar to FCR
3. Prepare skin over volar wrist (iodine/antiseptic soap)
4. Anesthetize skin locally (quarter size spot)
5. Insert 22 gauge or smaller needle into wrist under PL at flexion crease. Aspirate to ensure needle is not in a vessel. Inject 1-2ml of local or local/steroid preparation.
6. Dress injection site

HISTORY





QUESTION	ANSWER	CLINICAL APPLICATION
1. AGE	Young Middle age-elderly	Trauma: fractures and dislocations, ganglions Arthritis, nerve entrapments, overuse
2. PAIN **a.** Onset **b.** Location	Acute Chronic Dorsal Volar Radial Ulnar	Trauma Arthritis Kienbock's disease, ganglion Carpal tunnel syndrome (CTS), ganglion (especially radiovolar) Scaphoid fracture, DeQuervain's tenosynovitis, arthritis Triangular Fibrocartilage Complex(TFCC) tear, tendinitis
3. STIFFNESS	with dorsal pain with volar pain (at night)	Kienbock's disease Carpal tunnel syndrome
4. SWELLING	Joint: after trauma Joint: no trauma Along tendons	Fracture or sprain Arthritides, infection, gout Flexor or extensor tendinitis (calcific), DeQuervain's disease
5. INSTABILITY	Popping, snapping	Scapholunate dissociation

6. MASS	Along wrist joint	Ganglion
7. TRAUMA	Fall on hand	Fractures: distal radius, scaphoid; Dislocation: lunate, ulna TFCC tear
8. ACTIVITY	Repetitive motion (typing)	Carpal Tunnel Syndrome (CTS), DeQuervain's tenosynovitis
9. NEUROLOGIC SYMPTOMS	Numbness, tingling Weakness	Nerve entrapment, thoracic outlet syndrome, radiculopathy Nerve entrapment (median (e.g. CTS), ulnar, or radial)
10. HISTORY OF ARTHRITIDES	Multiple joints involved	Arthritides

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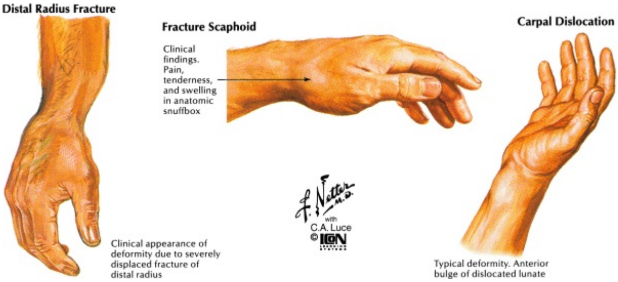
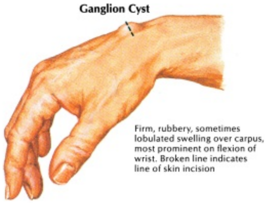
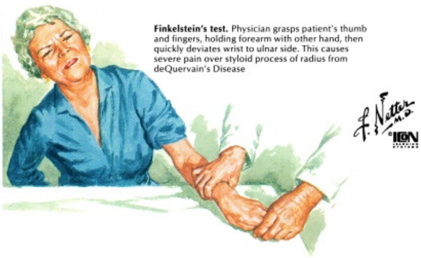
PHYSICAL EXAM



EXAMINATION	TECHNIQUE	CLINICAL APPLICATION
INSPECTION		
Gross deformity Swelling	Bones and soft tissues Especially dorsal or radial Diffuse	Fractures, dislocations: forearm and wrist Ganglion Trauma, infection
PALPATION		
Skin changes	Warm, red Cool, dry	Infection, gout Neurovascular compromise
Radial and Ulnar styloids	Palpate each separately	Tenderness may indicate fracture
Carpal bones	Both proximal and distal row	Snuffbox tenderness: scaphoid fracture; lunate tenderness: Kienbock's disease.
	Proximal row Pisiform	Scapholunate dissociation Tenderness: pisotrequetral arthritis or FCU tendinitis
Soft tissues	6 dorsal extensor compartments TFCC: distal to ulnar styloid Compartments	Tenderness over 1st compartment: DeQuervain's disease Tenderness indicates TFCC injury Firm/tense compartments: compartment syndrome
RANGE OF MOTION		
Flex and extend	Flex (toward palm), extend opposite	Normal: flexion 80°, extension 75°
Radial/ulnar deviation Pronate and supinate	In same plane as the palm Flex elbow 90°: hold pencil, rotate wrist	Normal: radial 15-20°, ulnar 30-40° Normal: supinate 90°, pronate 80-90° (only 10-15° is in the wrist, most motion is in elbow)
NEUROVASCULAR		
Sensory	(LT, PP, 2 pt)	
Musculocutaneous nerve (C6)	Lateral forearm	Deficit indicates corresponding nerve/root lesion
Medial Cutaneous nerve of forearm (T1)	Medial forearm	Deficit indicates corresponding nerve/root lesion
Motor		

Radial Nerve (C6-7)	Resisted wrist extension	Weakness=ECRL/B or corresponding nerve/root lesion
PIN (C6-7)	Resisted ulnar deviation	Weakness=ECU or corresponding nerve/root lesion
Ulnar Nerve (C8)	Resisted wrist flexion	Weakness=FCR or corresponding nerve/root lesion
Median Nerve (C7)	Resisted wrist flexion	Weakness=FCR or corresponding nerve/root lesion
Median Nerve (C6)	Resisted pronation	Weakness=Pronator Teres or nerve/root lesion
Musculocutaneous (C6)	Resisted supination	Weakness=Biceps or corresponding nerve/root lesion
Reflex		
C6	Brachioradialis	Hypoactive/absence indicates corresponding radiculopathy
Pulses	Radial, Ulnar	Diminished/absent = vascular injury or compromise (perform Allen test)

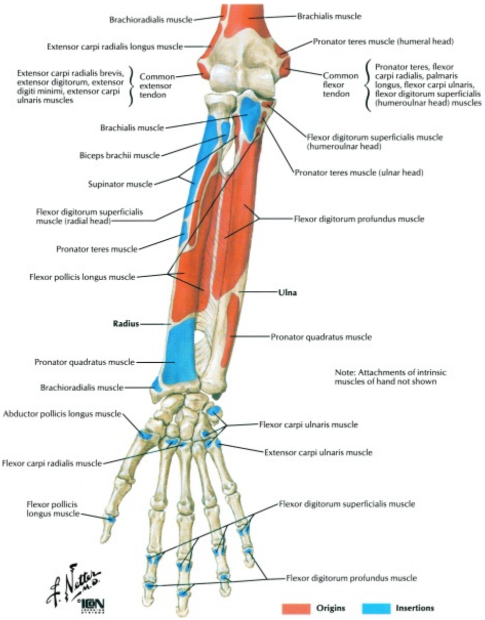




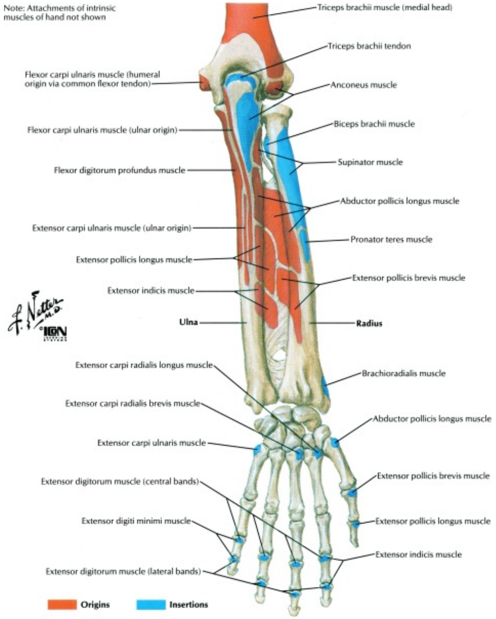
EXAMINATION	TECHNIQUE	CLINICAL APPLICATION
	SPECIAL TESTS	
Phalen	Maximal flexion of both wrists for several minutes	Reproduction of symptoms (numbness or tingling): Carpal Tunnel Syndrome (CTS)
Tinel	Tap volar wrist (carpal tunnel/TCL)	Pain, numbness suggests Median nerve compression (CTS)
Finkelstein	Make fist with thumb inside, then ulnar deviation	Pain over 1 st compartment (APL, EPB) suggests DeQuervain's tenosynovitis

Watson	Push scaphoid anteroposterior with wrist in radial or ulnar deviation	Positive if scaphoid subluxes or reduces: carpal ligament injury
Allen	Occlude radial ulnar arteries, pump fist then release one artery only	Delay or absent of “pinking up” of palm suggest arterial compromise of artery released

MUSCLES: ORIGINS INSERTIONS



PROXIMAL ULNA	PROXIMAL RADIUS
ANTERIOR	
INSERTIONS	**INSERTIONS**
Brachialis	Biceps
	Supinator
ORIGINS	**ORIGINS**
Flexor Digitorum	Flexor Digitorum
Superficialis [1 head]	Superficialis [1 head]
Pronator teres	
Flexor Pollicis longus	
Supinator	



PROXIMAL ULNA	PROXIMAL RADIUS
POSTERIOR	
INSERTIONS	**INSERTIONS**
Triceps	Biceps
Anaconeus	Supinator
ORIGINS	**ORIGINS**
Flexor carpi ulnaris	NONE

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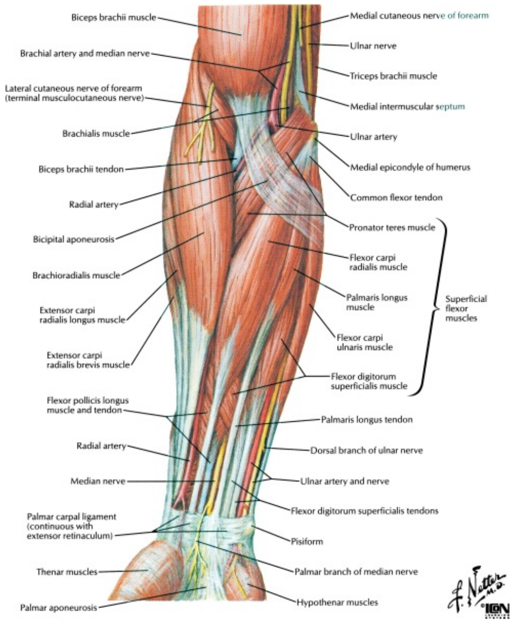
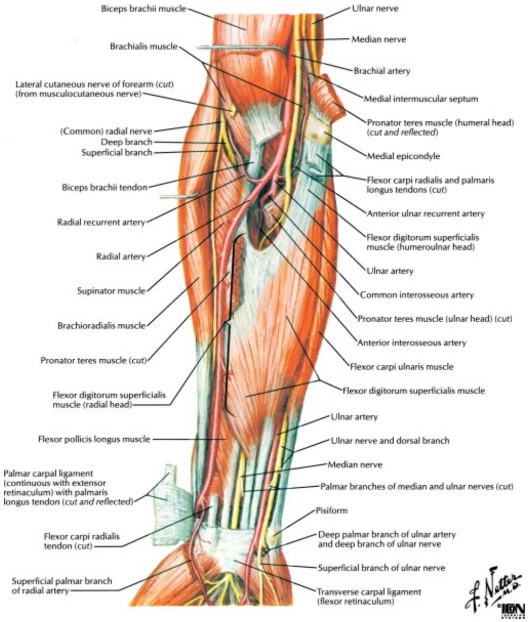
ANTERIOR COMPARTMENT MUSCLES: SUPERFICIAL FLEXORS

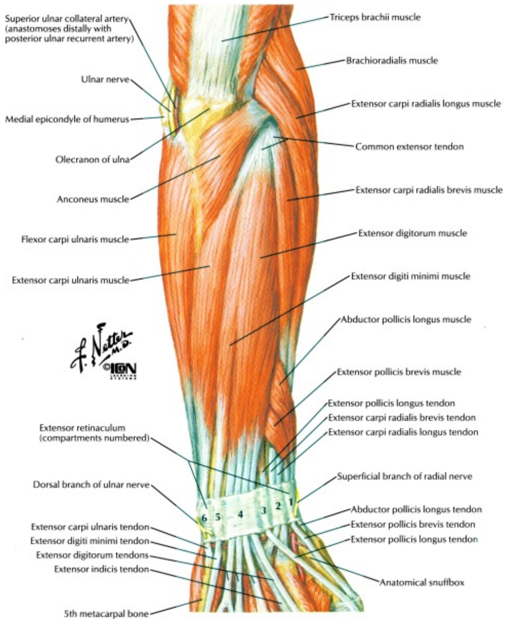


MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Pronator Teres [PT]	Medial epicondyle coronoid process	Lateral radius- middle 1/3	Median	Pronate and flex forearm	May trap AIN (AIN syndrome)
Flexor carpi radialis [FCR]	Medial epicondyle	Base of 2nd 3rd metacarpal	Median	Flex wrist, radial deviation	Radial artery is immediately lateral
Palmaris Longus [PL]	Medial epicondyle	Flexor retinaculum palmar aponeurosis	Median	Flex wrist	Used for tendon transfers. 10% congenitally absent
Flexor carpi ulnaris [FCU]	Medial epicondyle posterior ulna	Pisoform, hook of hamate, 5th MC	Ulnar	Flex wrist, ulnar deviation	Most powerful wrist flexor



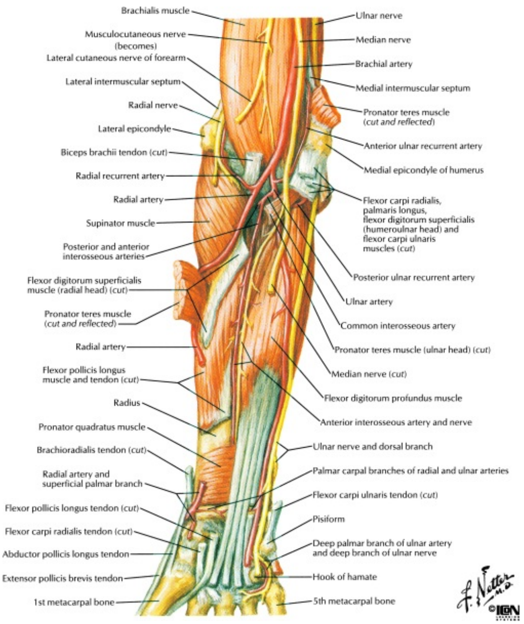
MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Flexor digitorum superficialis [FDS]	1. Medial epicondyle, coronoid process	Middle phalanges of digits (not thumb)	Median	Flex PIP (also flex digit and hand)	Sublimus test will isolate test function
	2. Anteroproximal radius				

POSTERIOR COMPARTMENT MUSCLES: SUPERFICIAL EXTENSORS



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Flexor digitorum profundus [FDP]	Anterior ulna Interosseus membrane	Distal phalanx (IF/MF)	Median/AIN	Flex DIP (also flex digit and hand)	Avulsion: Jersey finger.
		Distal phalanx (RF/SF)	Ulnar		FDP and FPL are most susceptible to Volkmann's contracture.
Flexor pollicis longus [FPL]	Anterior radius coronoid process	Distal phalanx of thumb	Median/AIN	Flex thumb (IP)	
Pronator quadratus [PQ]	Medial distal ulna	Anterior distal radius	Median/AIN	Pronate forearm	Primary pronator (initiates pronation)

ANTERIOR COMPARTMENT MUSCLES: DEEP FLEXORS



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Anaconeus	Posterior-lateral epicondyle	Posterior-poximal ulna	Radial	Forearm extension	Must retract on Kocher approach
Mobile Wad(3)					
Brachioradialis [BR]	Lateral supra-condylar humerus	Lateral distal radius	Radial	Forearm flexion	Is a deforming force in radius fractures.
Extensor carpi radialis longus [ECRL]	Lateral supra-condylar humerus	Base of 2nd MC	Radial	Wrist extension	Used for tendon transfer
Extensor carpi radialis brevis [ECRB]	Lateral epicondyle	Base of 3rd MC	Radial	Wrist extension	Inflamed in Tennis elbow, can compress PIN
Extensor digitorum [ED]	Lateral epicondyle	Sagittal bands, central slip, distal phalanx	Radial-PIN	Digit extension	Distal avulsion is mallet finger injury
Extensor digiti minimi [EDM]	Lateral epicondyle	Sagittal bands, central slip, distal phalanx of SF	Radial-PIN	SF extension	In 5th dorsal compartment.
Extensor carpi ulnaris [ECU]	Lateral epicondyle	Base of 5th MC	Radial-PIN	Hand extension and	Must retract on Kocher approach

				adduction	approach

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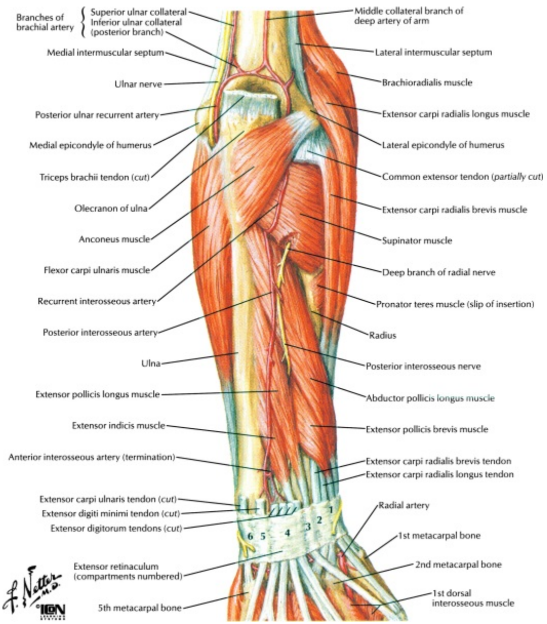
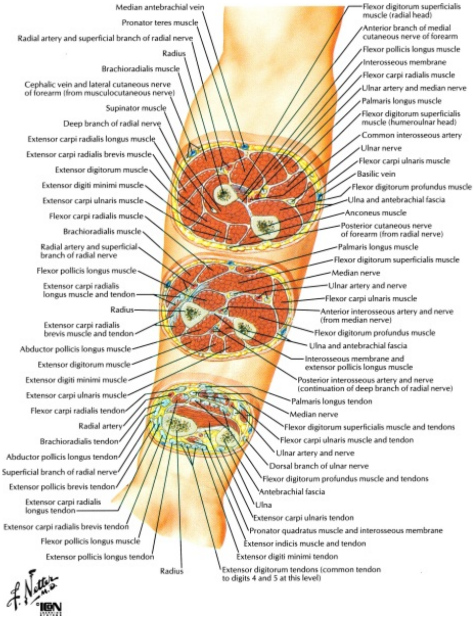
POSTERIOR COMPARTMENT MUSCLES: DEEP EXTENSORS

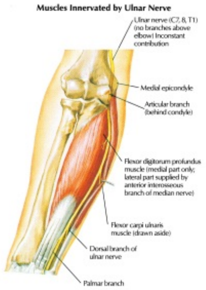


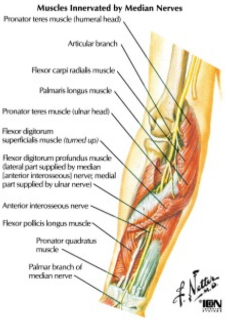
MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Supinator	Posterior medial ulna	Proximal lateral radius	Radial-PIN	Forearm supination	Can compress PIN
Abductor pollicis longus [APL]	Posterior radius/ulna	Base of 1st MC	Radial-PIN	Abduct and extend thumb (CMC)	1st compartment: DeQuervain Disease
Extensor pollicis brevis [EPB]	Posterior radius	Base of proximal phalanx of thumb	Radial-PIN	Extend thumb (MCP)	Same as above, radial border of snuffbox
Extensor pollicis longus [EPL]	Posterior ulna	Base of thumb distal phalanx	Radial-PIN	Extend thumb (IP)	Tendon turns 45° on Lister's tubercle
					Border of snuffbox
Extensor indicis proprius [EIP]	Posterior ulna	Sagittal bands, central slip, distal phalanx of index finger	Radial-PIN	Index finger extension	Used in tendon transfer

MUSCLES: CROSS SECTIONS



NERVES





INFRACLAVICULAR

LATERAL CORD

Musculocutaneous (C5-7): only sensory in the forearm

Sensory:	Lateral forearm [via Lateral cutaneous nerve of forearm]
Motor:	NONE (in forearm)

MEDIAL CORD

Medial Cutaneous Nerve of Forearm (Antibrachial) (C8-T1): runs with basilic vein

Sensory:	Medial forearm anterior arm
Motor:	NONE

***Ulnar* (C(7)8-T1)**: runs behind medial epicondyle in groove and between 2 heads of ECU[*], then under FCU[*], then to Guyon's canal[*].

Sensory:	NONE (in forearm)
Motor:	Flexor carpi ulnaris
	Flexor digitorum profundus [digits 4, 5]

MEDIAL AND LATERAL CORDS

Median(C(5)6-T1): runs between 2 heads of PT[*], through ligament of Struthers[*] and lacertus fibrosus[*], under FDS[*] into carpal tunnel[*] (Martin Gruber formation: ulnar motor branches run with median nerve then branch to ulnar nerve distally). In wrist, median divides to Motor branch and palmar cutaneous (runs between FCR/PL): at risk in CTS release

3.

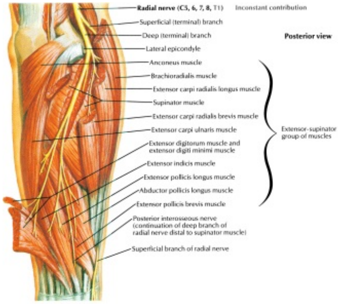
4.

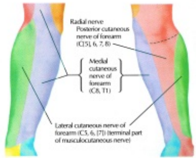
Sensory:	NONE (in forearm)
Motor:	<u>ANTERIOR COMPARTMENT OF FOREARM Superficial Flexors</u> Pronator Teres [PT]Flexor Carpi Radialis [FCR]Palmaris longus [PL]Flexor digitorum superficialis[FDS][sometimes considered a “middle” flexor]
	<u>Deep Flexors</u> **Anterior *Interosseous* N. (AIN)** AIN compressed by PT in forearm, injuredin supracondylar fractures Flexor digitorum profundus [digits 2, 3] Flexor pollicis longus [FPL] Pronator Quadratus [PQ]

* Potential nerve compression site

1.

2.





INFRACLAVICULAR

POSTERIOR CORD

Radial (C5-T1): Divides into 2 branches:

superficial radial (sensory) and 2. deep (motor)-which then pierces supinator and becomes PIN)

5. 1.

Sensory:	Posterior forearm: via Posterior CutaneousNerve of forearm
Motor:	MOBILE WAD(3): **Radial Nerve** (deep branch): runs around radius into posterior compartment, through radial tunnel [*] becomes PIN
	<u>Superficial Extensors</u> Brachioradialis [BR]Extensor carpi radialis longus [ECRL]Extensor carpi radialis brevis [ECRB]
	<u>POSTERIOR COMPARTMENT: **PIN**- Posterior*Interosseous* Nerve</u> Multiple sites ofcompression: 1. fibrous tissue of radialhead, 2. leash of Henry, 3. Arcade ofFrohse, 4. distal supinator, 5. ECRB
	<u>Superficial Extensors</u> Extensor carpi ulnaris [ECU]Extensor digiti minimi [EDM]Extensor digitorum communis [EDC]
	<u>Deep Extensors</u> SupinatorAbductor pollicis longusExtensor pollicis longusExtensor pollicis brevisExtensor indicis proprius

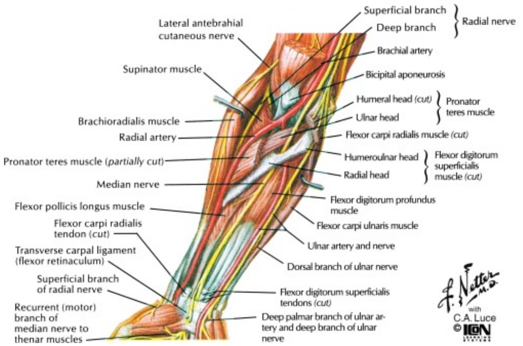
* Potential nerve compression site

ARTERIES

ARTERY	COURSE	BRANCHES
Radial	over PronatorTeres, underBrachioradialis.	Radial recurrent muscularbranches (leash of Henry)
Ulnar	on FDP, underFDS	Anterior ulnar recurrentPosterior ulnar recurrentCommon interosseousAnterior interosseousPosterior interosseousRecurrent interosseousMuscular branches
See Arm chapter for arterial anastomosis around the elbow		

Blood supply to scaphoid enters both distal and proximal parts of bone

In most persons, blood supply enters only distal part of scaphoid. Fracture through waist may lead to necrosis of proximal part

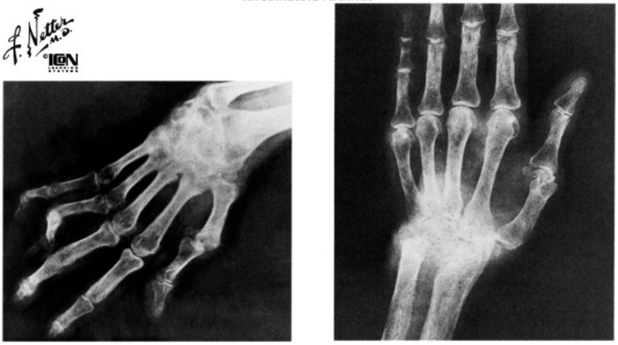


ARTERY	COURSE	BRANCHES	COMMENT
Radial	Volar: lateral to FCRDorsal: between EPL APL/EPB	3 branchesPalmar carpal branchDorsal carpal branchSuperficial palmar branchDeep palmar arch	Is in anatomic snuffboxDeep to flexor tendonsDeep to extensor tendonsAnastomoses with ulnar artery completes superficial palmar archTerminal branch of radial artery
Ulnar	on the TCL, lateral to pisoform.	4 branchesPalmar carpal branchDorsal carpal branchDeep palmar branch	Deep to FDSDeep to extensor tendonsAnastomoses with radial artery completes deeppalmar arch

		Superficial palmar arch	Terminal branch of ulnar artery
Allen test 1. Occlude both radial and ulnar arteries at wrist 2. Patient should squeeze fist several times 3. Release pressure on one artery 4. Repeat releasing other artery			Hand perfusion (“pinking up”) after release indicates patent arches collateral circulation.

DISORDERS: ARTHRITIS INSTABILITY

Rheumatoid Arthritis



Radiograph shows cartilage thinning at proximal interphalangeal joints, erosion of carpus and wrist joint, osteoporosis, and finger deformities

Same patient after 14 years (right). Carpus, wrist joint, and ulnar head completely eroded

DESCRIPTION	H P	WORK-UP/FINDING	TREATMENT
ARTHRITIS			
OSTEOARTHRITIS/DEGENERATIVE JOINT DISEASE			
• "Wear tear": articular cartilage loss • 1° or 2° (e.g. trauma.) • Seen in SLAC wrist	Hx: Older, women, pain (worse with activity) PE: Swelling, decreased ROM	XR: OA findings: spurs, joint space loss, sclerosis	**1.** NSAID, splint, steroid injection **2.** Arthrodesis (pain relief)
DEQUERVAIN'S DISEASE			
• Stenosing tenosynovitis of 1st dorsal compartment (APL/EPB)	Hx: Often history of tennis or golf. Pain, swelling. PE: 1Finkelstein test	XR: Possible calcified tendons Lab: Uric acid (rule out gout)	**1.** Splint, NSAID, injection **2.** Surgical release
RHEUMATOID ARTHRITIS			
• Systemic inflammatory disorder affecting synovium, destroys joint • Wrist common site • Associated with tenosynovitis CTS	Hx: Pain, stiffness (worse In AM) PE: Swelling throughout joint. Decreased ROM, ulnar drift at MCPs.	XR: Hand series: joint destruction erosion Labs: RF, ANA, WBC, ESR, uric acid	**1.** Medical management, splint joints **2.** Synovectomy (single joint) **3.** Tendon transfer or repair **4.** Arthrodesis or arthroplasty
INSTABILITY			
SLAC: SCAPHOLUNATE ADVANCED COLLAPSE			

• Degenerative arthritis secondary to instability (SL ligament disruption or scaphoid fracture/injury)	Hx/PE: Chronic pain, remote history of trauma.	XR: Radioscaphoid OA: (CL joint also involved, RL joint spared)	**1.** Scaphoid excision, capitolunate fusion **2.** Proximal row carpectomy or fusion
SCAPHOLUNATE DISSOCIATION: (static/dynamic)			
• SL/RCL ligament disrupted: lunate displaced dorsally [DISI: Dorsal Intercalated Segment Instability] • LT ligament disrupted: lunate displaced volarly [VISI:Volar ISI]	Hx: Fall (extension supination wrist injury). Pain in wrist. PE: 1Watson's test	XR: SL space .3mm 5 “Terry Thomas” sign. Closed fist: increases SL gap	Early: closed reduction, splint/cast. Repair ligament if full tear Late: STT fusion, carpectomy, or wrist fusion.

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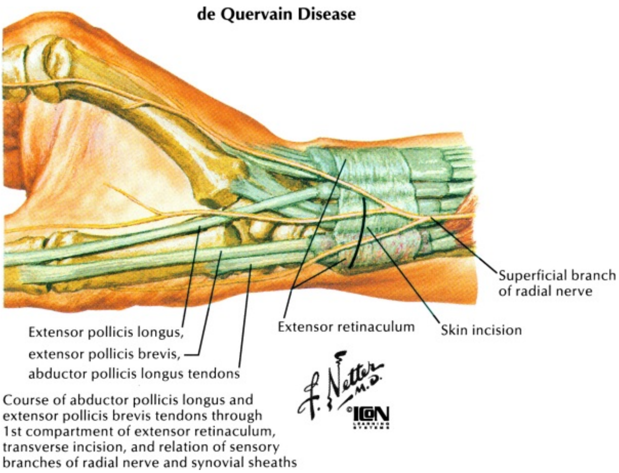
DISORDERS: NERVE COMPRESSION



DESCRIPTION	H P	WORK-UP/FINDING	TREATMENT
AIN (Anterior Interosseous Nerve) SYNDROME			
• AIN trapped under: 1. PT 2. FDS 3. FCR	Hx: No sensory findings	XR: Rule out other pathology	1. Conservative treatment
	PE: decreased thumb flexion, no "OK" sign (+ Kiloh-Nevinsign)		2. Surgical release if does not resolve
CARPAL TUNNEL SYNDROME (CTS)			
• Median nerve trapped in carpal tunnel	Hx: Repetitive motion, night pain, parathesias, clumbsy	XR: Rule out other pathology	1. Activity modification
• Most common nerve entrapment	PE: Weak thenar muscles, + Tinel Phalen tests	EMG/NCS: Localize the lesion	2. Cock-up splint, NSAID, steroid injection
• Associated with metabolic disease (DM, EtOH, pregnancy, thyroid disease)			3. Carpal tunnel release [avoid palmar branch]
PIN SYNDROME (Saturday Night Palsy)			
• PIN trapped by: 1. Supinator (proximal border most common) 2. Arcade of Frohse 3. Leash of Henry 4. Fibrous bands 5. ECRB	Hx: +/- pain	XR: Rule out other pathology	1. Observe. It may resolve
	PE: No sensory findings. Wrist drop	EMG/NCS:	2. Surgical

	findings: Wrist drop, decreased wrist digit extension	Localize the lesion	decompression if symptoms persist
PRONATOR SYNDROME			
• Median nerve trapped by:1. PT, 2. Ligament of Struther, 3. Lacertus fibrosus, 4. FDS	Hx: Forearm pain, increases with activity	XR: Rule out other pathology	1. NSAID, rest, splint
	PE: Thenar weakness, Tinel Phalen tests	EMG/NCS: Localize the lesion	2. Surgical release after 3-4 months
RADIAL TUNNEL SYNDROME			
• Radial nerve trapped in radial tunnel (1 of 4 places)	Hx: Pain in lateral forearm	XR: Rule out other pathology	1. Rule out lateral epicondylitis
	PE: No motor/sensory findings		2. Activity modification, splinting
			3. Surgical exploration/release
ULNAR TUNNEL SYNDROME			
• Ulnar nerve trapped in Guyon's canal	Hx: Pain, numbness, intrinsic weakness	XR: not indicated	1. Activity modification, rest, immobilize
• Can be trauma related	PE: +Tinel of ulnar nerve at wrist	EMG/NCS: will localize lesion	2. Surgical decompression

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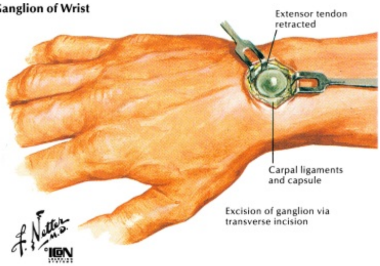
OTHER DISORDERS

Ganglion of Wrist

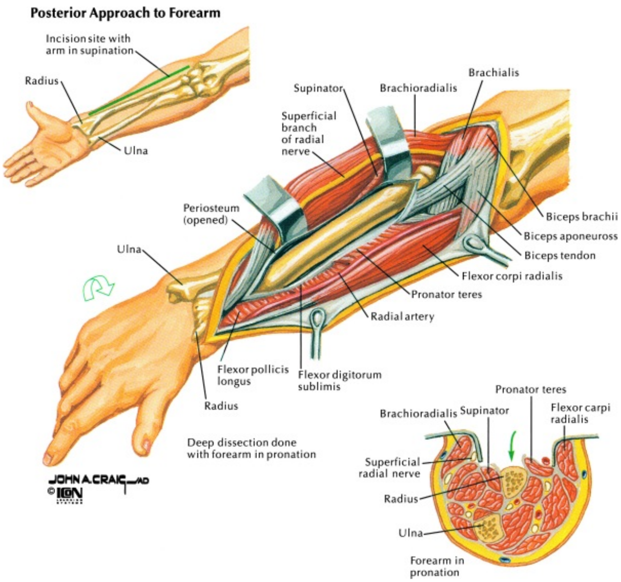


Kienböck's Disease

Radiograph of wrist shows characteristic sclerosis of lunate

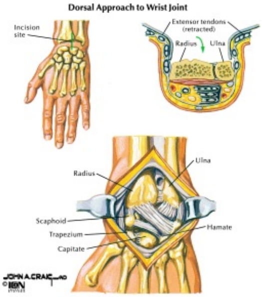
DESCRIPTION	H P	WORK-UP/FINDING	TREATMENT
GANGLION			
• Cyst with mucinous/joint fluid	Hx/PE: Round, large or small transilluminating mass, +/-pain	XR: Wrist series, no radiographic evidence of ganglion	1. Asymptomatic: reassurance
• Communicates with joint			2. Symptomatic: aspirate or surgically excise (with stalk or it will recur)
• Most common mass in wrist1. Dorsal (SL)2. Volar (ST)			
KIENBÖCK'S DISEASE			
• Osteonecrosis of lunate	Hx: Pain, swelling, stiffness	XR: Opacity of lunate	I. NSAID, splinting
• Wrist trauma or short ulna	PE: Grip strength may be reduced.	Bone scan/MRI: will confirm diagnosis	II/III. Joint leveling procedure/carpal fusion
• 4 stages: based on collapse			IV. Proximal row carpectomy or fusion

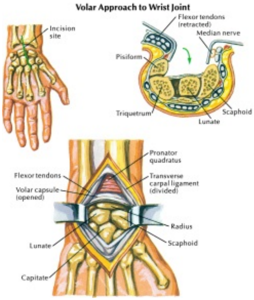
SURGICAL APPROACHES

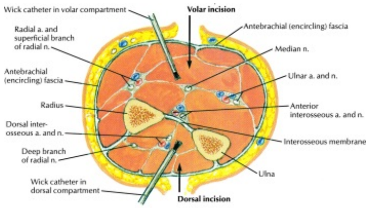


USES	INTERNERVOUS PLANE	DANGERS	COMMENT
FOREARM: ANTERIOR APPROACH (HENRY)			
1. ORIF fractures	Distal1. Brachioradialis [Radial]2. FCR [Median]	1. PIN	1. Radial recurrent artery (Leash of Henry) vein need ligation.
2. Osteotomy	Proximal1. Brachioradialis [Radial]2. Pronator Teres [Median]	2. Superficial radial nerve	2. If not ligated, hemorrhage could result in Compartment syndrome and/or Volkmann's contracture
3. Biopsy bone tumors		3. Radial artery	
WRIST: DORSAL APPROACH			
1. Fusion	1. 3rd dorsal compartment [EPL]	Radial nerve (Superficial)	1. Incise to the extensor retinaculum. This leaves cutaneous nerves intact in the subcutaneous fat.
2. Stabilization	2. 4th dorsal compartment [EDC, EIP]		2. Neuroma can develop from cutting cutaneous nerves.
3. ORIF fractures			
4. Carpectomy			
WRIST: VOLAR APPROACH			
1. Carpal tunnel	No planes	1. Median nerve• Palmar cutaneous	1. Retract PL/FPL radially

decompression	No planes	branch• Recurrent motor	Retract FDS/FDP ulnarly
2. ORIF volar fracture		2. Palmar arch	2. Dissect TCL carefully to avoid nerve damage.
3. Dislocated lunate			
4. Tendon laceration			







Section through midforearm

CHAPTER 5 - HAND

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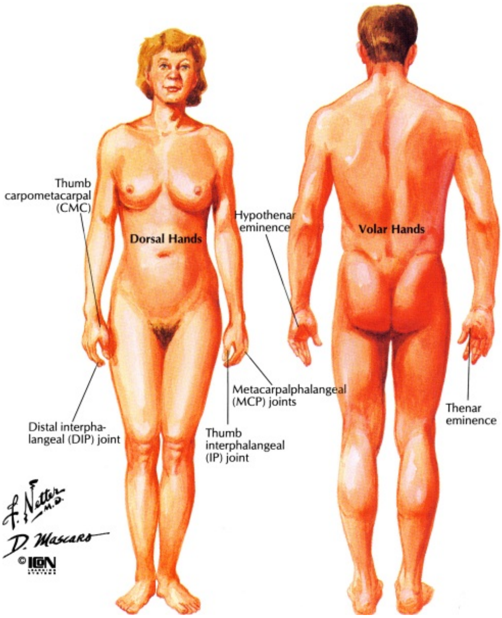
CHAPTER 5 – HAND

TOPOGRAPHIC ANATOMY



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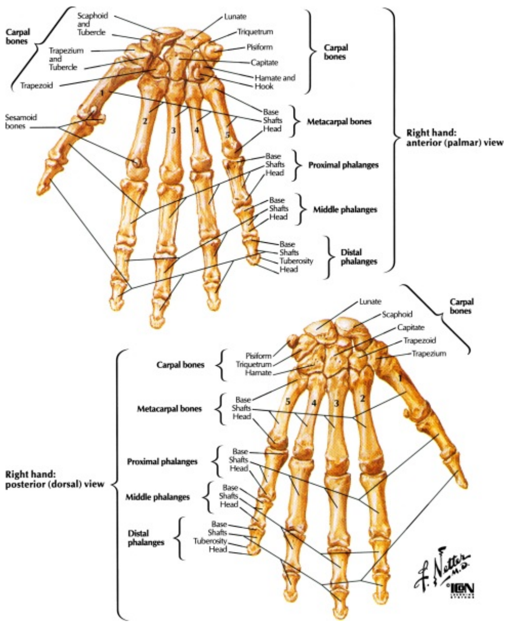
OSTEOLOGY OF THE HAND



CHARACTERISTICS	OSSIFY		FUSE	COMMENT
METACARPALS				
• Triangular in cross section: gives 2 volar muscular attachment sites	Primary: Body	9 wks (fetal)	18 yrs	• Named I-V (thumb to small finger)
• Thumb MC has saddle shaped base: increases it mobility	Epiphysis	2 yrs		• Only one epiphysis per bone in the head. In thumb MC it is in the base.
PHALANGES				
• Palmar surface is almost flat	Primary: Body	8 wks (fetal)	14-18 years	• 3 phalanges in each digit except thumb
• Tubercles and ridges are sites for attachment.	Epiphysis	2-3 yr		• Only one epiphysis per bone in base.
Nomenclature for digits: thumb, index finger, middle finger, ring finger, small finger				

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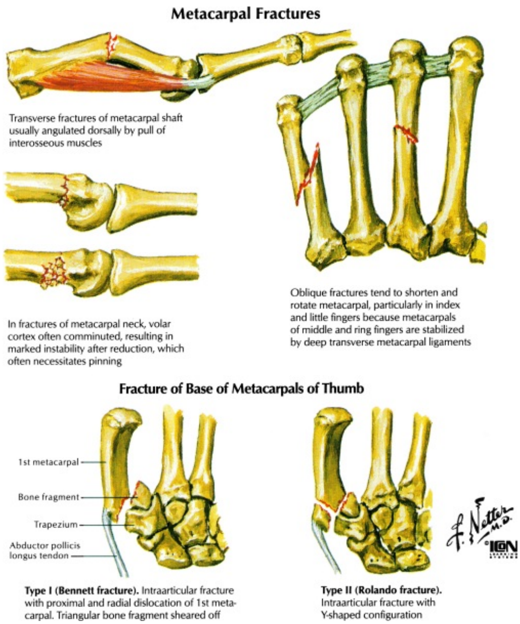
TRAUMA



DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
METACARPAL FRACTURES			
• Common in adults • 5th MC most common (Boxer's fracture at neck) • 1st MC base. Bennett Rolando fracture: displaced, intraarticular. • 4th 5th MC tolerate angulation; 2nd 3rd do not	HX: Trauma. Swelling, pain, deformity. PE: Swelling, tenderness, +/- rotational deformity, shortening. Decreased ROM. XR: PA, lateral, oblique	By location: • Head • Neck (most common) • Shaft (transverse, spiral, Oblique) • Base (Bennett, Rolando, "Baby Bennett"-base of 5th MC)	Nondisplaced: ulnar gutter splint 4 weeks, then ROM. Severely Angulated or shortened: percutaneous pins or ORIF Displaced or intraarticular: reduce then pin. Unstable: ORIF
COMPLICATIONS: Rotational deformity grip abnormalities (malunion)			
PHALANGEAL FRACTURES			
	HX: Trauma.	Descriptive/location: • Intra vs extraarticular •Displaced/undisplaced	Extraarticular Undisplaced: buddy tape and/or splint

• Childrenadults	Swelling, pain, deformity.	• Open/closed • Transverse/oblique • Base, shaft, neck, condyle	Displaced: reduce, splint Unstable: pin or ORIF
• Distal phalanx most common (MF)	PE: Swelling, tenderness, +/- rotational deformity, shortening. Decreased		
• Early ROM important for good results	ROM, 2 pt discrimination, capillary refill.		
• Articular surfaces do not Tolerate incongruity. **Close follow up is critical for intraarticular fractures**	XR: AP, lateral, blique		Splint must have MCP in flexion, IPs extended
			Intraarticular: ORIF
			Repair nail bed if needed
COMPLICATIONS: Rotational deformity (malunion); Decreased motion; Degenerative Joint Disease (DJD)			

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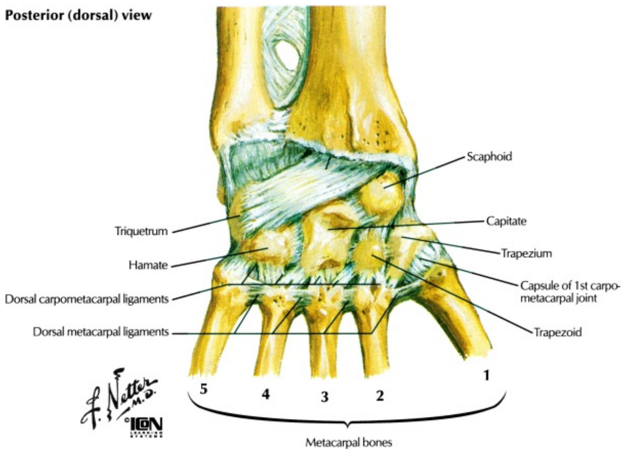
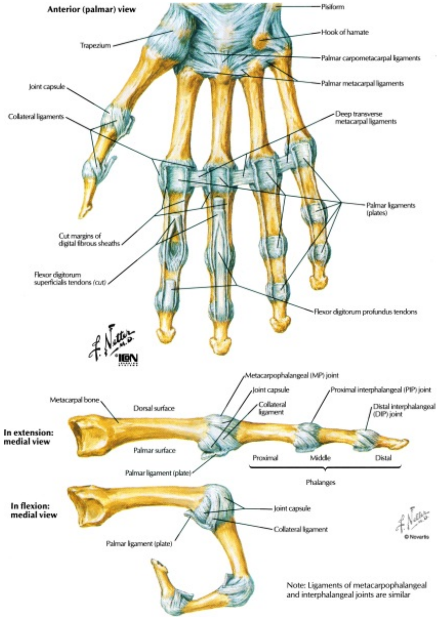
JOINTS



JOINT	TYPE	LIGAMENTS	ATTACHMENTS	COMMENTS
CARPOMETACARPAL				
Thumb	Saddle	Capsule		Highly mobile; common site for arthritis
		Dorsal, palmar, radial CMC	Trapezium to metacarpals	
Finger	Gliding	Capsule		
		Dorsal palmar CMC	Carpal to metacarpal bones	Dorsal strongest
		Interosseous CMC		
METACARPOPHALANGEAL				
	Ellipsoid	Capsule	Metacarpal to proximal phalanx	
		2 collateral (radial and ulnar)	Metacarpal to proximal phalanx	**Loose in extension, tight in flexion**
				Cast in flexion or ligaments will shorten
				Thumb ulnar collateral: • stabilizes pinch • injury is Gamekeeper's
		Palmar [volar plate]	Metacarpal to proximal phalanx	
		Deep transverse metacarpal		
INTERPHALANGEAL				
	Hinge	Capsule		
		2 collateral	Adjacent phalanges	Obliquely oriented
		Palmar [volar	Adjacent phalanges	Prevents hyperextension

		plate]	Adjacent phalanges	Prevents hyperextension



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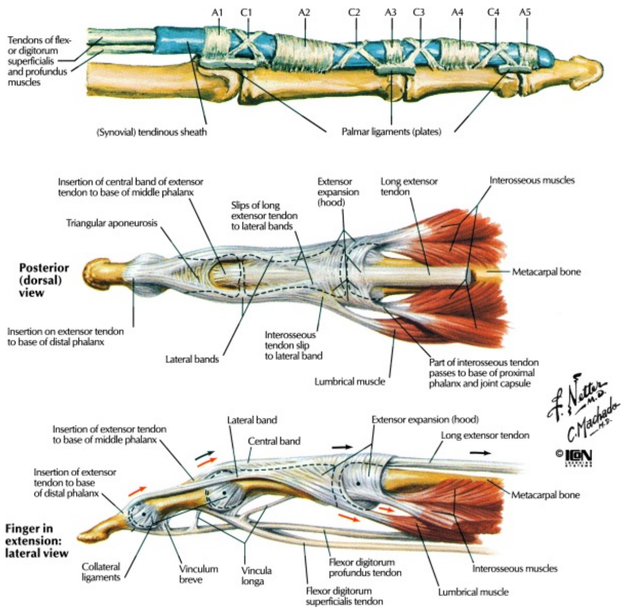
OTHER STRUCTURES: FLEXOR TENDON SHEATH AND PULLEYS



STRUCTURE	CHARACTERISTICS	COMMENT
Flexor tendon sheath	Fibroosseous tunnel, lined with tenosynovium	Pulleys (5 annular, 3 cruciate) are thickenings of sheath. **A2, A4 most important mechanically**. A1, 3, 5 cover joints; **A1 common cause of triggering**.
	Protect, lubricate, nourish tendons	
	In sheath: vinculae are vascular supply to tendons	
		Site of potential infection: **Kanavel signs often present** (see Disorders)
Intrinsic Apparatus	Sagittal bands	EDC attaches extends MCP
	Central Slip	EDC attaches extends PIP: injury can result in Boutonniere deformity
	Lateral bands	Lumbricals attach extend PIP
	Volar plate (transverse fibers)	FDS attaches flexes PIP
	Oblique retinacular ligaments	Interossei attach flex MCP
		EDC attaches extends DIP

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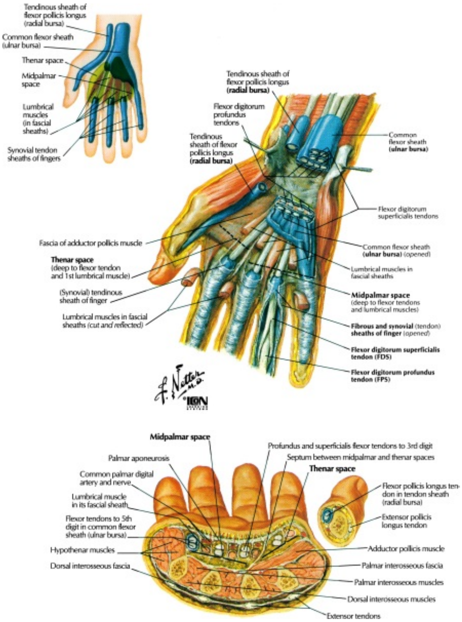
OTHER STRUCTURES: HAND SPACES



STRUCTURE	CHARACTERISTICS	COMMENT
HAND SPACES		
Thenar	Between flexor tendon and Adductor pollicis	Potential space: **site of possible infection**
Mid-palmar	Between flexor sheath and metacarpal	Potential space: **site of possible infection**
Radial bursa	Proximal extension of FPL sheath	Infection can track proximally
Ulnar bursa	Communicates with SF, FDS, FDP flexor tendon sheath	Flexor sheath infection can track proximally into bursa

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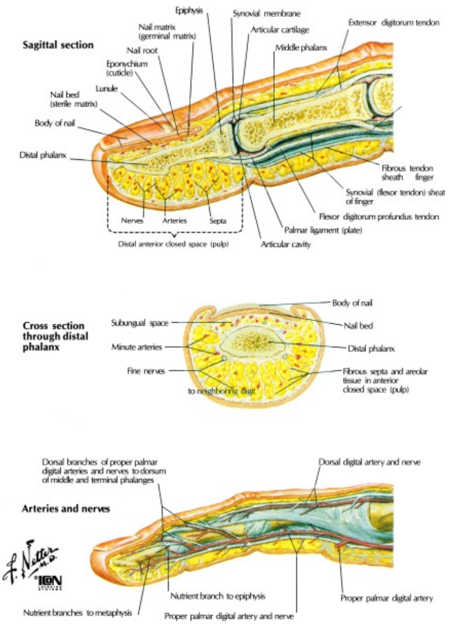
OTHER STRUCTURES: FINGER



STRUCTURE	CHARACTERISTICS	COMMENT
	FINGERTIP	
Nail	Cornified epithelium	If completely avulsed, replace to keep eponychium and matrix separated until nail can grow back.
Nail bed/Matrix	Germinal: to lunula, under eponychium	Where nail grows (1mm a week), **must be intact (repaired) for nail growth**
	Sterile: distal to lunula	If injured, does not need repair to function
Pulp	Multiple septae, nerves, arteries	Felon is an infection of the pulp

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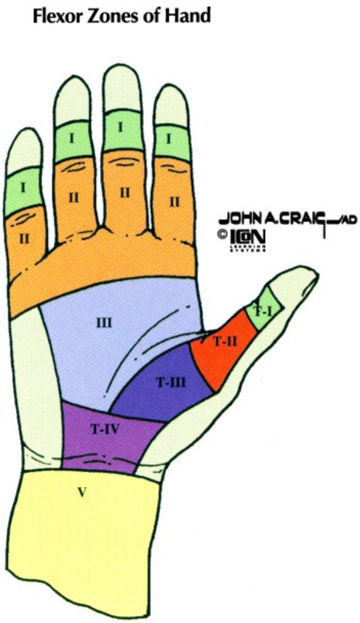
FLEXOR TENDON INJURY ZONES



ZONE	BOUNDARIES	COMMENT
I	FDS insertion to distal tip	Injuries amenable to repair (e.g. Jersey finger)
II	Midpalm fibroosseous tunnel to FDS insertion	Called "**No man's land**" because high rate of complications. Careful PE is required for diagnosis, the injury may not be at skin laceration site . FDS FDP may both require repair. A2, A4 must be preserved.
		Repair in zones 3-5 should be immediate
III	Transverse Carpal ligament to fibro-osseous tunnel	Injuries often associated with Median nerve or arterial arch injuries. Explore and repair all.
IV	Transverse carpal ligament (carpal tunnel)	Uncommon site of injury. Repair usually requires carpal tunnel release and repair. **Median nerve at risk.**
V	Proximal to the TCL	Injuries require end-to-end repair
Thumb I	Thumb IP to distal tip	Similar to finger
Thumb II	Thumb CMC to IP	Similar to finger
Thumb III	Thenar eminence	Repair may require lengthening or graft procedure

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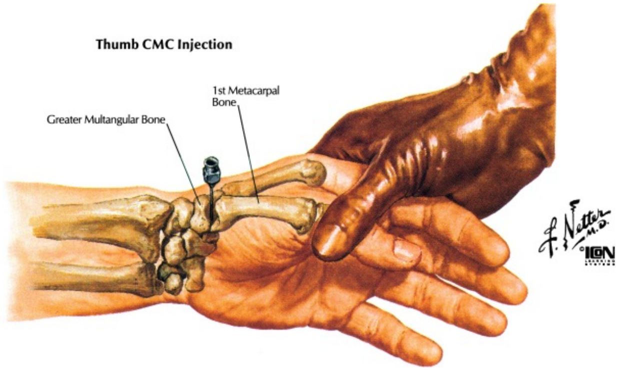
MINOR PROCEDURES



STEPS	
INJECTION OF THUMB CMC JOINT	
1.	Ask patient about allergies
2.	Palpate thumb CMC joint on volar radial aspect
3.	Prepare skin over CMC joint (iodine/antiseptic soap)
4.	Anesthetize skin locally (quarter size spot)
5.	Palpate base of thumb MC, pull axial distraction on thumb with slight flexion to open joint. Use 22 gauge or smaller needle, and insert into joint. **Aspirate to ensure needle is not in a vessel**. Inject 2-3ml of 1:1 local (**without epinephrine**)/corticosterioid preparation into CMC joint. (**The fluid should flow easily if needle is in joint**)
6.	Dress injection site
FLEXOR TENDON SHEATH BLOCK	
1.	Ask patient about allergies
2.	Palpate the flexor tendon at the distal palmar crease.
3.	Prepare skin over palm (iodine/antiseptic soap)
4.	Insert 22 gauge needle into flexor tendon at the level of the distal palmar crease. Withdraw needle so it is just outside tendon, but inside sheath. Inject 2-5ml of **local anesthetic without epinephrine.**
5.	Dress injection site
DIGITAL BLOCK	
1.	Prepare skin over dorsal proximal finger web space (iodine/antiseptic soap)
2.	Insert 22 gauge needle between metacarpal heads on both sides of finger. **Aspirate to ensure needle is not in a vessel**. Inject 2- 5ml of **local anesthetic without epinephrine**. The dorsum of the proximal digit may also require anesthesia for adequate anesthesia.
3.	Care should be taken not to inject too much fluid into the closed space of the proximal digit
4.	Dress injection site

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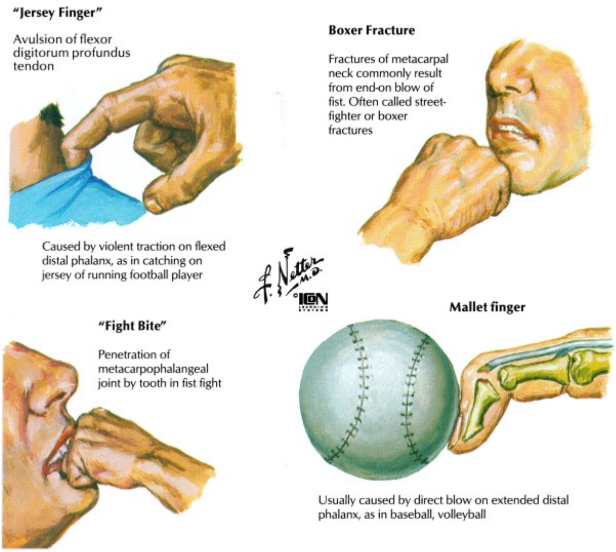
HISTORY



QUESTION	ANSWER	CLINICAL APPLICATION
1. HAND DOMINANCE	Right or left	Dominant hand injured more often
2. AGE	Young	Trauma, infection
	Middle age, elderly	Arthritis, nerve entrapments
3. PAIN		
a. Onset	Acute	Trauma, infection
	Chronic	Arthritis
b. Location	**CMC (thumb)**	**Arthritis (OA) especially in women**
	Volar (fingers)	Purulent tenosynovitis (1 Kanavel signs)
4. STIFFNESS	In AM, with **"catching"**	**Trigger finger,** rheumatoid arthritis
5. SWELLING	After trauma	Infection (e.g. purulent tenosynovitis, felon, paronychia)
	No trauma	Arthritides, gout, tendinitis
6. MASS		**Ganglion**, Dupuytren's contracture, giant cell tumor
7. TRAUMA	Fall, sports injury in dirty environment	Fracture, tendon avulsion
		Infection
8. ACTIVITY	Sports, mechanic	Trauma (e.g. fracture, dislocation, tendon rupture)
9. NEUROLOGIC SYMPTOMS	Pain, numbness, tingling	Nerve entrapment (e.g. carpal tunnel), thoracic outlet syndrome, radiculopathy
	Weakness	Nerve entrapment (usually in wrist or more

	Weakness	proximal)
10. HISTORY OF ARTHRITIDES	Multiple joints involved	Rheumatoid arthritis, Reiter syndrome, etc.

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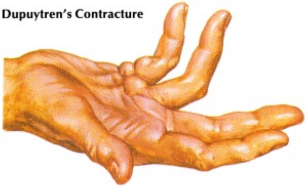
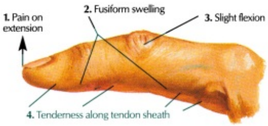
PHYSICAL EXAM

Dupuytren's Contracture



Flexion contracture of 4th and 5th fingers (most common). Dimpling and puckering of skin. Palpable fascial nodules near flexion crease of palm at base of involved fingers with cordlike formations extending to proximal palm

Purulent Tenosynovitis. Four cardinal signs of Kanavel



Rheumatoid Arthritis

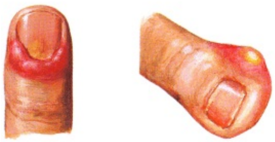
Boutonniere deformity of index finger with swan-neck deformity of other fingers

Osteoarthritis

Heberden's nodes seen in index and middle finger distal interphalangeal joints. Bouchard's nodes seen in proximal interphlangeal joints of the ring and small finger.

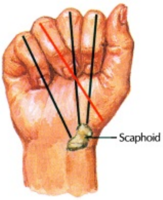
EXAMINATION	TECHNIQUE	CLINICAL APPLICATION
	INSPECTION	
Gross deformity	**Ulnar drift or swan neck**	Rheumatoid arthritis
	Rotational or angular deformity	Fracture
Finger position	Flexion	Dupuytren contracture, purulent tenosynovitis
Skin, hair, nail changes	Cool, hairless, spoon nails, etc.	Neurovascular disorders: Raynaud's, diabetes, nerve injury
Swelling	**DIPs**	Nodes from osteoarthritis: **Heberden's (at DIPs: #1),** Bouchard's (at PIPs)
	PIPs	
	MCP's	Rheumatoid arthritis
	Fusiform shape finger	Purulent tenosynovitis
Muscle wasting	Thenar eminence	Median nerve injury, CTS, C8/T1 pathology, CMC arthritis
	Hypothenar eminence or intrinsics	Ulnar nerve injury

Infections of the fingers



Paronychia

Felon

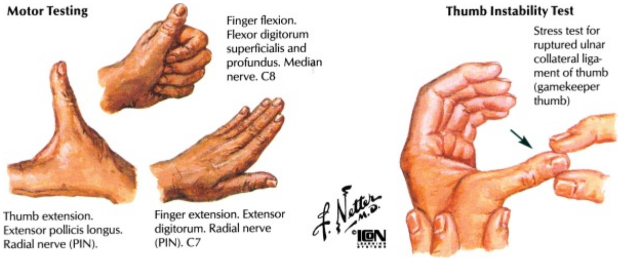


Rotation displacement of ring finger. All fingers should point toward scaphoid when clenched

Stenosing Tenosynovitis (Trigger Finger)

Patient unable to extend affected finger. It can be extended passively, and extension occurs with distinct and painful snapping action. Circle indicates point of tenderness where nodular enlargement of tendons and sheath is usually palpable

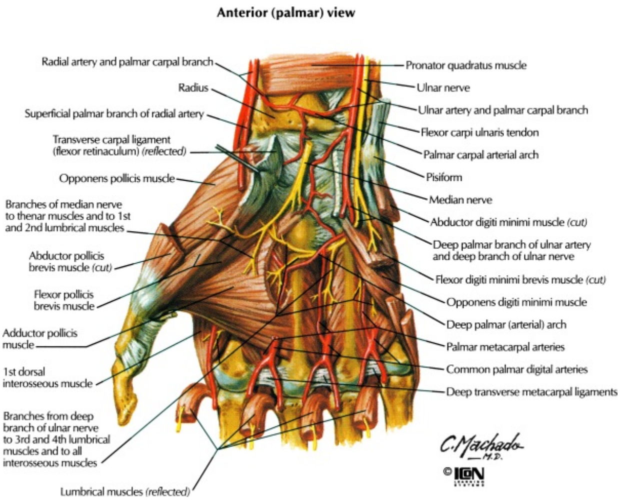
EXAMINATION	TECHNIQUE	CLINICAL APPLICATION
	PALPATION	
Skin	Warm, red	Infection
	Cool, dry	Neurovascular compromise
Metacarpals	Each along its length	Tenderness may indicate fracture
Phalanges finger joints	Each separately	Tenderness: fracture, arthritis; Swelling: arthritis
Soft tissues	Thenar hypothenar eminences	Wasting indicates median ulnar nerve injury respectively
	Palm (palmar fascia)	Nodules: Dupuytren's contracture; Snapping with finger extension: Trigger finger
	Flexor tendons: along volar finger	Tenderness suggests purulent tenosynovitis
	Sides of finger	Giant cell tumors
	All aspects of finger tip	Tenderness: paronychia or felon
	RANGE OF MOTION	
Finger: MCP joint	Flex 90°, extend 0°, Add/abd 0-20°	Decreased flexion if casted in extension (collateral ligaments shorten)
PIP joint	Flex 110°, extend 0°	Hyperextension leads to swan-neck deformity
DIP joint	Flex 80°, extend 10°	All fingers should point to scaphoid at full flexion
Thumb: CMC joint	Radial abduction: Flex 50°, extend 50°	Motion is in plane of palm
	Palmar abduction: Abduct 70°, adduct 0°	Motion is perpendicular to plane of the palm
MCP joint	In plane of palm: Flex 50°, extend 0°	
IP joint	In plane of palm: Flex 90°, extend 10°	
Opposition	Touch thumb to small fingertip	Motion is mostly at CMC joint



EXAMINATION	TECHNIQUE	CLINICAL APPLICATION
	NEUROVASCULAR	
Sensory	Light touch pinprick, 2 point	
Radial Nerve (C6)	Dorsal thumb web space	Deficit indicates corresponding nerve/root lesion
Median Nerve (C6-7)	Radial border middle finger	Deficit indicates corresponding nerve/root lesion
Ulnar Nerve (C8)	Ulnar border small finger	Deficit indicates corresponding nerve/root lesion
Motor		Number in parenthesis indicates compartment
Radial nerve/PIN (C7)	Finger extension	Weakness 5 EDC(4), EIP(4), EDM(5) or nerve lesion
	Thumb abduction extension	Weakness 5 APL(1) / EPL(3) or nerve/root lesion
Median nerve/AIN (C8)	PIP flexion	Weakness 5 FDS or corresponding nerve/root lesion
	DIP flexion	Weakness 5 FDP (1/2 of muscle) or nerve lesion
	Thumb IP flexion	Weakness 5 FPL or corresponding nerve/root lesion
Motor Recurrent Branch	“OK” sign	Weakness 5 APB, OP, 1/2 FPB or nerve lesion; (CTS)
	MCP flexion (index/middle fingers)	Weakness 5 IF, MF lumbricals or c nerve/root lesion
Ulnar nerve (Deep branch) (T1)	Finger cross (abduct/adduct)	Weakness 5 Dorsal/Volar interosseous or nerve lesion
	Small finger abduction	Weakness 5 FDM, ODM, ADM or nerve/root lesion
	MCP flexion (ring/small fingers)	Weakness 5 RF, SF lumbricals or nerve/root lesion
Reflex: Hoffmann	Tap a finger distal phalanx	Only pathologic (1 if different phalanx flexes): UMN syndrome
		Tests ulnar and radial artery patency
Pulses/capillary refill	Allen's test	
	Doppler: arches, digital pulses	
	SPECIAL TESTS	
	Stabilize PIP in	

Profundus	Stabilize PIP in extension, flex DIP only	Inability to flex DIP alone indicates **FDP pathology**	
Sublimis	Extend all fingers, flex a single finger at PIP	Inability to flex PIP of isolated finger indicates **FDS pathology**	
Froment's sign	Hold paper with thumb index finger, pull paper	Thumb PIP flexion is positive, suggest Adductor Pollicis or Ulnar nerve palsy	
CMC grind	Axial compress rotate CMC joint	Pain indicates arthritis at CMC and/or MCP joints of thumb	
Finger instability	Stabilize proximal joint, apply varus valgus stress	Laxity indicates collateral ligament damage	
Thumb instability	Stabilize MCP, apply valgus stress	Laxity indicates **ulnar collateral ligament strain (Gamekeeper's thumb)**	
Murphy sign	Make fist, observe height of MCP's	If 3rd MC (normally elevated) is flat with 2nd 4th MC, suggests lunate dislocation	
Bunnel-Littler	Extend MCP, passively flex PIP	Tight or inability to flex PIP, improved with MCP flexion indicates tight intrinsic muscles	

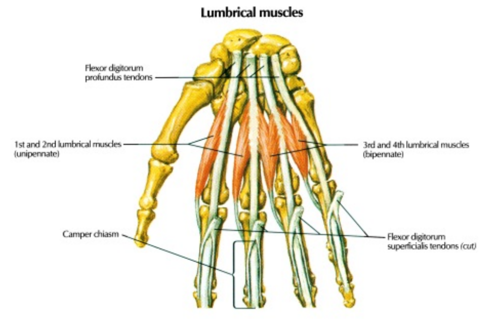
MUSCLES

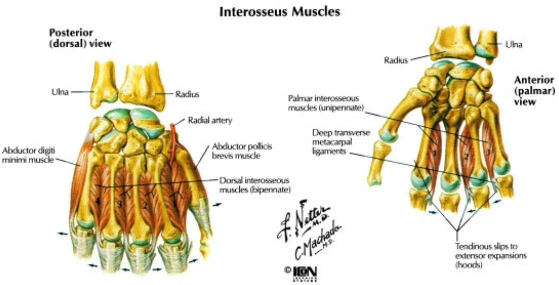


MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
THENAR COMPARTMENT					
Abductor pollicis brevis [APB]	Scaphoid, trapezium	Lateral proximal phalanx of thumb	Median	Thumb abduction	Palpable in lateral thenar eminence
Flexor pollicis brevis [FPB]	Trapezium	Base of proximal phalanx of thumb	Median	Thumb MCP flexion	Palpable in medial thenar eminence
Opponens pollicis	Trapezium	Lateral thumb MC	Median	Oppose thumb, rotate medially	Opposition is most important action
ADDUCTOR COMPARTMENT					
Adductor pollicis	1. Capitate, 2nd 3rd MC	Base of proximal phalanx of thumb	Ulnar	Thumb adduction	Radial artery between its two heads
	2. 3rd Metacarpal				
HYPOTHENAR COMPARTMENT					
Palmaris brevis [PB]	Transverse carpal ligament [TCL]	Skin on medial palm	Ulnar	Wrinkles skin	Protects ulnar nerve
Abductor digiti minimi [ADM]	Pisiform	Base of proximal phalanx of SF	Ulnar	SF abduction	Palpable laterally
Flexor digiti minimi brevis [FDMB]	Hamate, TCL	Base of proximal phalanx of SF	Ulnar	SF MCP flexion	Palpable medially
				Oppose SF	Deep to other

Opponens digiti minimi [ODM]	Hamate, TCL	Medial side 5th MC	Ulnar	Oppose SF, rotate laterally	Deep to other muscles in the group

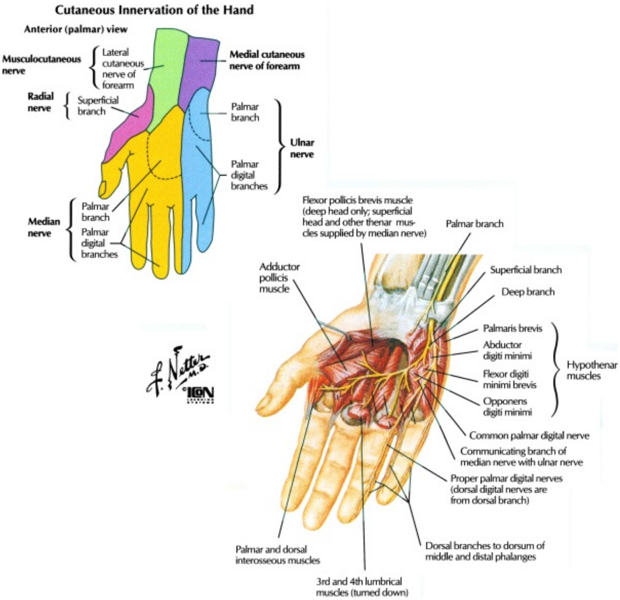
INTRINSIC MUSCLES



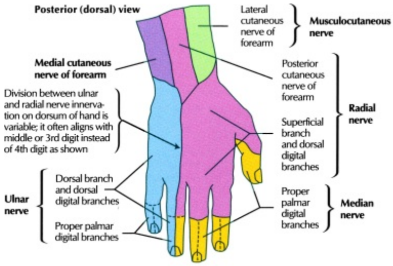


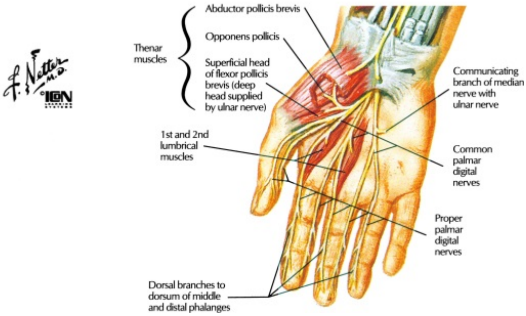
MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
INTRINSICS					
Lumbricals 1 2	FDP tendons (lateral 2)	Lateral bands	Median	Extend PIP, flex MCP	Only muscles in body to insert on their own antagonist.
Lumbricals 3 4	FDP tendons (medial 3)	Lateral bands	Ulnar	Extend PIP, flex MCP	
Interosseous: Dorsal [DIO]	Adjacent metacarpals	Proximal phalanx extensor expansion	Ulnar	Digit abduction	DAB: Dorsal ABduct
Interosseous: Volar [VIO]	Adjacent metacarpals	Proximal phalanx extensor expansion	Ulnar	Digit adduction	PAD: Palmar Adduct (volar 5 palmar)

NERVES



INFRACLAVICULAR	
MEDIAL CORD	
1. ***Ulnar*** (C(7)8-T1): through Guyon's canal, past hook of hamate	
Sensory:	Medial palm 1 1/2 digits via: palmar, palmar digital branches
	Medial dorsal hand 1 1/2 digits via: dorsal, dorsal digital, proper digital branches
	Nerve divides at hypothenar eminence
Motor:	**Superficial Branch** @[lateral to pisiform]
	Palmaris brevis
	Deep (Motor) Branch [around hook of hamate]
	Adductor pollicis
	THENAR MUSCLES
	Flexor pollicis brevis [FPB] [with median]
	HYPOTHENAR MUSCLES
	Abductor digiti minimi [ADM]
	Flexor digiti minimi brevis[FDMB]
	Opponens digiti minimi [ODM]
	INTRINSIC MUSCLES
	Dorsal interossei [DIO] [abduct DAB]
	Volar interossei [VIO] [adduct PAD]
	Lumbricals [medial two (3,4)]





INFRACLAVICULAR	
MEDIAL AND LATERAL CORDS	
2. **Median** (C(5)6-T1): runs through carpal tunnel, then cutaneous branches off at (risk in Carpal Tunnel release)	
Sensory:	**Palmar Cutaneous Branch**
	Dorsal distal phalanges of 3 1/2 digits: via proper palmar digital branches
	Volar wrist capsule
	Volar 3 1/2 digits and lateral palm: via palmar palmar digital branches (multiple variations of thumb sensory innervation)
Motor:	**Motor Recurrent (Thenar motor) Branch:** Usually branches off median before carpal tunnel
	THENAR
	Abductor pollicis brevis [APB]
	Opponens pollicis
	Flexor pollicis brevis [FPB]
	I(Joint innervation with ulnar nerve)/I
	INTRINSIC
	Lumbricals [lateral two (1,2)]
POSTERIOR CORD	
3. ***Radial*** (C5-T1):	
Sensory:	Dorsal 3 1/2 digits and hand: via superficial branch (dorsal digit branches)
	Dorsal wrist capsule

Motor:	NONE (in hand)

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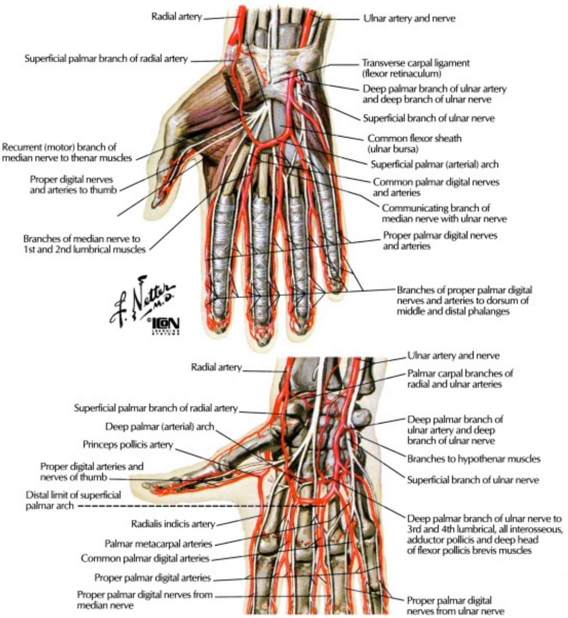
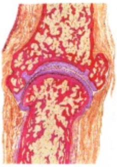
ARTERIES



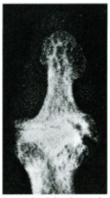
COURSE	BRANCHES	COMMENT
	DEEP PALMAR ARCH	
Through heads of the adductor pollicis	Terminal branch of *radial* artery deep branch of the *ulnar* artery	
	Princeps pollicis Radialis indicis Proper digital artery of thumb	Under FPL, along 1st metacarpal
		May come from deep arch
	Palmar metacarpal (3)	Joins common digital artery
	SUPERFICIALS PALMAR ARCH	
Just deep to aponeurosis.	Terminal branch of *ulnar* artery superficial branch of the *radial* artery	
	Common palmar digital (3)	Bifurcates
	Proper palmar digital	Along sides of fingers
	Proper palmar digital	Of small finger only

DISORDERS: ARTHRITIS

Osteoarthritis



Section through distal interphalangeal joint shows irregular, hyperplastic bony nodules (Heberden's nodes) at articular margins of distal phalanx. Cartilage eroded and joint space narrowed



Radiograph of distal interphalangeal joint reveals late-stage degenerative changes. Cartilage destruction and marginal osteophytes (Heberden's nodes)

Late-stage degenerative changes in carpometacarpal articulation of thumb

Rheumatoid Arthritis

Radiograph shows cartilage thinning at proximal interphalangeal joints, erosion of carpus and wrist joint, osteoporosis, and finger deformities

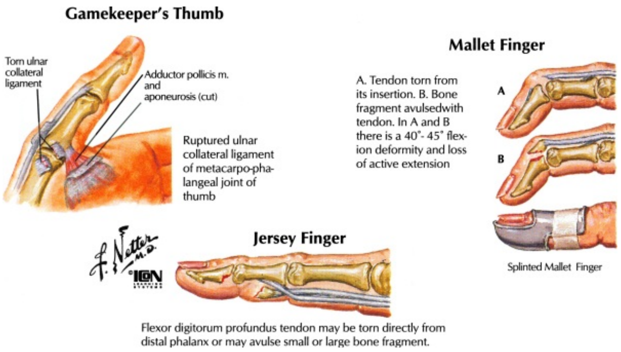
Stenosing Tenosynovitis (Trigger Finger)

Inflammatory thickening of fibrous sheath (pulley) of flexor tendons with fusiform nodular enlargement of both tendons. Broken line indicates line for incision of lateral aspect of pulley

DESCRIPTION	HISTORY/PHYSICAL EXAM	WORK-UP/FINDINGS	TREATMENT
ARTHRITIS: OSTEOARTHRITIS/DEGENERATIVE JOINT DISEASE (DJD)			
• Wear and tear arthritis	Hx: Older, women, pain worsewith activity	XR: OA findings:osteophytes, joint spaceloss, sclerosis,subchondral cysts	1. NSAID, splint, steroid injection
• Loss of articular cartilage	PE: + IP (DIP and/or PIP)nodes, + CMC grind test		2. DIP: arthrodesis, CMC/PIP: arthroplasty
• DIP #1 [Heberden's nodes] CMC, IP #2 [Bouchard's nodes]			
ARTHRITIS: RHEUMATOID			
• Systemic inflammatorydisease affecting synovium:destroys joints. MCP #1	Hx: Painful, stiff (worse in AM)	XR: Hand series: joint destruction	I. Medical management splinting
• Has 4 stages	PE: Multiple joint swelling. deformities: ulnar drift (MCP)swan neck, boutonniere	Labs: RF, ANA, WBC, ESR, uric acid	II. Synovectomy (single joint)
• Associated with tenosynovitis,Carpal Tunnel Syndrome			III/IV. Tendon transfer orrepair, arthrodesis,arthroplasty
FLEXOR TENOSYNOVITIS: TRIGGER FINGER/THUMB			
• Nodule on tendon	Hx: Age: 401, tender		1. Steroid injection (+/-

catcheson pulley (A1 most common)	Hx: Age: 40+, tender nodule	XR: None needed	1. Steroid injection (+/- splint)
• Also seen in Diabetes Mellitus	PE: Pain. Locking with flexion extension		2. A1 release [must spare A2]

DISORDERS: LIGAMENT INJURIES

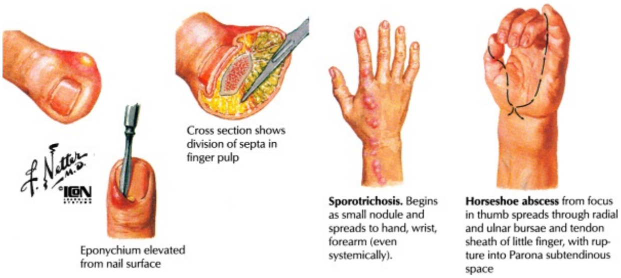


DESCRIPTION	HISTORY/PHYSICAL EXAM	WORK-UP/FINDINGS	TREATMENT
CENTRAL SLIP INJURY: BOUTONNIERE DEFORMITY			
• Extensor tendon (central slip) at PIP ruptures, lateral bands slip volar and flex PIP.	Hx: Hand trauma	XR: Hand series: normal	1. Splint PIP in extension, DIP free
	PE: PIP flexed, no active extension, DIP extended		2. Reconstruct central slip and bands
• Associated with RA			3. Severe: fusion or arthroplasty
FLEXOR TENDON INJURY: JERSEY FINGER			
• Flexor tendon avulses from forceful extension	Hx: Extension injury, 1/2 pain.	XR: Rule out fracture (1/2 avulsion fracture)	1. Primary repair
• In football; RF#1; FDPFDS	PE: FDS: 1 sublimus test FDP: 1 profundus test		2. Older patient: DIP fusion
MALLET FINGER			
• Extensor tendon rupture atdistal phalanx	Hx: Minor trauma	XR: 1/2 avulsion fracture	1. CONSTANT splint (DIP only) for 8 weeks
	PE: Cannot extend DIP, minimal pain swelling		
• FDP unopposed so DIP flexes	.		2. Repair if large bony avulsion fracture
SWAN NECK DEFORMITY			
• FDS rupture/volar plate injury	Hx: Trauma, RA, spastic	XR: Hand series	1. Early: splint
• Lateral bands subluxes dorsally, PIP hyperextends DIP flexes	PE: PIP yperextended, DIP flexed		2. Late: surgical repair (individualize

flexes	flexed		each case)
ULNAR COLLATERAL OF THUMB: GAMEKEEPER'S THUMB			
• Ulnar collateral ligament torn	Hx: Trauma. Pain swelling.	XR: 1/2 avulsion fracture.	1. Incomplete: splint 2-4 weeks
• Mechanism: forceful radial deviation	PE: Ulnar thumb unstable with radial extension/abduction	Stress view shows injury	2. Complete: surgical repair (treat Stener lesion)
• Often in ski pole injury			

DISORDERS: INFECTIONS

Felon



DESCRIPTION	HISTORY/PHYSICAL EXAM	WORK-UP/FINDINGS	TREATMENT
BITES: HUMAN/ANIMAL			
• Usually dominant hand	Hx: Laceration or puncture,dorsal MCP most common location	XR: Rule out fracture	1. Thorough ID, Td if necessary
• Classic mechanism: fist fight		Labs: Aerobic anaerobic cultures, WBC	2. IV antibioticsAnimal: Unasyn Human: Augmentin
• Human: poly bacterial including Eikenella corrodens	PE: Red, swollen, 1/2 drainage, streaking. Decreased extension if tendon torn	[Contact health officials if animal possibly rabid]	
			3. Do not close wound, dress appropriately
• Animal: Pasteurella multocida			
DEEP SPACE INFECTION			
• From palm puncture or spread from finger (+/- Horseshoe)	Hx/PE: Erythema, fluctuance, and tenderness	XR: Usually normal	Dorsal volar ID and IV antibiotics
FELON			
• Deep infection or abscess in pulp	Hx/PE: Erythematous, swollen, and painful.	XR: Usually normal	1. ID, release septae
			2. IV antibiotics
• Staph Aureus #1 organism			
PARONYCHIA/EPONYCHIA			
• Nail bed infection (most common finger infection)	Hx/PE: Red, painful, swollen, often purulent drainage	XR: Usually normal	1. Soaks and oral antibiotics
			2. ID with nail removal if necessary
• Staph Aureus #1			

organism			
PURULENT TENOSYNOVITIS			
• Infection of flexor tendon sheath	Hx: Puncture wound	XR: Possible foreign body or subcutaneous air	1. Mild (early): IV antibiotics, re-evaluate within 24 hours
• Usually from puncture wound	PE: KANAVEL SIGNS: 1. Flexed position, 2. Pain on passive extension, 3. Fusiform swelling, 4. Tender flexor sheath		2. Most: I D (1/2 drain) and IV antibiotics
• May extend into palm and develop “horseshoe” infection			No treatment results in adhesions necrosis
SPOROTRICHOSIS			
• Lymphatic infection (from roses)	Hx/PE: Discoloration or rash	XR: None	Potassium iodine solution

DISORDERS: MASSES TUMORS

DESCRIPTION	HISTORY/PHYSICAL EXAM	WORK-UP/FINDINGS	TREATMENT
DUPUYTREN'S DISEASE			
• Proliferation of fascia (long bands)	Hx: Male, 401 years old	XR: None needed	1. No proven conservative treatment
• Northern European descent	PE: nodule, non-tender, flexed digit (RF#1, SF#2)		
• Associated with DM, epilepsy			2. Fasciotomy
ENCHONDROMA			
• #1 Primary bone tumor	Hx: Pain after pathologic fracture	XR: Lytic lesion	Curettage and bone graft
• Usually proximal phalanx			
EPIDERMAL INCLUSION CYST			
• Epidermal cells embedded deep into tissue	Hx: Trauma or puncture	XR: Normal	Excision (get all epidermal cells or it will recur)
	PE: Painless mass, usually on digits, no transillumination		
GANGLION RETINACULAR CYST			
• Cyst (arises from joint or tendon) with mucinous joint fluid	Hx: Young patient	XR: No osteophyte in corresponding area	Aspiration of cyst if symptomatic. (may recur)
	PE: Visible, firm mass (volar MCP flexor tendon #1 site).		
• Most common mass in hand			
GIANT CELL TUMOR (FIBROXANTHOMA)			
• Originates from tendon sheath	Hx/PE: Firm, painless mass, usually volar finger (IF,MF)	XR: Normal	Excise, they do recur
• 2nd most common hand mass			

MALIGNANT TUMORS			
• #1 Primary: squamous cell	Hx/PE: Mass, usually on dorsum of hand	XR: Normal	Excise
• #1 Metastatic: lung			
MUCOUS CYST			
• A ganglion of dorsal DIP	Hx: Women, older patients	XR: OA and/or spur at DIP	Excision and osteophyte or joint debridement
• Associated with OA at DIP	PE: Dorsal DIP mass, 1/2 pain		

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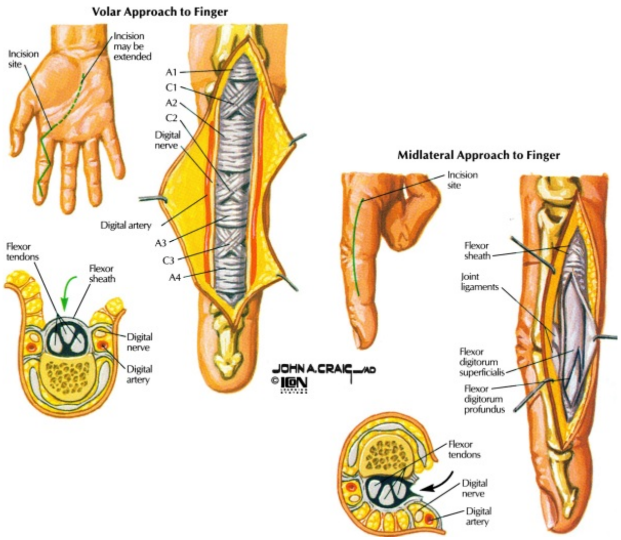
SURGICAL APPROACHES

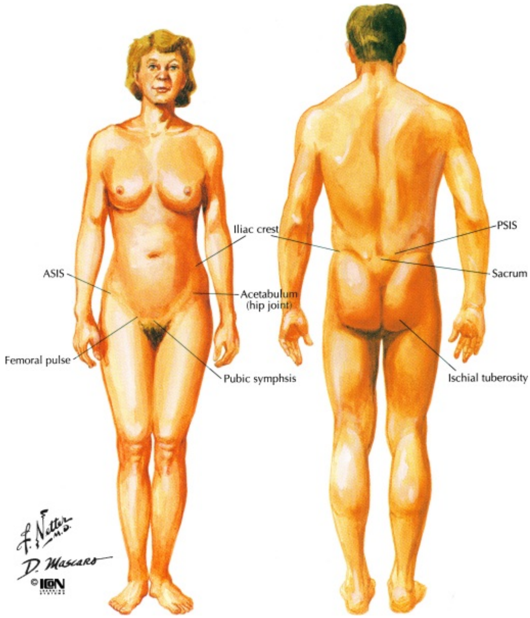


USES	INTERNERVOUSPLANE	DANGERS	COMMENT
FINGER: VOLAR APPROACH			
1. Flexor tendons (repair/explore)	No planes	1. Digital artery	1. Make a “zig-zag” incision with angles of 90°
2. Digital nerve		2. Digital nerve	
3. Soft tissue releases			2. Neurovascular bundle is lateral to the tendon sheath
4. Infection drainage			
FINGER: MID-LATERAL APPROACH			
Phalangeal fractures	No planes	1. Digital nerve	Soft tissues are thin, capsule can be incised if care is not taken.
		2. Digital artery	

CHAPTER 6 - PELVIS

CHAPTER 6 – PELVIS

TOPOGRAPHIC ANATOMY



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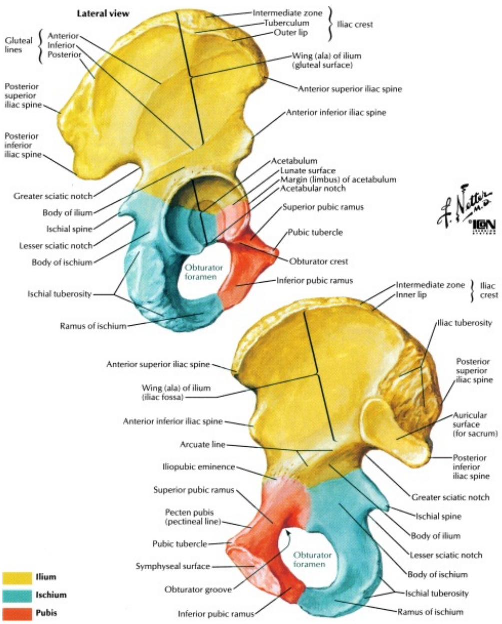
OSTEOLOGY



CHARACTERISTICS	OSSIFY		FUSE	COMMENT
INNOMINATE: COXAL BONE				
• One bone: started as 3, connected by tri-radiate cartilage at acetabulum Ilium: body ala Ischium: body ramus Pubis: body 2 rami	Primary (one in each body)	2-6 mo	to acetabulum 15 yrs	• Iliac wing and superior pubic ramus are "weak spots"
				• ASIS: avulsion fracture can result from sartorius
	Secondary Iliac crest Acetabulum Ischial tuberosity AIIS Pubis	15 yrs	All fuse 20 yrs	• AIIS: avulsion fracture can result from rectus femoris
• Two innominate per pelvis (L R)				• Iliac crest ossification used to determine skeletal maturity (Risser stage)

• Acetabulum: anteverted and oblique orientation (approx. 45°)				• Iliac crest contusion referred to as “hip pointer”
SACRUM				
See spine chapter				

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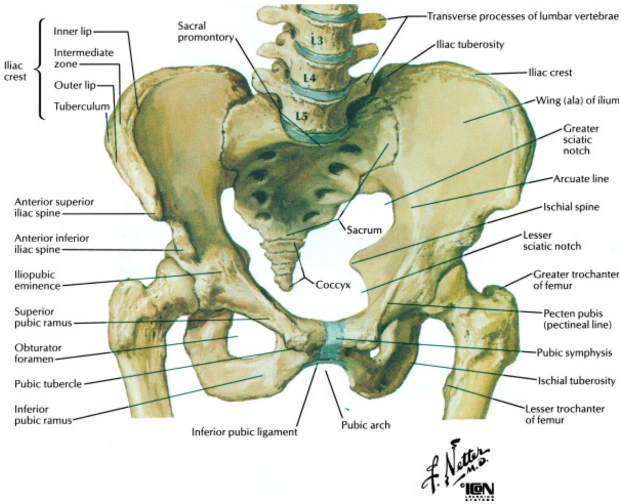
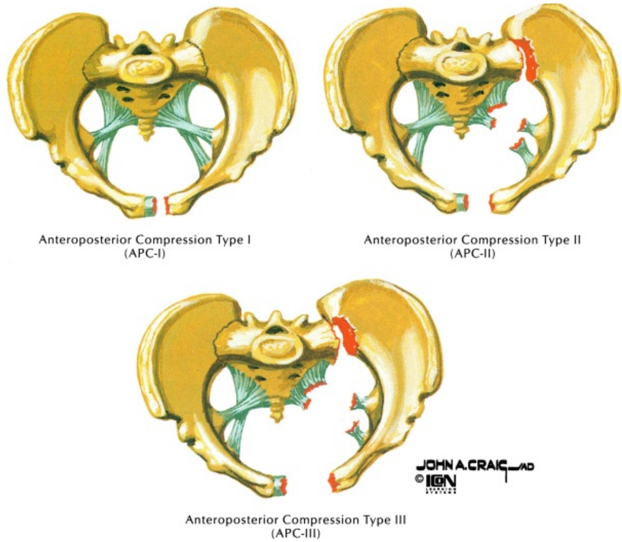
LANDMARKS AND OTHER STRUCTURES

STRUCTURE	ATTACHMENTS/ RELATED STRUCTURES	COMMENT
ASIS	Sartorius Inguinal ligament	• LFCN crosses the ASIS can be compressed there (Meralgia paresthetica)
	Transverse internal oblique abdominal muscles	• Sartorius can avulse from it (avulsion fracture)
AIIS	Rectus femoris Tensor fascia lata Iliofemoral ligament (hip capsule)	• Rectus femoris can avulse from it (avulsion fracture)
PSIS	Posterior sacroiliac ligaments	• Excellent bone graft site
	Marked by skin dimple	
Arcuate line	Pectineus muscle	• Strong, weight bearing region
Gluteal lines	3 lines: anterior, inferior, posterior	• Separate origins of gluteal muscles
Greater trochanter	SEE ORIGINS/INSERTIONS	• Tender with trochanteric bursitis
Lesser trochanter	Iliacus Psoas muscles	
Ischial tuberosity	SEE ORIGINS/INSERTIONS Sacrotuberous ligaments	• Excessive friction can cause bursitis (Weaver's bottom)
Ischial spine	Coccygeus Levator ani attach Sacrospinous ligaments	
Anterior (iliopubic) column of acetabulum	Consists of: 1. Pubic ramus 2. Anterior acetabulum 3. Anterior iliac wing	• Involved in several different fracture patterns
Posterior (ilioischial) column of acetabulum	Consists of: 1. Ischial tuberosity 2. Posterior acetabulum 3. Sciatic notch	• Involved in several different fracture patterns
Lesser sciatic foramen	Short external rotators exit: Obturator externus Obturator internus	
Greater sciatic foramen	Structures that exit: 1. Superior gluteal nerve 2. Superior gluteal artery 3. Piriformis muscle 4. **P**udendal nerve 5. Inferior pudendal artery 6. Nerve to the **O**bturator internus 7. **Posterior**	• Piriformis muscle is the reference point • Superior Gluteal nerve and artery exit superior to the piriformis • **POP'S IQ** is a mnemonic for the

	Cutaneous nerve of thigh 8. **S**ciatic nerve 9. **I**nferior gluteal nerve 10. Inferior gluteal artery 11. Nerve to **Q**uadratus femoris	nerves (structures) that exit inferior to the piriformis (medial to lateral)



TRAUMA



Classification of Pelvic Fractures (Young and Burgess)

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
PELVIC FRACTURE			
• Mechanism 1: High energy force (e.g. MVA). Lateral force more common than AP • Usually associated with other injuries (often life threatening). • Open pelvic fracture with associated GI and/or GU injury: 50% mortality • Posterior SI ligament is key to pelvic stability • Mechanism	HX: Trauma. Swelling, pain, deformity. PE: ABC's. Affected LE shortened, +/-blood in rectum/vagina/urethra. Do good neurovascular exam: +/-pulses in groin LE with neurologic deficits including loss of rectal tone bulbocavernosus reflex. XR: AP, Inlet, Outlet Judet views of the pelvis.	Young and Burgess: • AP compression (APC): I. 2.5cm pubic diastasis fracture of 1-2 rami II. 2.5cm diastasis; SI disruption, but stable III. Complete disruption pubis symphysis SI joint: unstable fracture • Lateral Compression (LC): I. Sacral compression with rami fractures	Treat life threatening injuries first (ABC's). Treat pelvic hemorrhage with external fixation (+/- 2embolization) Diverting colostomy for GI injury (avoid sepsis) Stable fractures: (single ramus, avulsion fx, APC or LC I): conservative treatment; bedrest, decreased

Mechanism 2: Minor trauma (e.g. fall on osteopenic bone): stable single ramus fracture • Mechanism 3: Stable avulsion fracture - ASIS (Sartorius) - AIIS (Rectus femoris) - Ischium (hamstring)	CT: Scan entire pelvis AGRAM: for hemorrhage	II. Rami fracture, posterior SI ligment disrupted, but stable III. LC II, with contralateral APC III ("windswept") • Vertical shear: anterior posterior pelvic injury (displacement): vertically unstable.	decreased activity Unstable fractures: external fixation with ORIF as needed Early mobilization aids recovery

COMPLICATIONS: Associated injuries (especially with APC III): 1. GI, 2. GU, 3. Vascular/hemorrhage, 4. Neurologic; Prolonged hospital stay with associated risks (infection, DVT, etc.); Residual deformity and/or pain (lower back or SI); Leg length discrepancy


Lateral Compression Type I (LC-I)

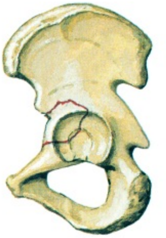

Lateral Compression Type II (LC-II)


Lateral Compression Type III (LC-III)

Vertical shear

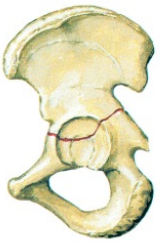
I. Fracture of posterior wall.
Repair with plate and lag screws

II. Fracture of posterior column.
Repair with plate and lag screw



III. Wedge fracture of anterior wall.
Repair with lag screws

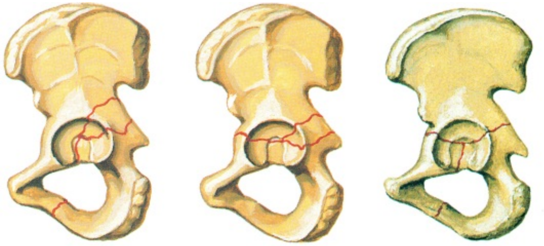
IV. Fracture of anterior column.
Repair with plate and long screws



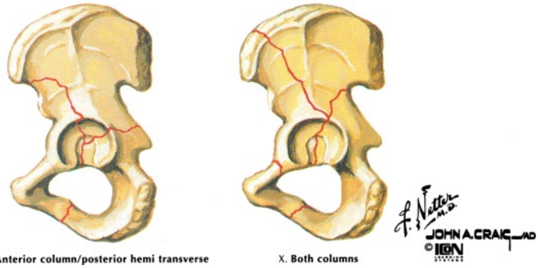
V. Transverse fracture.
Repair with plate and lag screw

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
ACETABULAR FRACTURE			
• Uncommon, younger • High energy or violent injury; femoral head is forced into acetabulum • **Dislocation of hip is often associated** • Also GI, GU, vascular associated injuries.	HX: Trauma (e.g. dashboard injury). Pain, deformity. PE: LE shortened, rotated. Usually neurovascularly intact distally. XR: AP. Internal external obliques (Judet views): many possible fracture sites CT: shows fracture pattern and loose fragments	Judet/Letournel: I. Posterior wall II. Posterior column III. Anterior wall IV. Anterior column V. Transverse VI. Posterior column wall VII. Transverse post. wall VIII. T-type IX. Anterior column posterior emi-transverse X. Both columns	Traction on affected side Nondisplaced, congruent joint, Displaced, dislocation, unstable fx: ORIF XRT (600 rads) prophylaxis for heterotopic bone.

COMPLICATIONS: Need for Total Hip Arthroplasty; Nerve injury (sciatic); Heterotopic bone formation; Osteonecrosis steoarthritis



VI. **Posterior column/posterior wall** VII. **Transverse/posterior wall** VIII. **T-shaped fracture.**
Repair with plate and lag screws



IX. **Anterior column/posterior hemi transverse** X. **Both columns**

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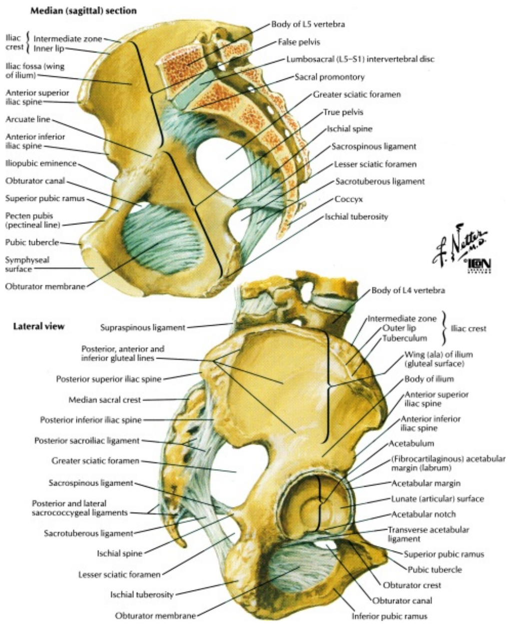
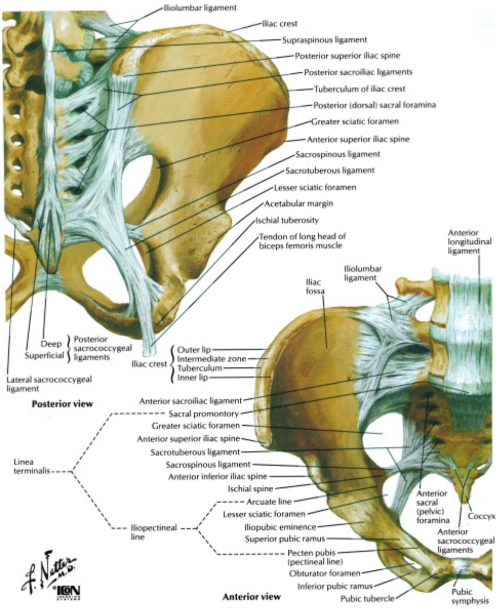
JOINTS



LIGAMENTS	ATTACHMENTS	COMMENTS
	SACROILIAC (GLIDING)	
Posterior SI (short long)	Sacrum to ilium: Short are horizontal Long are vertical	Strongest SI ligaments: key to stability. Short: resist rotation Long: resist vertical shear
		Disruption: rotational vertical instability
Anterior SI	Sacrum to ilium (horizontal)	Rotational stability
Interosseous	Sacral to iliac tuberosities	Strong



LIGAMENTS	ATTACHMENTS	COMMENTS
SYMPHYSIS PUBIS		
Superior pubic ligament	Both pubic bones superiorly	There is a fibrocartilage disc between the two hemipelvi
Arcuate pubic ligament	Both pubic bones inferiorly	
OTHER LIGAMENTS		
Sacrospinous	Anterior sacrum to ischial spine	Divides greater lesser sciatic foramina; provides rotational stability
Sacrotuberous	Anterior sacrum to ischial tuberosity	Inferior border of lesser sciatic foramina; provides vertical stability
Iliolumbar	L5 transverse process to crest	Can result in avulsion fracture
Lumbosacral	L5 transverse process to ala	Vertical stability

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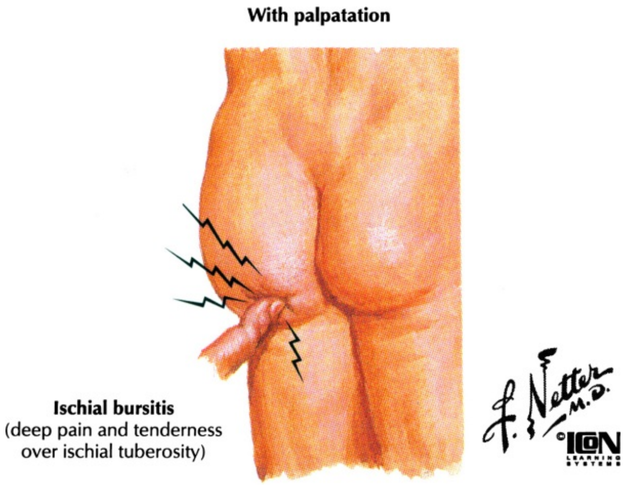
HISTORY AND PHYSICAL EXAM

QUESTION	ANSWER	CLINICAL APPLICATION
1. AGE	Young Middle age, elderly	Ankylosing Spondylitis (1HLA-b27) Decreased mobility
2. PAIN a. Onset b. Character c. Occurrence	Acute Chronic Deep, non-specific Radiating In out of bed, on stairs Adducting legs	Trauma: fracture, sprain Systemic inflammatory disorder Sacroiliac etiology To thigh or buttock on ipsilateral side: SI joint injury Sacroiliac etiology Symphysis pubis etiology
3. PMHx	Pregnancy	Laxity of ligaments of SI joint causes pain
4. TRAUMA	Fall on buttock, twist injury	Sacroiliac joint injury
	High velocity: MVA, fall	Fracture
5. ACTIVITY/WORK	Twisting, stand on one leg	Sacroiliac etiology
6. NEUROLOGIC SYMPTOMS	Pain, numbness, tingling	Spine etiology, sacroiliac etiology
7. HISTORY of ARTHRITIDES	Multiple joints involved	SI involvement of RA, Reiter's syndrome, Ankylosing Spondylitis, etc.

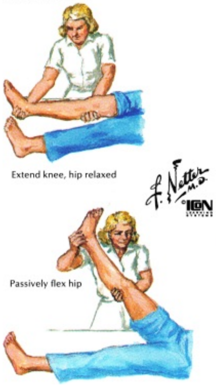
PHYSICAL EXAM OF THE PELVIS



EXAM/ OBSERVATION	TECHNIQUE	CLINICAL APPLICATION
	INSPECTION	
Skin	Discoloration, wounds	
ASIS's, Iliac crests	Both level (same plane)	If on different plane: Leg length discrepancy, sacral torsion
Lumbar curvature	Increased lordosis	Flexion contracture
	Decreased lordosis	Paraspinal muscle spasm
	PALPATION	
Bony structures	Standing: ASIS, Pubic Iliac tubercles, PSIS	Unequal side to side 5pelvic obliquity: leg length discrepancy
	Lying: Iliac crest, Ishial tuberosity	Mass: cluneal neuroma
Soft tissues	Inguinal ligament	Protruding mass: hernia
	Femoral pulse nodes	Diminished pulse: vascular injury; palpable nodes: infection
	Muscle groups	Each group should be symmetric bilaterally
	RANGE OF MOTION	
Forward flexion	Standing: bend forward	PSIS's should elevate slightly (equally)
Extension	Standing: lean backward	PSIS's should depress (equally)
Hip flexion	Standing: knee to chest	PSIS should drop but will elevate in hypomobile SI joint
		Ischial tuberosity should move laterally, will elevate in hypomobile SI joint

PHYSICAL EXAM

Straight Leg Test



Trendelenburg test Left: patient demonstrates negative Trendelenburg's test of normal right hip. Right: positive test of involved left hip. When weight is on affected side, normal hip drops, indicating weakness of left gluteus medius muscle. Trunk shifts left as patient attempts to decrease biochemical stresses across involved hip and thereby maintain balance

Rectal examination for sphincter function and perianal sensation important in all patients with spinal injury. Gloved finger in rectum feels contraction when patient instructed to contract anal sphincter. Gross blood indicates pelvic fracture communicating with colon.

EXAM/ OBSERVATION	TECHNIQUE	CLINICAL APPLICATION
NEUROVASCULAR		
Sensory		
Iliohypogastric nerve (L1)	Suprapubic, lateral buttocks thigh	Deficit indicates corresponding nerve/root lesion
Ilioinguinal nerve (L1)	Inguinal region	Deficit indicates corresponding nerve/root lesion (e.g. abdominal muscle compression)
Genitofemoral nerve (L1-2)	Scrotum or mons	Deficit indicates corresponding nerve/root lesion
Lateral femoral cutaneous nerve (L2-3)	Lateral hip thigh	Deficit indicates corresponding nerve/root lesion (e.g. Meralgia paresthetica)
Pudental nerve (S2-4)	Perineum	Deficit indicates corresponding nerve/root lesion
Motor		
Femoral (L2-4)	Hip flexion	Weakness 5Iliopsoas or corresponding nerve/root lesion
Inferior Gluteal nerve	External rotation	Weakness 5Gluteus maximus or nerve/root lesion
Nerve to Quadratus femoris	External rotation	Weakness 5Short rotators or corresponding nerve/root lesion
Nerve to Obturator internus		
Nerve to Piriformis		
Superior Gluteal nerve	Abduction	Weakness 5Gluteus medius/minimus, TFL or corresponding nerve/root lesion
Reflex	Bulbocavernosus	Finger in rectum, squeeze or pull penis (Foley), anal sphincter should contract
Pulses	Femoral pulse	
SPECIAL TESTS		
Straight leg	Supine: extend	Pain radiating to LE: HNP with radiculopathy

Straight leg	knee, flex hip	Pain radiating to LE: HNP with radiculopathy
SI stress	Press ASIS, iliac crest, sacrum	Pain in SI could be SI ligament injury
Trendelenburg sign	Standing: lift one leg (flex hip)	Flexed side: pelvis should elevate; if pelvis falls: Abductor or gluteus medius dysfunction
Patrick (FABER)	**F**lex, **AB**duct, **ER** hip, then abduct more	Positive if pain or LE will not continue to abduct below other leg: SI joint pathology
Meralgia	Pressure medial to ASIS	Reproduction to pain, burning, numbness: LFCN entrapment
Rectal Vaginal exam	Especially after trauma	Gross blood indicates trauma communicating with those organ systems

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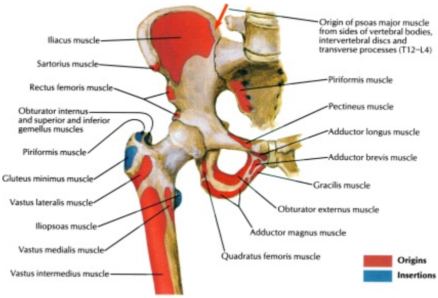
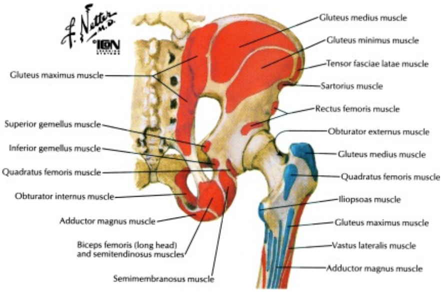
MUSCLES: ORIGINS AND INSERTIONS





PUBIC RAMI (ASPECT)	GREATER TROCHANTER	ISCHIAL TUBEROSITY	LINEA ASPERA/ POSTERIOR FEMUR
Pectineus (pectineal line/superior)	Piriformis (anterior)	Inferior gemellus	Adductor magnus
Adductor magnus (inferior)	Obturator internus (anterior)	Quadratus femoris	Adductor longus
Adductor longus (anterior)	Superior gemellus	Semimembranosus	Adductor brevis
Adductor brevis (inferior)	Gluteus medius (posterior)	Semitendinosus	Biceps femoris
Gracilis (inferior)	Gluteus minimus (anterior)	Biceps femoris (LH)	Pectineus
Psoas minor (superior)		Adductor magnus	Gluteus maximus
			Vastus lateralis
			Vastus medialis

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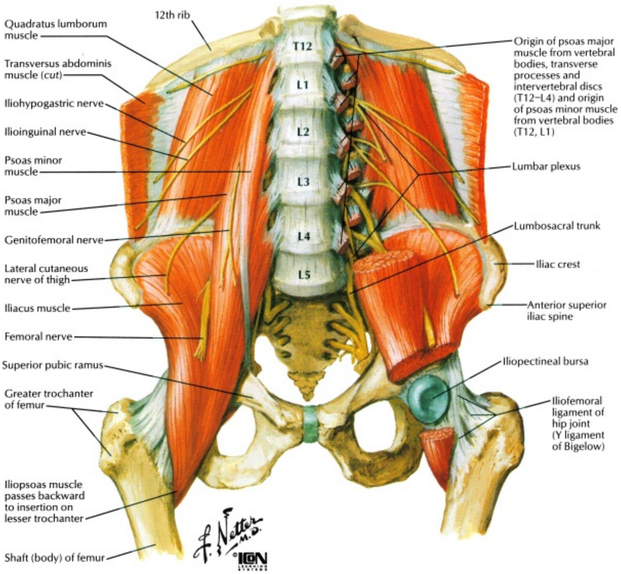
ANTERIOR MUSCLES (also see muscles of the thigh/hip)



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
HIP FLEXORS					
ANTERIOR					
Psoas	T12-L5 vertebrae	Lesser trochanter	Femoral	Flex hip	Covers lumbar plexus
Iliacus	Iliac fossa	Lesser trochanter	Femoral	Flex hip	Covers anterior ilium

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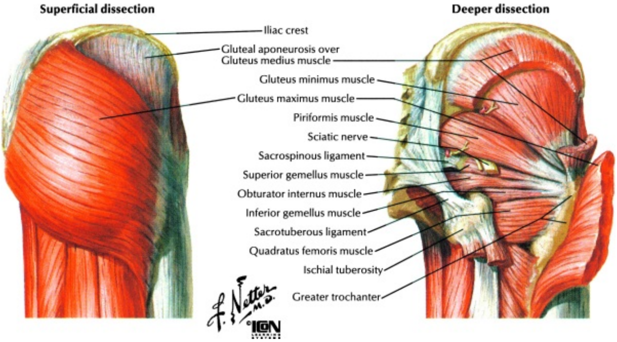
GLUTEAL MUSCLES (also see muscles of the thigh/hip)



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
HIP ABDUCTORS					
Tensor fascia latae	Iliac crest, ASIS	Iliotibial band	Superior Gluteal	Abducts, flex, IR thigh	A plane in anterior approach to hip
HIP ABDUCTORS					
Gluteus medius	Ilium between anterior posterior gluteal lines	Greater trochanter	Superior Gluteal	Abduct (IR) thigh	Trendelenburg gait if muscle is out.
Gluteus minimus	Ilium between anterior interior gluteal lines	Anterior greater trochanter	Superior Gluteal	Abduct (IR) thigh	Works in conjunction with medius
HIP EXTERNAL ROTATORS					
Gluteus maximus	Ilium, dorsal sacrum	Gluteal tuberosity (femur), ITB	Inferior Gluteal	Extend, ER thigh	Must detach in post. approach to hip
Piriformis	Anterior sacrum	Superior greater trochanter	Piriformis	ER thigh	Used as landmark
Obturator externus	Ischiopubic rami, obturator membrane	Trochanteric fossa	Obturator	ER thigh	Muscle actually in medial thigh
Short Rotators					
Obturator internus	Ischiopubic rami, obturator membrane	Medial greater trochanter	N. to Obturator internus	ER, abduct thigh	Muscle makes a right turn
Superior gemellus	Ischial spine	Medial greater trochanter	N. to Obturator internus	ER thigh	Assists obturator internus
Inferior gemellus	Ischial tuberosity	Medial greater trochanter	N. to Quadratus femoris	ER thigh	Assists obturator internus
Quadratus femoris	Ischial tuberosity	Intertrochanteric crest	N. to Quadratus femoris	ER thigh	Runs with ascending branch of medial circumflex artery

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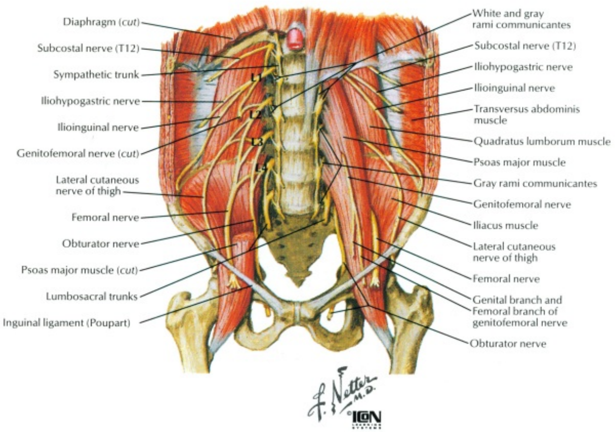
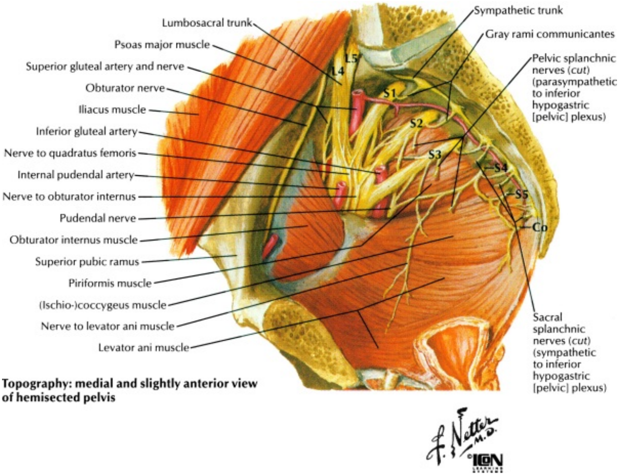
NERVES



LUMBAR PLEXUS	
ANTERIOR DIVISION	
1. **Subcostal** (T12):	
Sensory:	Subxyphoid region
Motor:	NONE
2. **Iliohypogastric** (L1)	
Sensory:	Above pubis
	Posterolateral buttocks
Motor:	Transversus abdominus
	Internal Oblique
3. **Ilioinguinal** (L1)	
Sensory:	Inguinal region
Motor:	NONE
4. **Genitofemoral**(L1-2): pierces Psoas, lies on anteromedial surface.	
Sensory:	Scrotum or mons
Motor:	Cremaster
5. ***Obturator*** (L2-4): exits via obturator canal, splits into ant. post. divisions. Can be injured by retractors placed behind the transverse acetabular ligament.	
Sensory:	Inferomedial thigh via cutaneous branch of Obturator nerve
Motor:	External oblique
	Obturator externus (posterior division)
6. **Accessory *Obturator*** (L2-4): inconsistent	
Sensory:	NONE
Motor:	Psoas
POSTERIOR DIVISION	
7. **Lateral Femoral Cutaneous** [LFCN](L2-3): crosses, ASIS, can be compressed at ASIS	

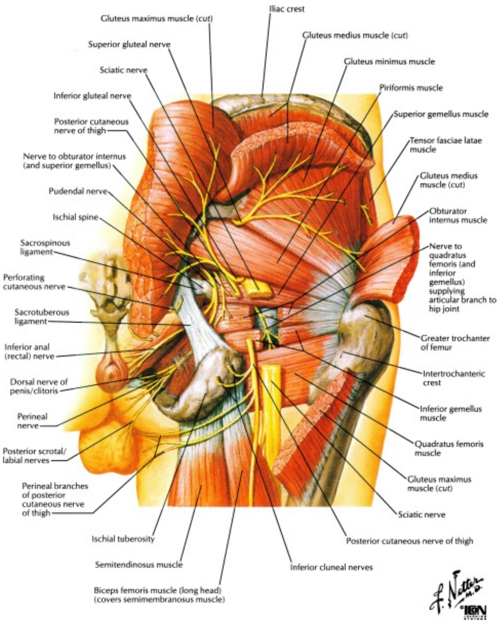
Sensory:	NONE (in pelvis)
Motor:	NONE
8. ***Femoral*** (L2-4): lies between psoas major and iliacus	
Sensory:	NONE (in pelvis)
Motor:	Psoas
	Iliacus
	Pectineus



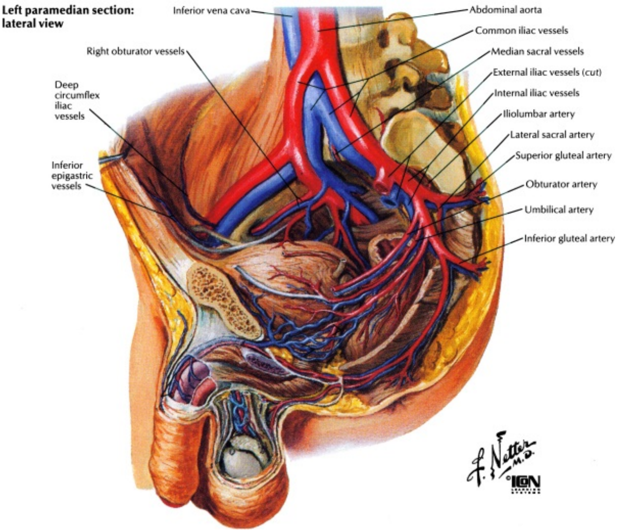
Topography: medial and slightly anterior view of hemisected pelvis

SACRAL PLEXUS	
ANTERIOR DIVISION	
9. **Nerve to Quadratus femoris** (L4-S1):	
Sensory:	NONE
Motor:	Quadratus femoris
	Inferior gemelli
10. **Nerve to Obturator internus** (L5-S2): exits greater sciatic foramen	
Sensory:	NONE
Motor:	Obturator internus
	Superior gemelli
11. ***Pudendal*** (S2-4): exits greater then re-enters lesser sciatic foramen	
Sensory:	Perineum:via Perineal (scotal/labial branches)via Inferior rectal nervevia Dorsal nerve to penis/clitoris
Motor:	Bulbospongiosus: Perineal nerve
	Isiocavernosus: Perineal nerve
	Urethral sphincter: Perineal nerve
	Urogenital diaphragm: Perineal nerve
	Sphincter ani externus: Inf. rectal nerve
12. **Nerve to coccygeus** (S3-4)	
Sensory:	NONE

Motor:	Coccygeus
	Levator ani
POSTERIOR DIVISION	
13. **Superior *Gluteal*** (L4-S1):	
Sensory:	NONE
Motor:	Gluteus medius
	Gluteus minimus
	Tensor fascia lata
14. **Inferior *Gluteal*** (L5-S2):	
Sensory:	NONE
Motor:	Gluteus maximus
15. **Nerve to piriformis** (S2):	
Sensory:	NONE
Motor:	Piriformis
OTHER NERVES (non-plexus)	
16. **Cluneal nerves**: branches of lumbar and sacral dorsal rami. Can be injured during bone grafts.	
Sensory:	Skin of gluteal region
Motor:	NONE



ARTERIES



COURSE	BRANCHES	COMMENT
	AORTA	
Along anterior vertebral bodies ALL	Common iliacs at L4 Lumbar arteries (4 sets)	
		Paired: posterior branch supplies cord, meninges paraspinal muscles
	Median sacral artery 5th Lumbar arteries (2)	Unpaired vessel
		Anastomoses with lat. sacral artery
	COMMON ILIACS	
Still on anterior L-spine sacrum	Divide into internal external iliacs at S1	
	INTERNAL ILIAC	
Under ureter near SI joint, divides into its divisions at edge of greater sciatic foramen	Supplies most of pelvis and the pelvic organs	
	<u>ANTERIOR DIVISION</u>	
	Obturator	Runs with nerve through foramen
	Fovea artery (artery of ligamentum teres in hip)	Minor contributions to the vascular supply of the femoral head
	Inferior gluteal	Supplies muscles of the

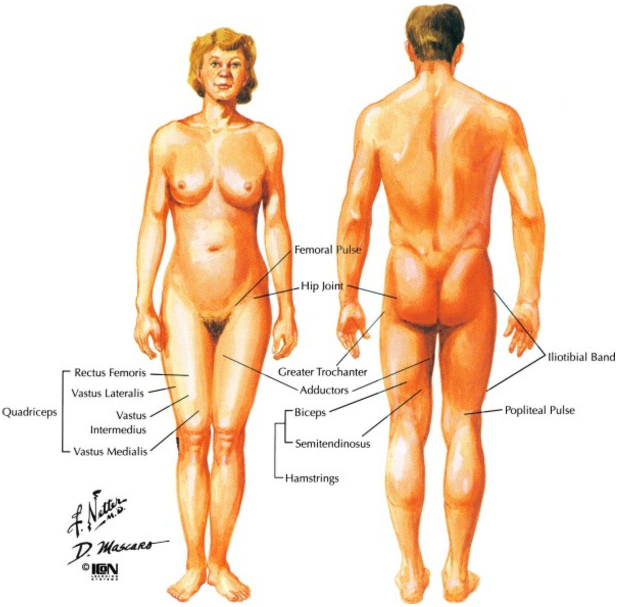
	Inferior *gluteal*	buttocks
	Multiple visceral branches [*]	
	POSTERIOR DIVISION	
	Superior *gluteal*	Supplies muscles of the buttocks
	Iliolumbar	Supplies iliopsoas and ilium
	Lateral sacral	Supplies sacral roots, meninges, muscles covering sacrum
EXTERNAL ILIAC		
Under inguinal ligament over the pubic rami, on the psoas muscle	Does not supply much in the pelvis	
	Deep circumflex iliac artery	
	Inferior epigastric artery	
	Femoral artery (under inguinal ligament)	At risk Total Hip Arthroplasty (THA)

* Other branches of the Internal iliac include: Umbilical, Vaginal/Inferior vesical, Uterine, Middle rectal, Inferior pudendal

CHAPTER 7 - THIGH/HIP

CHAPTER 7 – THIGH/HIP

TOPOGRAPHIC ANATOMY



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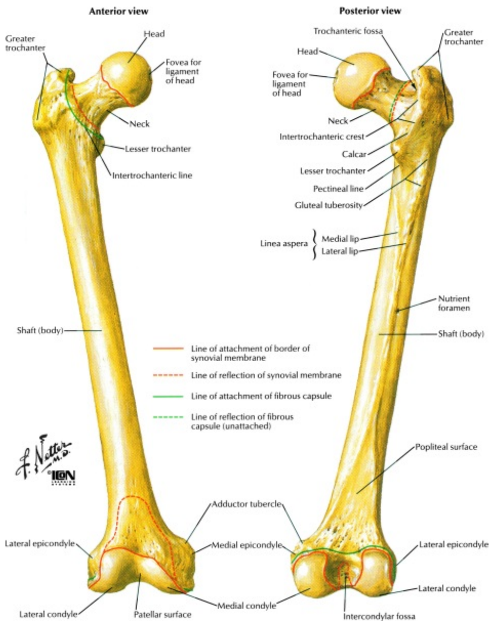
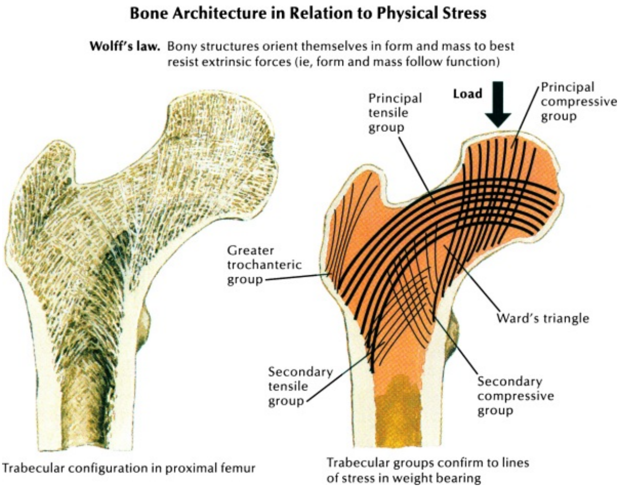
OSTEOLOGY



CHARACTERISTICS	OSSIFY		FUSE	COMMENT
		FEMUR		
• Long bone characteristics • Proximally: head, neck, greater lesser trochanters • Neck: bone comprised of tensile compressive groups • Distally: 2 condyles • Lateral: more anterior proximal Medial: larger, more posterior distal	Primary (Shaft) Secondary 1. Distal physis 2. Head 3. Greater trochanter 4. Lesser trochanter	7-8 wks (fetal) Birth 1 yr 4-5 yr 10 yr	16-18 years 19 years 18 years 16 years 16 years	• Blood supply Head neck: branches of the Medial Lateral circumflex artery (from profunda) Shaft: nutrient (from profunda) • Head neck vascularity tenuous: increased risk of ischemia in fracture or dislocation. • Femoral neck weakens with age: susceptable to

• Femoral anteversion: 12-14° • Neck/shaft angle: 126°					fracture • Anatomic axis: along shaft of femur • Mechanical axis: femoral head to intercondylar notch



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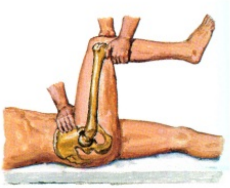
TRAUMA

Anteroposterior view. Dislocated femoral head lies posterior and superior to acetabulum. Femur adducted and internally rotated; hip flexed. Sciatic nerve may be stretched

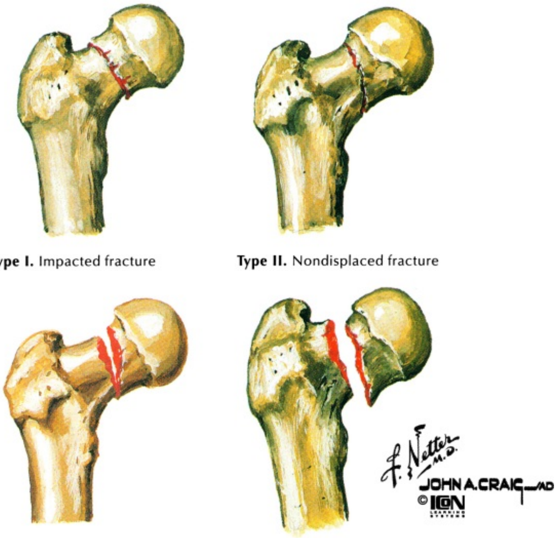
Anteroposterior radiograph shows posterior dislocation



Allis maneuver. Patient supine on table, under anesthesia or sedation. Examiner applies firm distal traction at flexed knee to pull head into acetabulum; slight rotatory motion may also help. Assistant fixes pelvis by pressing on anterior superior iliac spines

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
HIP DISLOCATION			
• High energy trauma (esp MVA-dashboard injury or significant fall.) • Orthopaedic emergency • Multiple associated injuries +/- fractures, (e.g. femoral head neck) • Posterior most common (85%)	HX: Trauma. Severe pain, Cannot move thigh/hip. PE: Thigh position: Post: adducted, flexed, IR Ant: abducted, flexed, ER. Pain (esp. with motion), good neurovascular exam XR: AP pelvis, frog lateral (Femoral head is different size) Also femur knee series CT: Rule out fracture or bony fragments	Posterior. Thompson: **I.** Simple, no posterior fragment **II.** Simple, large posterior fragment **III.** Comminuted posterior fragment **IV.** Acetabular fracture **V.** Femoral head fracture Anterior. Epstein: **I.** (A, B, C): Superior **II.** (A, B, C): Inferior A: No associated fracture B: Femoral head fracture C: Acetabular fracture	Early reduction essential, then repe XR neurologic exar Posterior: I: Closed reduction abduction pillov II-V: 1. Closed Reduction (ope if irreducible) **2.** ORIF fracture or excise fragme Anterior: closed reduction, ORIF if necessary.
COMPLICATIONS: Osteonecrosis (AVN) reduced risk with early reduction; Sciatic nerve injury (posterior dislocations); Femoral artery nerve injury (anterior dislocations); Instability recurrence; Osteoarthritis; Heterotopic ossification			

Femoral Neck Fracture



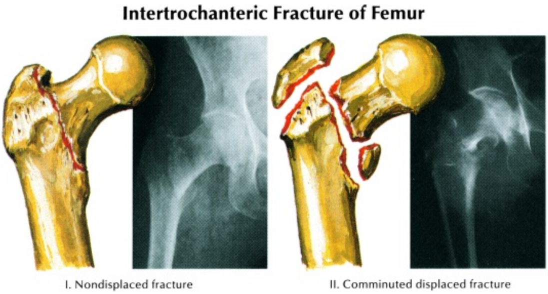
Type I. Impacted fracture

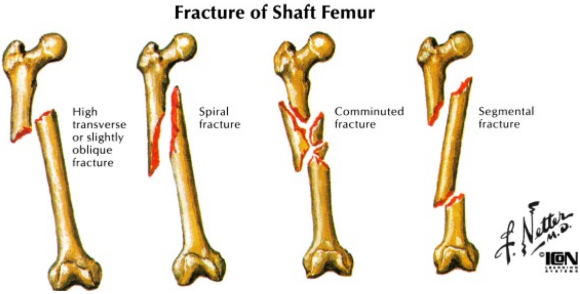
Type II. Nondisplaced fracture

Type III. Partially displaced

Type IV. Displaced fracture. Vertical fracture line generally suggests poorer prognosis

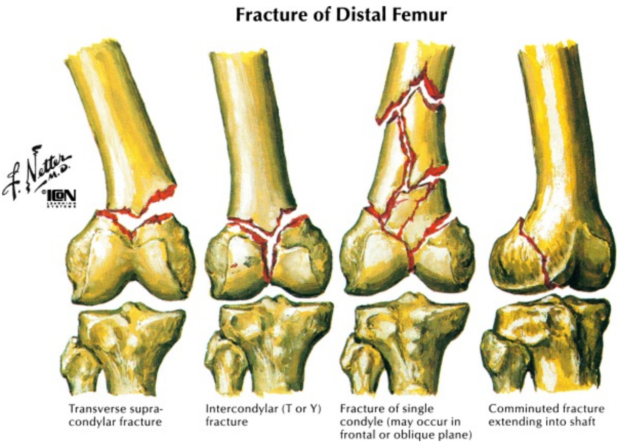
DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
FEMORAL NECK FRACTURE			
• Mechanism: 1. Fall by elderly woman most common; 2. High velocity injury in young adults • Intracapsular fractures • Associated with osteoporosis • Often caused by medical condition (syncope, etc) • High morbidity complication rate (25%)	HX: Fall. Pain, inability to bear weight or walk. PE: LE shortened, abducted, externally rotated. Pain with “rolling” of leg. XR: AP pelvis (+/-IR), groin lateral MR: If symptomatic with negative XR	Garden (4 types): **I.** Incomplete fracture; valgus impaction **II.** Complete fracture; nondisplaced **III.** Complete fracture, Partial displacement (varus) **IV.** Complete fracture, total displacement	Early reduction essential All fractures: Closed (open) reduction then IF of fracture: Young: 3 parallel screws Old: hemi-arthroplasty (Stable fracture, type I, may heal without surgery, ORIF because of displacement risk)
COMPLICATIONS: Osteonecrosis (AVN) incidence increases with fracture type (displacement) +/- late segmental collapse; Nonunion; Hardware failure			





DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
SUBTROCHANTERIC FRACTURE			
• Fall by a more elderly woman most common • Associated with osteoporosis • Occurs along or below the intertrochanteric line • Extracapsular fractures • Stable vascularity • Most heal well with proper fixation	HX: Fall. Pain, inability to bear weight or walk PE: LE shortened, ER. Pain with "log rolling" of leg XR: AP pelvis (+/- IR), groin lateral MR: If symptomatic with negative XR	Evans (based on post-reduction stability) Type I. Stable Type II. Unstable	Nonoperative is very rarely indicated. Operative treatment with sliding compression hip screw and side plate. Early mobilization with partial weight-bearing
COMPLICATIONS: Nonunion/Malunion; Hardware failure or loss of reduction; Infection. Mortality rate, first 6 months after fracture, is 15-25%			
SUBTROCHANTERIC FRACTURE			
• Mechanism: 1. Fall in elderly 2. Trauma in young Occurs below	HX: Trauma or fall. Pain, swelling PE:	Seinsheimer (5 types): I. Non or minimally displaced II. Displaced: 2 parts	Nonoperative treatment: traction hip spica cast for 6-8 wks (not commonly used)

• the lesser trochanter (up to 5cm below it). • Pathologic fractures seen here. • Decreased vascularity = tenuous healing	Swelling, tenderness +/- shortening of LE XR: AP lateral	**II.** Displaced: 2 parts **III.** Displaced: 3 parts **IV.** Comminuted (41parts) **V.** Subtrochanteric/intertrochanteric fracture.	used) Operative treatment: Locked IM nail, compression screw, or Zickel nail, +/-bone graft
COMPLICATIONS: Nonunion/Malunion; Hardware failure or loss of reduction; Refracture with hardware removal			



DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
FEMORAL SHAFT FRACTURE			
• Orthopaedic emergency • High energy injury • Multiple associated injuries (many serious) • Potential source of significant blood loss • Patient should be transported with leg in traction	HX: Trauma. Pain, swelling deformity PE: Deformity, +/- open wound soft tissue injury; Check distal pulses XR: AP lateral thigh, knee trauma series.	Winquist/Hansen (4 types): Stable **I.** No/minimal comminution **II.** Comminuted: 50% of cortices intact Unstable **III.** Comminuted: 50% of cortices intact **IV.** Complete comminution, no intact cortex	Extensive irrigation of any open fractures Operative: Interlocking intramedullary rods (closed) Early mobilizaton with crutch ambulation
COMPLICATIONS: Neurovascular injury and/or hemorrhagic shock; Nonunion/Malunion; Hardware failure or loss of reduction; Knee injury (5%)			
DISTAL FEMUR FRACTURE			

• Mechanism: direct blow • Metaphysis or epiphysis • Quadriceps or gastrocnemius often displace fragments • Restoration of articular surface is essential to regain normal knee mobility function	HX: Trauma. Cannot bear weight, pain, swelling. PE: Effusion, tenderness, do good neurovascular exam XR: Knee trauma series CT: Better defines fracture AGRAM: if pulseless	Extraarticular Supracondylar Intraarticular Intercondylar: T or Y Condylar	+/- aspirate hemarthroses Undisplaced/extraarticular: reduce, immobilize (less commonly used method) Displaced/intraarticular: ORIF: plates and screws or intramedullary nails Early mobilization
COMPLICATIONS: Osteoarthritis and/or pain; Decreased range of motion; Malunion/nonunion; Instability			

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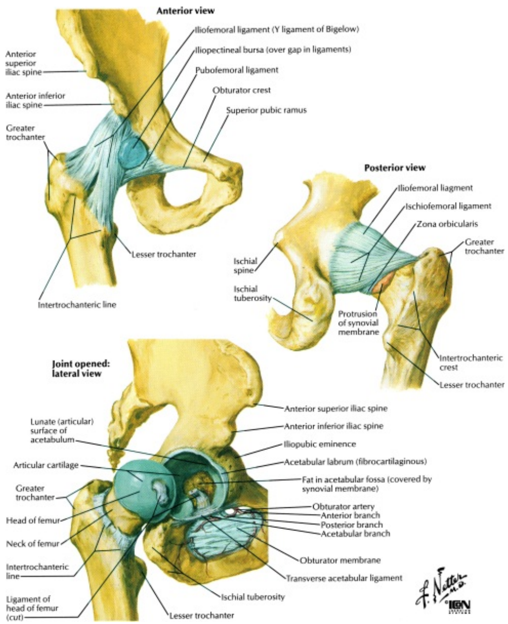
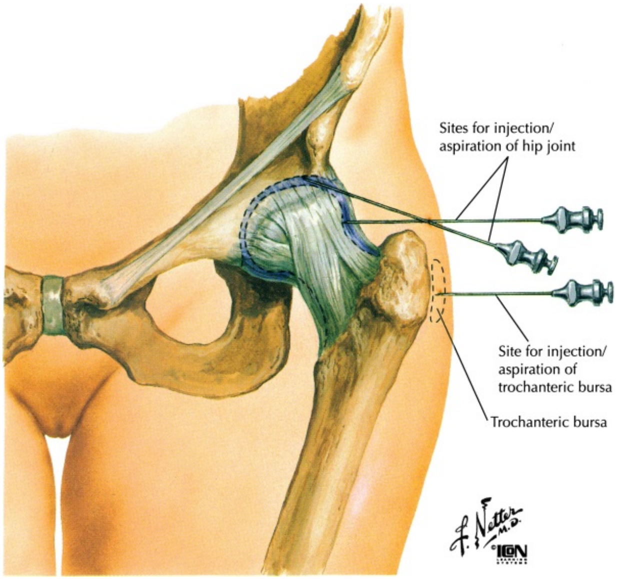
JOINTS



LIGAMENTS	ATTACHMENTS	COMMENTS
HIP JOINT (Spheroidal/Ball and Socket type)		
Transverse acetabular	Anteroinferior to posteroinferior acetabulum	Cups the acetabulum
Labrum	Acetabular rim	Deepens stabilizes acetabulum
JOINT CAPSULE	Acetabular rim to femoral neck	
Pubofemoral (anterior/inferior)	Femoral neck to superior pubic ramus	Covers femoral NECK
Iliofemoral (anterior) (Y ligament of Bigelow)	AIIS to intertrochanteric line	Strongest, most support
Ishiofemoral (posterior)	Posterior rim to intertrochanteric crest	Posterior femoral neck only partially covered (weak)
Zona orbicularis (posterior)		
Ligament of Teres	Fovea to cotyloid notch	Artery runs in ligament

MINOR PROCEDURES



STEPS	
HIP INJECTION OR ASPIRATION	
1.	Ask patient about allergies
2.	Place patient supine, palpate the greater trochanter.
3.	Prepare skin over insertion site (iodine/antiseptic soap)
4.	Anesthetize skin locally (quarter size spot)
5.	**ANTERIOR:** Find the point of intersection between a vertical line below ASIS and horizontal line from Greater trochanter. Insert 20 gauge (3 inch/spinal needle) upward slightly medial direction at that point. **LATERAL**: Insert a 20 gauge (3 inch/spinal needle) superior and medial to greater trochanter until it hits the bone (the needle should be within the capsule which extends down the femoral neck). Inject (or aspirate) local or local/steroid preparation into joint. (The fluid should flow easily if needle is in joint)
6.	Dress injection site
TROCHANTERIC BURSA INJECTION	
1.	Ask patient about allergies
2.	Place patient in lateral decubitus position, palpate the greater trochanter.
3.	Prepare skin over lateral thigh (iodine/antiseptic soap)
4.	Insert 20 gauge needle (at least 1 1/2inches) into thigh to the bone at the point of most tenderness. Withdraw needle (1—2mm) so it is just off the bone and in the bursa. Aspirate to ensure needle is not in a vessel. Inject 10ml of local or 4:1 local/corticosteroid preparation into bursa
5.	Dress injection site

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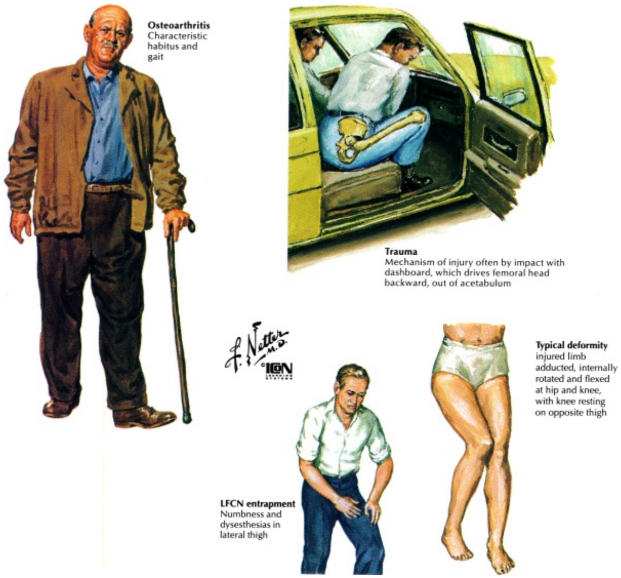
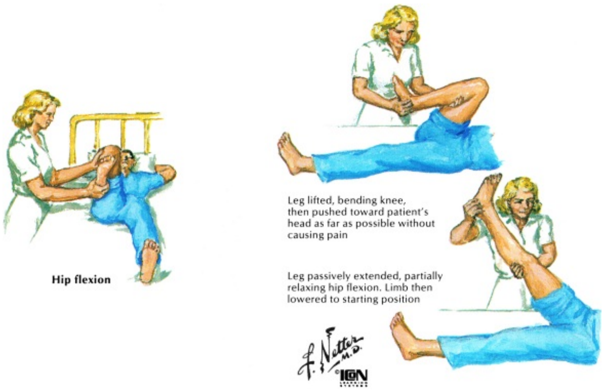
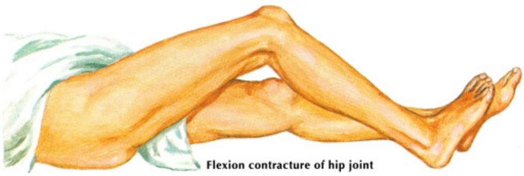
HISTORY



QUESTION	ANSWER	CLINICAL APPLICATION
1. AGE	Young	Trauma, developmental disorders
	Middle age, elderly	Arthritis (inflammatory conditions), femoral neck fractures
2. PAIN a. Onset b. Location c. Occurrence	Acute Chronic Lateral hip or thigh Buttocks/posterior thigh Groin/medial thigh Anterior thigh Ambulation/motion At night	Trauma, infection Arthritis (inflammatory conditions) Bursitis, LFCN entrapment, snapping hip Consider spine etiology Hip joint or acetabular etiology (less likely to be from pelvis or spine) Proximal femur Hip joint etiology (i.e. not pelvis or spine) Tumor, infection
3. SNAPPING	With ambulation	Snapping hip syndrome, loose bodies, arthritis, synovitis
4. ASSISTED AMBULATION	Cane, crutch, walker	Use (and frequency) indicates severity of pain condition
5. ACTIVITY TOLERANCE	Walk distance activity cessation	Less distance walked and fewer activities no longer performed = more severe
6. TRAUMA	Fall, MVA	Fracture, dislocation, bursitis
7. ACTIVITY/WORK	Repetitive use	Femoral stress fracture
8. NEUROLOGIC SYMPTOMS	Pain, numbness, tingling	LFCN entrapment, spine etiology
9. HISTORY OF ARTHRITIDES	Multiple joints involved	Systemic inflammatory disease

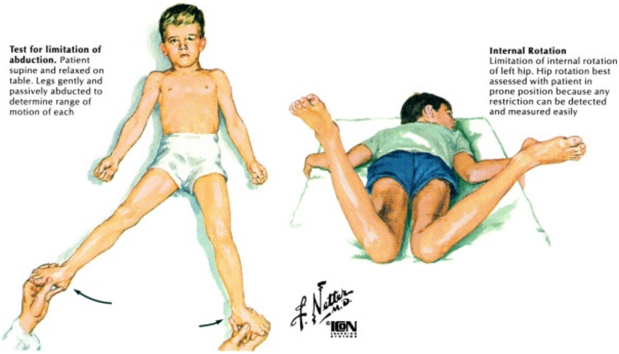
PHYSICAL EXAM





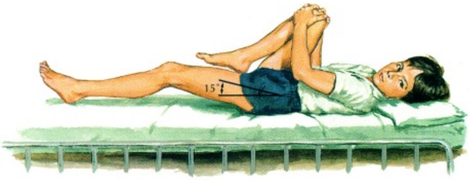
EXAM/OBSERVATION	TECHNIQUE	CLINICAL APPLICATION
	INSPECTION	
Skin	Discoloration, wounds	Trauma
	Gross deformity	Fracture, dislocation
Gait	60%stance, 40%swing	Normal gait: 20% double stance (both feet on ground)
Antalgic (painful)	Decreased stance phase	Knee, ankle, heel (spur), midfoot, toe pain
Lurch (Trendelenburg)	Laterally (on WB side)	Gluteus medius weakness, hip disease (OA, AVN)
Lurch	Posteriorly (hip extended)	Gluteus maximus weakness
Steppage	More hip knee flexion	Foot drop, weak anterior leg muscles
Flat foot	No push off	Hallux rigidus, gastrocnemius/soleus weakness
Wide	Feet 4 inches apart	Neurologic/cerebellar disease
Decreased step size	Less than previous normal	Pain, age, other pathology
	PALPATION	
Bony structures	Greater trochanter/bursa	Pain/palpable bursa: infection/bursitis, gluteus medius tendinitis
Soft tissues	Sciatic nerve (hip	Pain: disc herniation, piriformis spasm

Soft tissues	flexed)	Pain: disc herniation, piriformis spasm
	Muscle groups	Each group should be symmetric bilaterally



EXAM/OBSERVATION	TECHNIQUE	CLINICAL APPLICATION
	RANGE OF MOTION	
Flexion	Supine: knee to chest	Normal: 130 degrees
	Thomas test: see next page	Rule out flexion contracture
Extension	Prone: lift leg off table	Normal: 20 degrees
Abduction/adduction	Supine: leg lateral/medial	Normal: Abd: 40 degrees, Add: 30 degrees
Internal / External rotation	Seated: foot lateral/medial	Normal: IR: 30 degrees, ER: 50 degrees
	Prone: flex knee leg: in out	Normal: IR: 30 degrees, ER: 50 degrees
	NEUROVASCULAR	
Sensory		
Genitofemoral nerve (L1-2)	Proximal anteromedial thigh	Deficit indicates corresponding nerve/root lesion
Obturator nerve (L2-4)	Inferomedial thigh	Deficit indicates corresponding nerve/root lesion
Lateral Femoral Cutaneous nerve (L2-3)	Lateral thigh	Deficit indicates corresponding nerve/root lesion
Femoral nerve (L2-4)	Anteromedial thigh	Deficit indicates corresponding nerve/root lesion
Posterior Femoral Cutaneous nerve (S1-3)	Posterior thigh	Deficit indicates corresponding nerve/root lesion
Motor		
Obturator nerve (L2-4)	Thigh adduction	Weakness =Adductor muscle group or nerve/root lesion.
Superior Gluteal nerve (L5)	Thigh abduction	Weakness =Gluteus medius or nerve/root lesion.
Femoral nerve (L2-4)	Hip flexion	Weakness =Iliopsoas or corresponding nerve/root lesion.
		Weakness =Quadriceps or

	Knee extension	Weakness =Quadriceps or corresponding nerve/root lesion.
Inferior Gluteal nerve (L5-S2)	Hip extension	Weakness =Gluteus maximus or nerve/root lesion.
Sciatic:		
Tibial portion (L4-S3)	Knee flexion	Weakness =Biceps Long Head or nerve/root lesion.
Peroneal portion (L4-S2)	Knee flexion	Weakness =Biceps Short Head or nerve/root lesion
Reflex	None	
Pulses	Femoral	

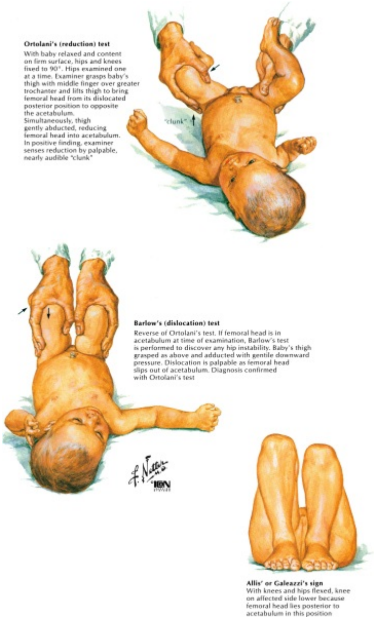


Thomas' sign
Hip flexion contracture determined with patient supine. Unaffected hip flexed only until lumbar spine is flat against examining table. Affected hip cannot be fully extended, and angle of flexion is recorded. 15° flexion contracture of hip is typical of Legg-Calvé-Perthes disease

"Roll" test for muscle spasm. Patient relaxed and supine on table. Examiner places hands on limb, gently rolls hip into internal and external rotation, noting resistance

EXAM/OBSERVATION	TECHNIQUE	CLINICAL APPLICATION
	SPECIAL TESTS	
Thomas sign	Supine: one knee to chest	If opposite thigh elevates off table: flexion contracture of that side
Ober	On side: flex abduct hip	Leg should then adduct, if stays in abduction: ITB contracture
Piriformis	On side: adduct hip	Pain in hip/pelvis indicates tight piriformis (compressing sciatic nerve)
Leg length discrepancy	ASIS to medial malleolus	A measured difference of 1cm is positive
90-90 straight leg	Flex hip knee 90°, extend knee	20 degrees of flexion after full knee extension =tight hamstrings
Ely's	Prone: passively flex knee	If hip flexes as knee is flexed: tight rectus femoris muscle
Log roll	Supine, hip extended: IR/ER	Pain in hip is consistent with arthritis

Patrick (FABER)	**F**lex, **AB**duct, **ER** hip, then abduct more (figure of 4)	Positive if pain or LE will not continue to abduct below other leg: Hip or SI joint pathology
Meralgia	Pressure medial to ASIS	Reproduction to pain, burning, numbness: LFCN entrapment
Ortolani (Peds)	Hips at 90°, abduct hips	A clunk indicates the hip(s) was dislocated and now reduced
Barlow (Peds)	Hips at 90°, posterior force	A clunk indicates the hip(s) is now dislocated, should reduce with Ortolani
Galeazzi (Peds)	Supine:Flex hips knees	Any discrepancy in knee height : 1. Dislocated hip, 2. Short femur



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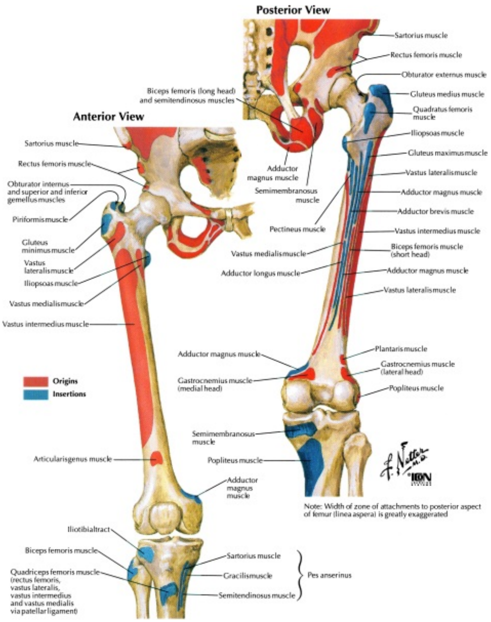
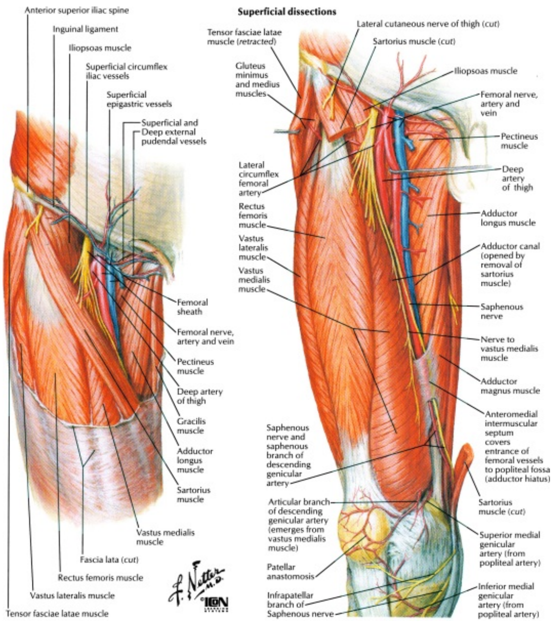
MUSCLES: ORIGINS AND INSERTIONS



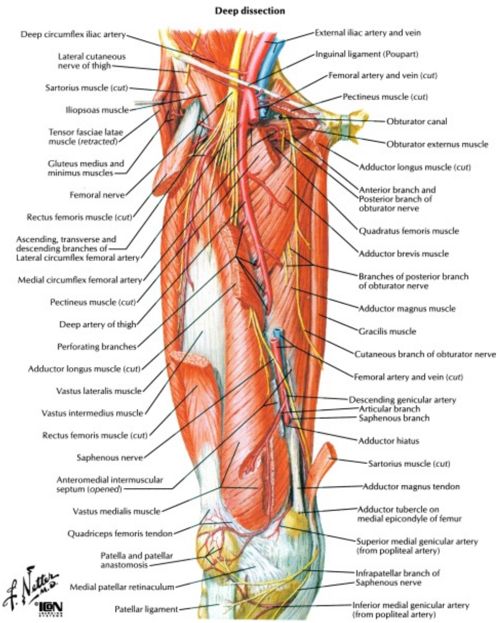
PUBIC RAMI (ASPECT)	GREATER TROCHANTER	ISCHIAL TUBEROSITY	LINEA ASPERA/ POSTERIOR FEMUR
Pectineus (pectineal line/sup)	Piriformis (anterior)	Inferior gemellus	Adductor magnus
Adductor magnus (inferior)	Obturator internus (anterior)	Quadratus femoris	Adductor longus
Adductor longus (anterior)	Superior gemellus	Semimembranosus	Adductor brevis
Adductor brevis (inferior)	Gluteus medius (posterior)	Semitendinosus	Biceps femoris
Gracilis (inferior)	Gluteus minimus (anterior)	Biceps femoris (LH)	Pectineus
Psoas minor (superior)		Adductor magnus	Gluteus maximus
			Vastus lateralis
			Vastus medialis

MUSCLES: ANTERIOR



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Articularis genu	Distal anterior femoral shaft	Synovial capsule	Femoral	Pulls capsule superiorly in extension	May join with vastus intermedius
Sartorius	ASIS	Proximal medial tibia (Pes anserinus)	Femoral	Flex, ER hip	Can avulse from ASIS (fracture)
QUADRICEPS					
Rectus femoris	AIIS, superior rim of acetabulum	Patella/tibial tubercle	Femoral	Flex thigh, extend leg	Can avulse from AIIS (fracture)
LEG EXTENSORS					
Vastus lateralis	Greater trochanter, lateral linea aspera	Lateral patella, tibial tubercle	Femoral	Extend leg	Oblique fibers can affect Q angle
Vastus intermedius	Proximal femoral shaft	Patella; tibial tubercle	Femoral	Extend leg	Covers articularis genu
Vastus medialis	Intertrochanteric line, medial linea aspera	Medial patella, tibial tubercle	Femoral	Extend leg	Weak in many patello-femoral disorders.

MUSCLES: MEDIAL



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Obturator externus	Ischiopubic rami, obturator membrane	Trochanteric fossa	Obturator	ER thigh	Tendon posterior to femoral neck
HIP ADDUCTORS					
Adductor longus	Body of pubis (inferior)	Linea aspera (mid 1/3)	Obturator	Adducts thigh	Tendon can ossify
Adductor brevis	Body and inferior pubic ramus	Pectineal line, upper linea aspera	Obturator	Adducts thigh	Deep to pectineus
Adductor magnus	Ischiopubic ramus ischial tuberosity	Linea aspera/adductor tubercle	Obturator/ Sciatic	Adducts flex/ extend thigh	2 portions: separate insertions innervation
Gracilis	Body and inferior pubic ramus	Proximal medial tibia (Pes anserinus)	Obturator	Adducts (flex) thigh flex, IR leg	Used in ligament reconstruction (ACL)
HIP FLEXORS (also iliopsoas)					
Pectineus	Pectineal line of pubis	Pectineal line of femur	Femoral	Flex and adduct thigh	Part of femoral triangle floor

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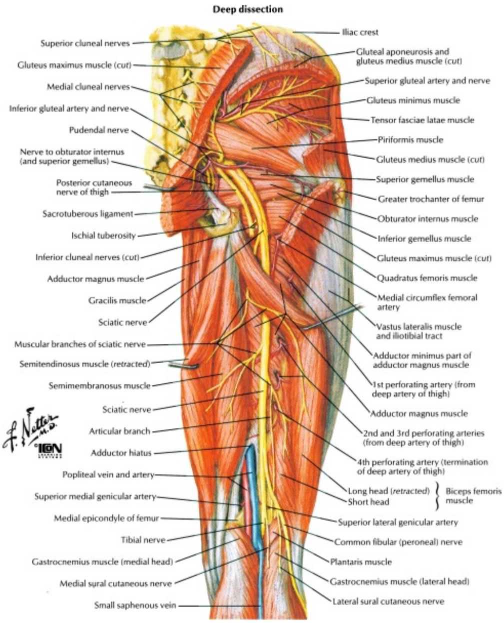
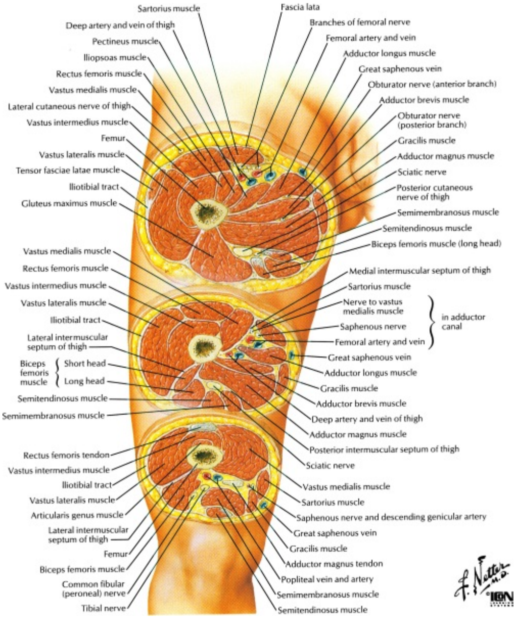
MUSCLES: POSTERIOR (HAMSTRINGS)



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Semitendinosus	Ischial tuberosity	Proximal medial tibia (Pes anserinus)	Sciatic (tibial)	Extend thigh, flex leg	Used in ligament reconstructions (ACL)
Semimembranosus	Ischial tuberosity	Posterior medial tibial condyle	Sciatic (tibial)	Extend thigh, flex leg	A border in medial approach
Biceps femoris: Long Head	Ischial tuberosity	Head of fibula	Sciatic (tibial)	Extend thigh, flex leg	Covers sciatic nerve
Biceps femoris: Short Head	Linea aspera, supra condylar line	Fibula, lateral tibia	Sciatic (peroneal)	Extend thigh, flex leg	Shares insertion tendon with Long Head

THIGH MUSCLES: CROSS SECTIONS



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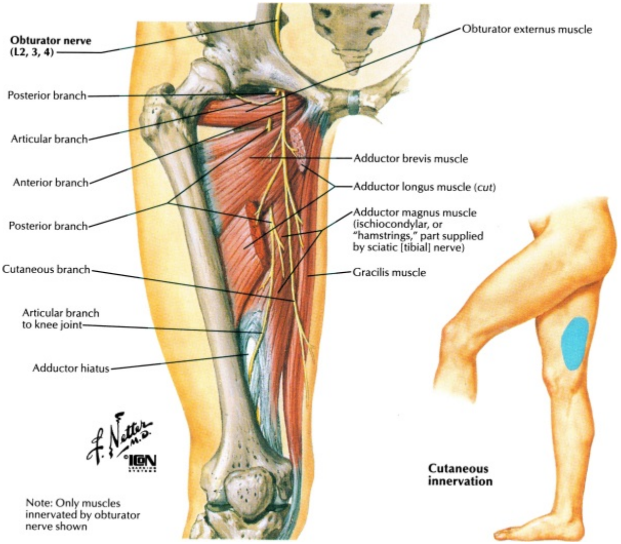
NERVES



LUMBAR PLEXUS

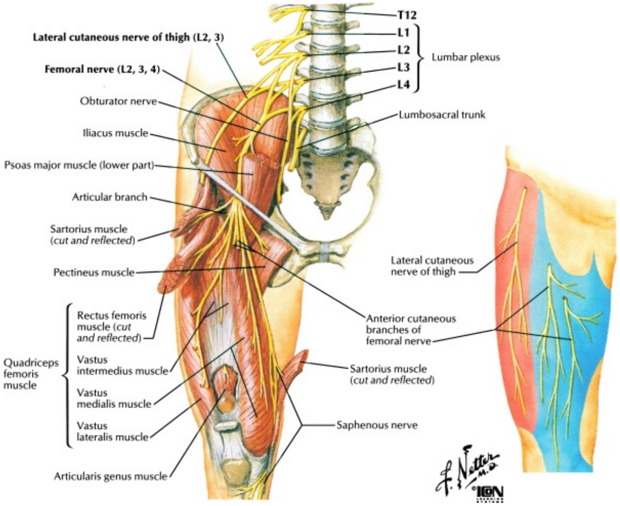
ANTERIOR DIVISION

Genitofemoral (L1-2): pierces Psoas, lies on anteromedial surface

Sensory:	Proximal anteromedial thigh
Motor:	NONE (in thigh)

2. ***Obturator*** (L2-4): exits via obturator canal, splits into anterior posterior divisions. Can be injured by retractors placed behind the transverse acetabular ligament.

Sensory:	Inferomedial thigh: via cutaneous branch of obturator nerve
Motor:	Gracilis (anterior division) Adductor longus (anterior division) Adductor brevis (ant/post divisions) Adductor magnus (posterior division)



LUMBAR PLEXUS

POSTERIOR DIVISION

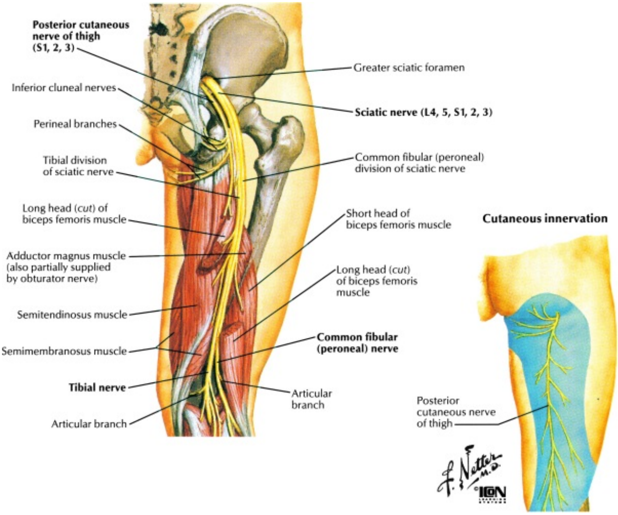
Lateral Femoral Cutaneous [LFCN](L2-3): crosses ASIS, can be compressed at ASIS.

Sensory:	Lateral thigh
Motor:	NONE

4. ***Femoral*** (L2-4): lies between psoas major and iliacus; Saphenous nerve branches in Femoral Triangle runs under sartorius.

Sensory:	Anteromedial thigh: via anterior/intermediate cutaneous nerves
Motor:	Psoas Sartorius Articularis genu <u>QUADRICEPS</u> Rectus femoris Vastus lateralis Vastus intermedius Vastus medialis

1.



3.

SACRAL PLEXUS

ANTERIOR DIVISION

Tibial (L4-S3): descends (as sciatic) in posterior thigh

Sensory:	NONE (in thigh)
Motor:	POSTERIOR THIGH Biceps femoris [long head] Semitendinosus Semimembranosus

POSTERIOR DIVISION

5.

Common *peroneal* (L4-S2): descends(as sciatic) in posterior thigh

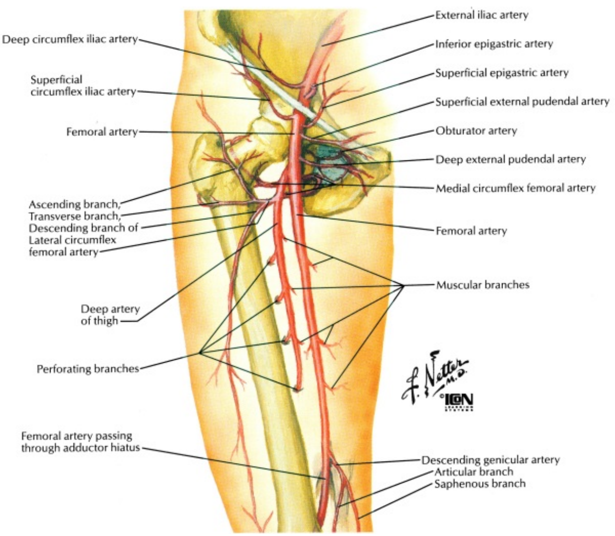
Sensory:	NONE (in thigh)
Motor:	Biceps femoris [short head]

6. 7.

Posterior Femoral Cutaneous Nerve [PFCN] (S1-3)

Sensory:	Posterior thigh
Motor:	NONE

ARTERIES



ARTERY	BRANCHES	COMMENT
Obturator	Anterior posterior branches	Runs through obturator foramen
Femoral (Superficial Femoral) [SFA]	In femoral triangle, runs in medial thigh between vastus medialis and adductor longus, to obturator canal, through adductor hiatus, then becomes Popliteal Artery behind knee.	
	Superficial circumflex iliac	
	Superficial epigastric	
	Superficial external pudendal	
	Deep external pudendal	
	Deep artery of thigh (Profunda)	See below
	Descending genicular artery	Anastomosis at knee to supply knee
	Articular branch	
	Saphenous branch	
Deep Artery of the thigh (Profunda)	Medial circumflex	Supplies femoral neck
	Lateral circumflex	Supplies femoral neck
	Ascending branch	Forms anastomosis at femoral neck
	Transverse branch	Contributes to anastomosis at femoral neck
	Descending branch	Contributes to anastomosis at femoral neck
	Perforators/muscular branches	Supplies femoral shaft and thigh muscles

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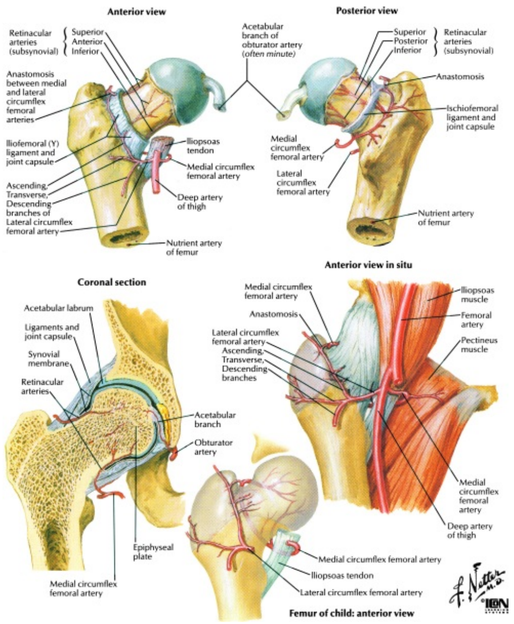
ARTERIES OF THE FEMORAL NECK

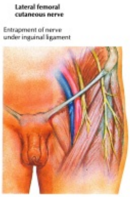


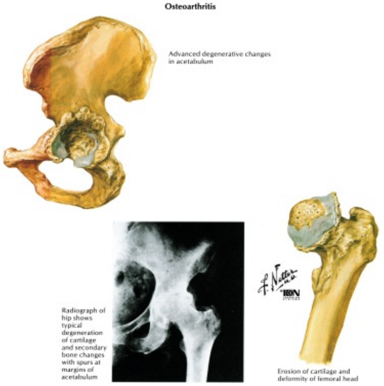
ARTERY	COURSE	COMMENT
Obturator: Fovea artery (A. of Ligament Teres)	Runs through the ligament of femur head	Relatively minor contribution to femoral head
Deep Artery of thigh	Branches from Femoral in Femoral triangle.	Supplies anterior medial thigh
Medial circumflex	Between pectineus iliopsoas to posterior femoral neck	Anastomosis: posterior supply
Ascending branch	Runs on Quadratus femoris	Can be injured in posterior approach
Lateral circumflex	Deep to sartorius and rectus femoris	Extracapsular anastomosis at neck
Ascending branch	To greater trochanter anteriorly	Anastomosis: anterior supply
Cervical branches	Extracapsular branches of anastomosis	Pierce the capsule
Retinacular arteries	Intracapsular branches: run along neck, enter bone at base of femoral head.	Most of femoral head supply is posterior (at risk in injury: AVN)
Transverse branch	Extends laterally	Minor contribution to anastomosis
Descending branch	Under rectus femoris	Minor contribution to anastomosis
Inferior Superior Gluteal arteries	Branches make small contributions to femoral neck anastomosis	

DISORDERS

DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
INFLAMMATORY ARTHRITIS			
• Host immunologic response results in synovitis. • RA, Lupus, SeroNegative arthropathies, gout, etc.	Hx: Pain, stiffness, +/- other joints involved. PE: Antalgic gait, decreased ROM (especially IR)	XR: AP, frog leg lateral Labs: RF, ESR, CRP ANA, CBC, uric acid, crystals, culture	1. Physical therapy, NSAIDs 2. Cane or crutch 3. Synovectomy (early) 4. Total hip Arthroplasty (late)
OSTEOARTHRITIS			
• Loss or damage to articular cartilage • Etiology: developmental, trauma, infection, metabolic, idiopathic	Hx: Chronic hip or groin pain, increasing over time with activity PE: Decrease ROM (first IR), + log roll, +/- flexion contracture antalgic gait	XR: AP/lateral hip 1. Joint space narrowing 2. Osteophytes 3. Subchondral sclerosis 4. Bony cysts	1. NSAIDs, Physical Therapy 2. Injection, activity modification, cane 3. Osteotomy (young) 4. Arthrodesis (young) 5. Total Hip Arthroplasty (elderly)
LATERAL FEMORAL CUTANEOUS NERVE ENTRAPMENT (Meralgia Paresthetica)			
• Nerve trapped near ASIS. • Due to activity (hip extension), or clothing (e.g. belt)	Hx: Pain/burning in lateral thigh PE: Decreased sensation on lateral thigh, + Meralgia	XR: AP/lateral of hip: rule out other pathology	1. Remove compressive entity 2. Surgical release: rare
OSTEONECROSIS (Avascular necrosis: AVN)			
• Necrosis of femoral head (trabecular bone) • Due to vascular disruption • Associated with trauma, Etoh, steroid use, RA • Ficat classification: 4 stages based on sx, XR, bone scan	Hx: Insidious onset dull hip ache PE: With collapse: pain with IR ER Without collapse: discomfort with IR ER	XR: AP, frog leg lateral: femoral head sclerosis MR: Double line sign (T2)	Early: core decompression or vascularized fibular graft Late or collapse: Total hip arthroplasty
SNAPPING HIP (Iliotibial band)			
• ITB snapping over greater trochanter of iliopsoas tendon over pectineal eminence	Hx: Snapping in hip with walking (as hip extends). Pain rare. PE: Adduct flex	XR: AP pelvis, AP/latearl of hip: usually normal, rule	1. Reassurance 2. Avoid activity, Physical therapy

eminence • Women (wide pelvis) most common	PE: Adduct flex hip, then extend: + snap	out other pathology	3. Injection for acute bursitis 4. Surgery rare
TROCHANTERIC BURSITIS			
• Inflammation of bursa over greater trochanter or gluteal tendons	Hx: Lateral hip pain. Cannot sleep on affected side. PE: Point tenderness at greater trochanter	XR: AP pelvis, AP/lateral of hip: rule out spur, OA, calcified tendons	1. NSAIDs 2. Physical therapy (IT Band stretching) 3. Steroid injection





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TOTAL HIP ARTHROPLASTY

TIPS ON TOTAL HIPS

GENERAL INFORMATION

- Types of implants: cemented, noncemented (press fit porous ingrowth), hybrid
  - "Supermetals": cobalt chrome titanium (shaft/head)
  - Acetabular cup: Ultra high-molecular weight polyethylene
  - Porous ingrowth: best pore size 200-400 microns
  - Cemented usually used in elderly patients, noncemented for younger patients
- Cement: Polymethylmethacralate
- Head size: 26-28mm is optimal

INDICATIONS

1. Arthritis of hip: common etiologies: OA, RA, AVN
   Most patients complain of pain, worsening over time (wakes them from sleep), and decreased ability to ambulate.
   Patient should have appropriate radiographic evidence of arthritis
   It is preferable when the patient is elderly (needs only one replacement)

OSTEOARTHRITIS	**RHEUMATOID ARTHRITIS**
1. Joint space narrowing	1. Joint space narrowing
2. Sclerosis	2. Periarticular osteoporosis
3. Subchondral cysts	3. Joint erosions
4. Osteophyte formation	4. Ankylosis

2. Failed conservative treatment: activity modification, weight loss, physical therapy/strengthening, NSAIDs, ambulation assistance (cane used on unaffected side, walker, etc.), injections.
3. Other: Fractures, tumors, developmental disorders (DDH, etc.)

CONTRAINDICATIONS

- Young, active patient (will wear out replacement many times)
- Medically unstable (e.g. severe cardiopulmonary disease)
- Neuropathic joint
- Any infection

ALTERNATIVES

- Considerations: Age, activity level, overall health
- Osteotomy: Femoral or pelvic; not common in U.S.
- Arthrodesis/Fusion: good for young patients/laborers, unilateral disease, no other joint disease (e.g. spine, knee). Fuse with hip in slight flexion

PROCEDURE

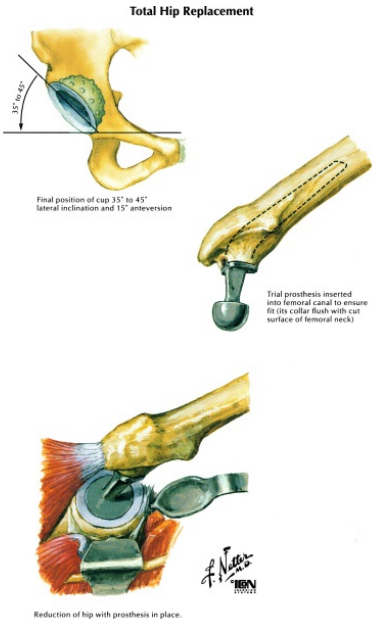
- Posterior or lateral approach usually used
- Femoral component should be in valgus ("Thou shalt not Varus")
- Acetabular cup at 45°

COMPLICATIONS

- Failure of Implant
  1. Loosening (#1 complication in cemented joints)
  2. Varus alignment
  3. Implant breakage (patients: active, heavy, young, will wear out prosthetic)
- Hip thigh pain post-operatively (#1 complication in noncemented joints)
- Deep Venous Thrombosis (DVT)/Pulmonary emboli: patients should be anticoagulated (Heparin/warfarin) postoperatively

- Infection: often leads to removal of prosthesis (Staph #1 cause)
- Dislocation: posterior are most common (abduction pillow can help prevent)
- External iliac/Femoral artery and vein injury with anterior/superior quadrant screw
- Obturator nerve, artery, vein injury with anterior/inferior quadrant screw. Posterior screw placement is preferable
- Nerve injury (sciatic: peroneal portion) by retractors: Foot drop
- Heterotopic ossification: one dose prophylactic XRT can help prevent it.
- Osteolysis: Macrophage response; due to polyethylene wear debris

TIPS ON TOTAL HIPS



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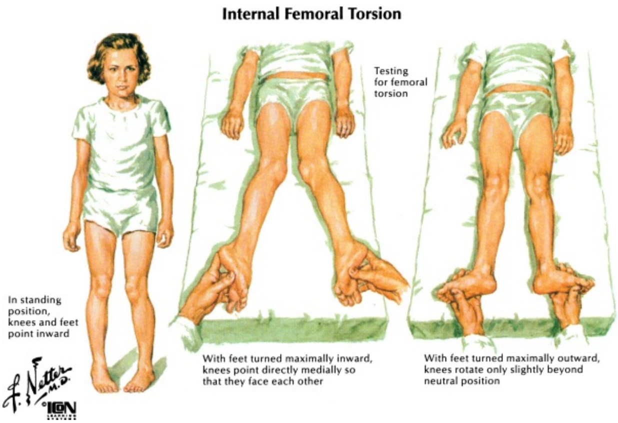
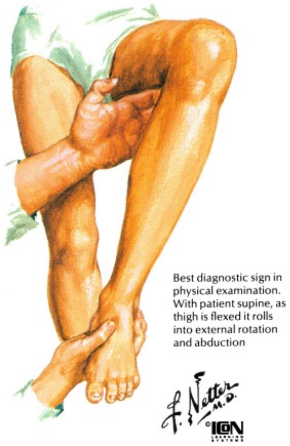
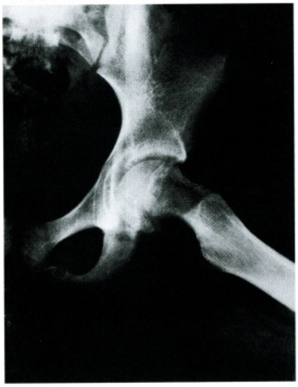
PEDIATRIC DISORDERS



DESCRIPTION	EVALUATION	TREATMENT/COMPLICATIONS
	DEVELOPMENTAL DYSPLASIA	
• 1. Capsule/ligament laxity, or 2. Acetabular roof abnormal: hip does not develop correctly • Associated with: First female, breech delivery, + family health, decreased intrauterine space conditions • Early diagnosis and treatment essential (3mo) • Poor outcomes if diagnosis delayed	Hx: Twins, other risk factors. Often unnoticed by parents. PE: + Barlow (dislocation), + Ortalani (relocation), + Galeazzi tests. Decreased abduction XR: In older patients US: if PE not conclusive	• Goal: maintain femoral head in the acetabulum (concentric reduction): 1. Pavlik harness (3mo) 2. Closed reduction cast (6-18mo) 3. Osteotomy (18mo) • Post reduction films essential COMPLICATIONS: Osteonecrosis (femoral head)
	FEMORAL ANTEVERSION	
• Internal rotation of femur, femoral anteversion does not decrease properly • #1 cause of intoeing	Hx: Usually presents 3-6 yrs PE: Femur IR (IR 65°), patella is medial, intoeing gait	1. Most spontaneously resolve 2. Derotational osteotomy if it persists past age 10 (mostly cosmetic)



Slipped Capital Femoral Epiphysis

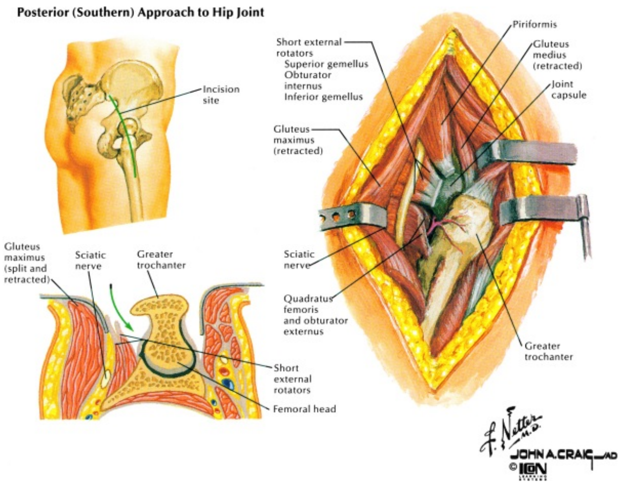


Frog-leg radiograph, which demonstrates slipped epiphysis more clearly, always indicated when disorder is suspected

DESCRIPTION	EVALUATION	TREATMENT/COMPLICATIONS
LEGG-CALVE-PERTHES DISEASE		
• Osteonecrosis of femoral head • Idiopathic, vascular etiology (hypercoaguable/sludging) • Associated with: + family history, breech birth • Catteral classification: 4 stages • Poor prognosis: after age 9 or with large femoral head involvement	Hx: Boys(4:1) usually 4-8 yo, unilateral thigh or knee pain limp PE: Decreased abduction, no point tenderness on exam XR: AP pelvis, frog lateral (density of the femoral head is indicative; crescent sign: subchondral fx)	The femoral head must revascularize Based on age: 5 yrs: observation NSAIDs 5-8 yrs: concentric containment: abduction brace or osteotomy 9+ yrs: operative treatment often fails (many need THA as adult)
SLIPPED CAPITAL FEMORAL EPIPHYSIS (SCFE)		
• Proximal femoral epiphysis falls off femur (posterior) head in acetabulum • Obese adolescents • Early diagnosis and treatment essential	Hx: 11-14 yo, often obese, slow onset hip, thigh, knee pain, +/- limp PE: Decreased ROM (especially IR,	Do not attempt reduction 1. Non weight-bearing 2. Percutaneous pinning COMPLICATIONS: Osteonecrosis, chondrolysis, osteoarthritis, decreased ROM

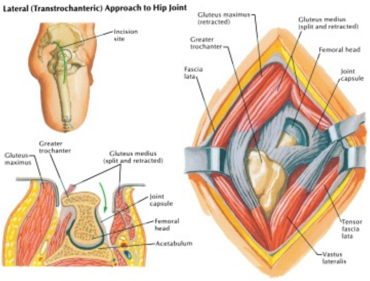
	abduction) XR: AP pelvis, frog lateral	

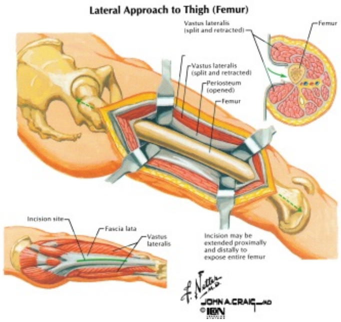
SURGICAL APPROACHES



USES	INTERNERVOUS PLANE	DANGERS	COMMENT
POSTERIOR (Moore/Southern) APPROACH TO HIP			
1. Total Hip Arthroplasty 2. Arthroplasty 3. ORIF posterior acetabulum 3. Posterior hip dislocations	Split gluteus maximus [Inferior gluteal n]	1. Sciatic nerve 2. Inferior gluteal artery	1. Superior and inferior gluteal arteries need to be controlled. 2. The short external rotators must be detached to access the joint.
LATERAL (Hardinge) APPROACH TO HIP			
Total Hip Arthroplasty (not used for revisions)	Split gluteus medius [Superior gluteal n]	1. Superior gluteal artery 2. Femoral nerve 3. Femoral Artery vein	1. No osteotomy of greater trochanter required. Leads to earlier mobilization. 2. Less exposure than posterior approach, thus not used for revision THA.
LATERAL APPROACH TO THIGH			
1. Fractures 2. Tumors	Split vastus lateralis (and intermedius)	1. Branch of Lateral femoral circumflex artery	1. Incision can be large or small; it is made along the line between greater trochancter and lateral condyle.

2. Tumors	[Femoral nerve]	2. Superior lateral geniculate artery	2. Arteries (#1 2 at left) encountered if incision extended proximally or distally; ligate them.





CHAPTER 8 - LEG/KNEE

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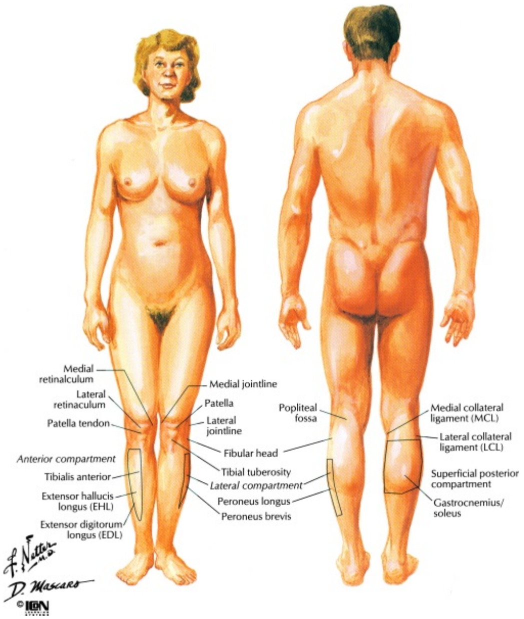
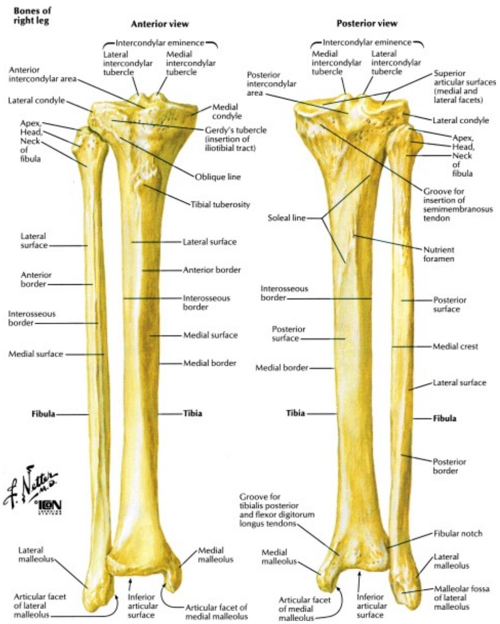
CHAPTER 8 – LEG/KNEE

TOPOGRAPHIC ANATOMY

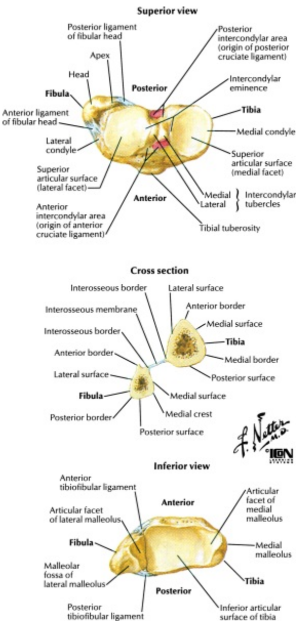


OSTEOLOGY



CHARACTERISTICS	OSSIFY		FUSE	COMMENT
		TIBIA		
• Long bone characteristics	Primary: Body	7 wks (fetal)	18 years	• Ossification site at the tibial tuberosity can be confused with a fracture.
• Wide proximal end (plateau) articulates with the femoral condyles	Secondary		18-20 years	• Traction (quadriceps) apophysitis at the tibial tuberosity: Osgood Schlatter disease
• Distal end (plafond) cups the talus	1. Proximal epiphysis	9 mo		• Primary weight-bearing bone in leg
• Medial malleolus is distal end	2. Distal epiphysis	1 yr		
• IT Band inserts on Gerdy's tubercle	3. Tibial tuberosity			
		FIBULA		
• Long bone characteristics	Primary: Body	8 wks (fetal)	20 years	• Common peroneal nerve runs across the neck, injured in fractures (foot drop)
• Distal end (lateral malleolus) is lateral wall of ankle mortise.	Secondary		18-22 years	• Used to determine “lateral” on radiographs
	1. Proximal epiphysis	1-3 yr		
	2. Distal			

	2. Distal epiphysis	4 yr		



CHARACTERISTICS		OSSIFY	FUSE	COMMENT
		PATELLA		
• Largest sesamoid bone in the body	Primary (single center)	3 years	11-13 years	• Failure to fuse: Bipartite patella (can be confused with patella fracture).
• Two facets (lateral is larger)				• Functions: **1.** Enhances quadriceps pull **2.** Protects knee
• Triangular in cross-section				
• Very thick articular cartilage (bearing heavy loads)				

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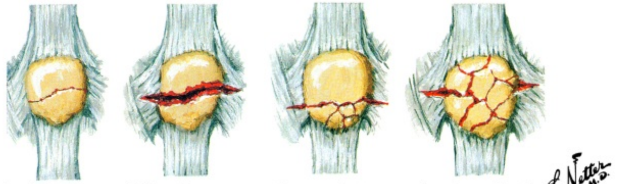
TRAUMA



Nondisplaced transverse fracture with intact retinacula

Displaced transverse fracture with tears in retinacula

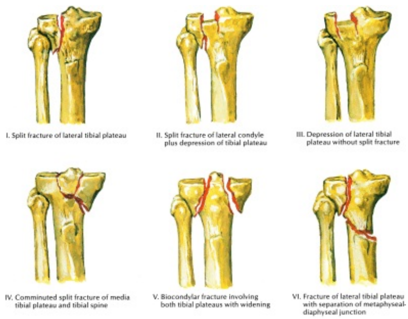
Transverse fracture with comminution of distal pole

Severely comminuted fracture

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
PATELLA FRACTURE			
• Mechanism: direct indirect: (e.g. fall, dashboard or kicking injury) • Pull of quadriceps and patella tendons displace most fractures • If intact, retinaculum resists displacement • Do not confuse with bipartite patella	HX: Trauma. Pain, cannot extend knee, swelling. PE: "Dome" effusion. Tenderness, +/- palpable defect. Inability to extend knee. XR: Knee trauma series CT: Not usually needed	Descriptive location: Nondisplaced Transverse Vertical Stellate Inferior/superior pole Comminuted	Nondisplaced or comminuted: cylinder cast for 6 wks Displaced(2-3mm): ORIF (e.g. tension bands) to restore articular surface Severely comminuted: may require patellectomy
COMPLICATIONS: Osteoarthritis and/or pain, Decreased motion and/or strength; Osteonecrosis; Refracture			
TIBIAL PLATEAU FRACTURE			
• Mechanism: Direct blow (e.g. MVA) • Intraarticular fracture • Restoration of articular surface is important • Most often lateral • Metaphyseal injury: bone compresses, leads to functional bone loss. • Associated with ligament injuries	HX: Trauma. Cannot bear weight. Pain, swelling. /PE: Effusion, tenderness, do good neurovascular PE XR: Knee trauma series CT: Better defines fracture. AGRAM: if pulseless	Schatzker (6 types): I. Lateral plateau split fx II. Lateral split/depression fx III. Lateral plateau depression IV. Medial plateau split fx V. Bicondylar plateau fx VI. Fx with metaphyseal-diaphyseal separation	+/- Aspirate hemarthroses Undisplaced (6 mm): cast, ROM at 6 wks, WB 3mos. Displaced/unstable: ORIF: plates and screws +/- bone graft Mobilize early, weight- bear at 2 months

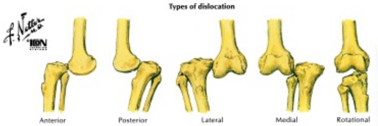
COMPLICATIONS: Compartment syndrome; Hardware failure or loss of reduction; OA; Popliteal artery or nerve injury

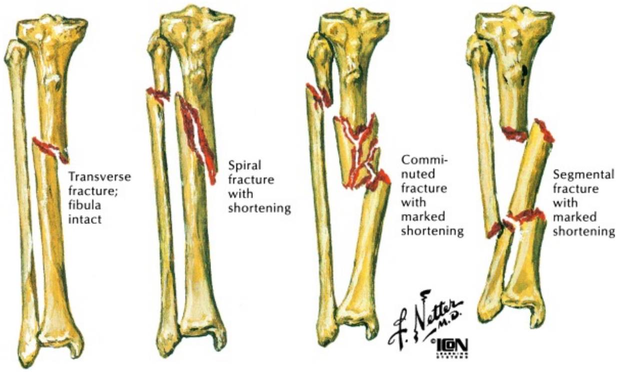
KNEE DISLOCATION			
• Rare: Ortho emergency • Usually high energy injury • Ligaments other soft tissue are disrupted • High incidence of associated fracture neurovascular injury • Close follow up is important for good result	HX: Trauma. Pain, inability to bear weight. PE: Effusion, deformity, pain, +/- distal pulses peroneal nerve function XR: AP/lateral AGRAM: ID arterial injury MR: Ligament injury	By position: Anterior Posterior Lateral Medial Rotatory: Anteromedial or anterolateral.	Early reduction essential Post reduction neuro-logic exam and x-rays. Immobilize (cast): 6-8 wks (not if ligaments torn) Open: If irreducible, vascular injury (+/- pro-phylactic fasciotomy), early repair of ligaments if needed.
COMPLICATIONS: Neurovascular: Popliteal artery, peroneal nerve injury; Decreased motion; Instability			



Dislocation of Knee Joint

Types of dislocation

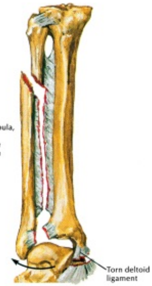




DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
TIBIA SHAFT FRACTURE			
• Common long bone fracture • Young adults • Often tibia/fibula fracture or tibia fracture/dislocation combination injuries • Tenuous blood supply: union is a problem. • Up to 5% residual angulation is acceptable	HX: Trauma. Cannot bear weight, pain, swelling. PE: Swelling, deformity, +/- tense compartments open wound. Palpate pulse XR: AP/lateral leg, + knee and ankle series AGRAM: if pulseless	Descriptive: Location Displaced/comminuted Type: transverse, spiral oblique Rotation/angulation	Stable, non or minimally displaced, closed injury: Long leg cast 4-6 wks then shorter cast Unstable, displaced, comminuted injury: ORIF Intramedullary nails (external fixation for severe open fractures)
COMPLICATIONS: Malunion/nonunion: especially mid-distal 1/3; Compartment syndrome; Decreased motion; Hardware failure; Neurovascular injury; Reflex Sympathetic Dystrophy (RSD)			
MAISONNEUVE FRACTURE			
• Complete syndesmosis disruption with diastasis proximal fibula fracture • Variant of ankle fracture deltoid ligament rupture • Unstable fracture	HX: Trauma. Ankle pain, +/- knee pain. PE: Ankle pain, swelling, +/- knee signs. XR: Knee series with each ankle fracture		Reduce and stabilize syndesmosis with a screw
COMPLICATIONS: Ankle instability; Ankle arthritis			
PILON (DISTAL TIBIA) FRACTURE			
• Intraarticular: through distal articular/WB surface. • Comminution common • Associated soft	HX: Trauma. Cannot bear weight, pain, swelling PE: Effusion, tenderness, do good neurovascular	Ruedi-Allgower (3 types): I. Non or minimally displaced. II. Displaced: articular	Nondisplaced: Long leg cast NWB for 6 wks Displaced/Comminuted: ORIF: plates screws +/-

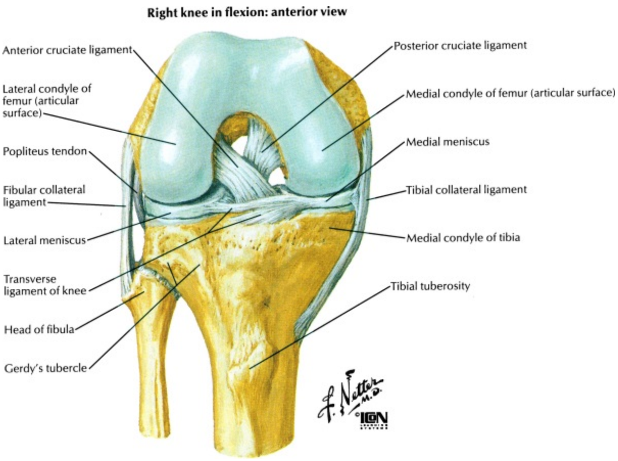
• tissue injuries • Articular surface repair is difficult essential • Healing is often slow	PE XR: AP/lateral (obliques) CT: Needed: better image of articular surface	surface incongruous. III. Comminuted articular surface.	bone grafting Severely comminuted: external fixation
COMPLICATIONS: Post-traumatic Osteoarthritis (almost 100% in comminuted fractures); Decreased motion; Malunion/nonunion			

Maisonneuve fracture. Complete disruption of tibiofibular syndesmosis with diastasis caused by external rotation of talus and transmission of force to proximal fibula, resulting in high fracture of fibula. Interosseous membrane torn longitudinally. Radiograph shows repair with long transverse screw. (These fractures easily missed on radiographs)



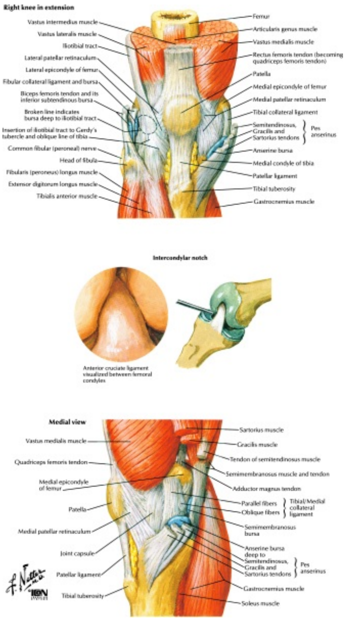
Pilon fracture
Usual cause is vertical loading of ankle joint, eg, falling from height and landing on heel (usually with ankle dorsiflexed). Fracture and compression of articular surface of tibia plus separation of malleoli and fracture of fibula

KNEE JOINTS



SUPPORT	ATTACHMENTS	COMMENTS
	FEMORAL/TIBIAL: CONDYLOID	
ANTERIOR		
Patellofemoral joint	See page 212	
Anterior cruciate (ACL)	Tibial eminence to medial aspect of lateral femoral condyle	Prevents anterior translation, tight in flexion, must reconstruct if injured
Transverse meniscal ligament	Anterior menisci	Meniscus support stability
MEDIAL		
Meniscus	Between femoral condyle tibial plateau	More crescentic than lateral
Capsule (III)	Surrounds joint	Minimal support
Medial collateral (MCL)	Medial epicondyle to tibia (II) meniscus (III)	Superficial (II) and Deep (III) portion
Coronary ligament (III)	Meniscus to medial tibia	Stabilizes meniscus
Semimembranous membrane (II)	Attach to posterior tibial condyle	
Pes anserinus tendons (I)	Medial tibial condyle	Tendinitis can occur at insertion
LATERAL		
Meniscus	Between femoral condyle tibial plateau	More circular than medial
Popliteus muscle tendon	Proximal tibia	Intraarticular tendon
Capsule (III)	Surrounds joint	Minimal support
Arcuate ligament (III)	Posterolateral femoral condyle to fibular head	Covers popliteus tendon
Fabellofibular ligament (III)	Fabella to fibula	Variable
Lateral collateral (LCL)	Lateral femoral condyle to	Prevents varus angulation

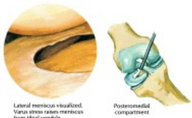
(III)	fibular head	Prevents varus angulation
Biceps muscle tendon (I)	Gerty's tubercle fibular head	
Iliotibial band (I)	Lateral tibial condyle	If tight, ITB syndrome can occur
POSTERIOR		
Capsule (III)	Surrounds joint	Minimal support
Ligament of Humphrey	Posterior lateral meniscus to medial femoral condyle	In front of PCL
Posterior cruciate (PCL)	Tibial sulcus to anterior medial femoral condyle	Prevents posterior translation
Ligament of Wrisberg	Posterior lateral meniscus to medial femoral	Behind the PCL
	condyle	
Oblique popliteal ligament	Semimembranous to lateral femoral condyle	Derived from semimembranous
Gastrocnemius/plantaris muscle	Origin: posterior medial lateral femoral condyles	Two heads originate above knee



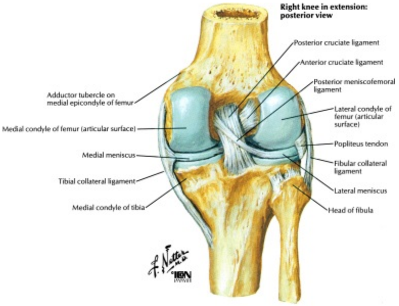
Anteromedial compartment

Medial meniscus visualized below femoral condyle. Meniscus rises with valgus stress, permitting inspection beneath it

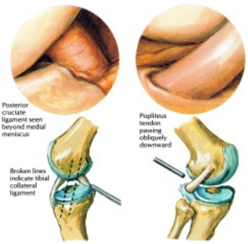
Anterolateral compartment

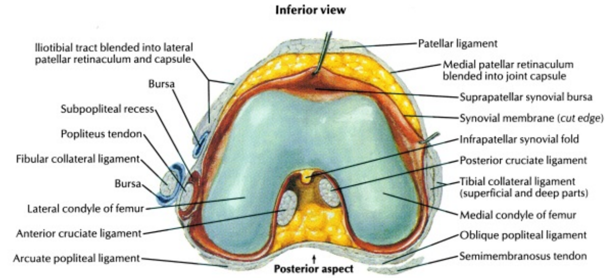


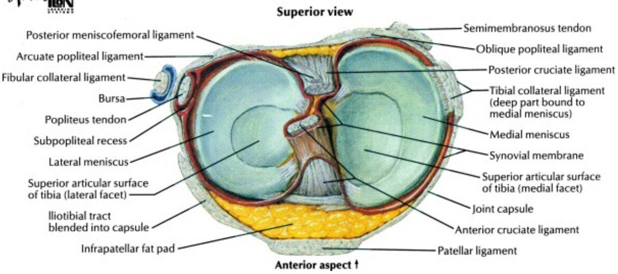
Lateral meniscus visualized. Varus stress raises meniscus from tibial condyle

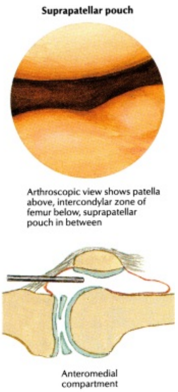


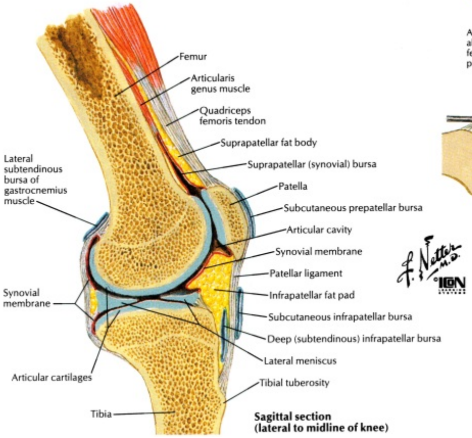
Posteromedial compartment **Posterolateral compartment**





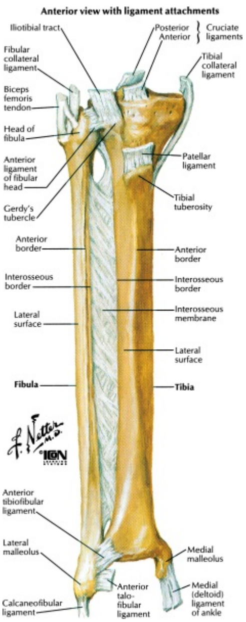






SUPPORT	ATTACHMENTS	COMMENTS
PATELLOFEMORAL		

Quadriceps tendon	Attach on superior patellar pole	Superior extensor mechanism
Patellar ligament (tendon)	Inferior patella pole to tibial tuberosity	Inferior extensor mechanism
Medial lateral retinaculum (quadriceps oblique fibers) (II)	Quadriceps extensions to patella, then to tibial condyles	Stabilizes patella in motion. Can affect Q angle if tight
Medial lateral patellofemoral ligaments (II)	Patella to femoral condyles	Stabilizes patella
Medial lateral patellotibial ligaments	Patella to tibial condyles	Stabilizes patella
PROXIMAL TIBIOFIBULAR : Plane		
Anterior ligament of head of fibula	Fibula head to lateral tibia	Broader than posterior
Posterior ligament of head of fibula	Fibula head to lateral tibia	Weaker than anterior
OTHER STRUCTURES		
Interosseous membrane	Lateral tibia to medial fibula	Strong; runs length of leg
• Three compartments in the knee: Medial, Lateral, Patellofemoral		
• Meniscus: Made of fibrocartilage. Function: 1) Protects articular cartilage (increases weight bearing surface area, 2) Stabilizes by deepening facet, 3) Load transmission		
Peripheral 1/3 vascular (geniculate arteries): can be repaired; Inner 2/3 supplied by synovial fluid: must debride in injured		
• There are three layers of support in the knee: I, II, III (noted in parentheses next to structure)		
• Posterolateral corner complex: Arcuate ligament, popliteus, posterolateral capsule		
• Muscles attaching at the pes anserinus: sartorius, gracilis, semitendinosus		



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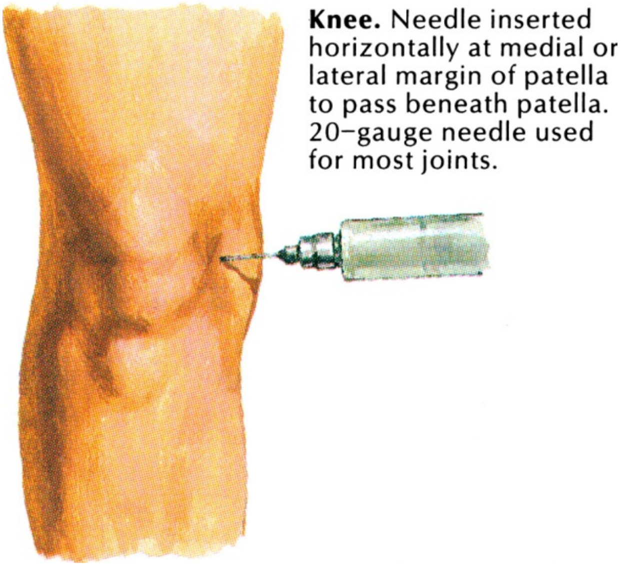
MINOR PROCEDURES: KNEE



STEPS
ARTHOCENTESIS/INJECTION
1. Ask patient about allergies
2. Place patient supine, knee extended, palpate the lateral patella and lateral distal femur.
3. Prepare skin over the knee (iodine/antiseptic soap)
4. Anesthetize skin locally (quarter size spot)
5. Insert an 18 gauge needle laterally into the suprapatella pouch (between the patella and femur) proximal to the joint. Aspirate fluid from joint (or inject 3-5cc of local/steroid preparation). Fluid should flow easily if needle is in joint.
6. If suspicious of infection, send fluid for GS culture.
7. Dress injection site

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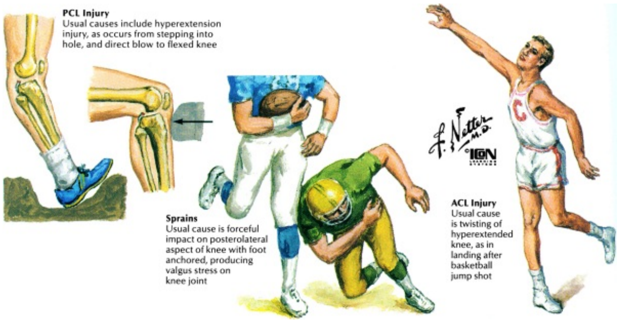
HISTORY



QUESTION	ANSWER	CLINICAL APPLICATION
1. AGE	Young	Trauma: fractures, ligamentous or meniscal injury
	Middle age, elderly	Arthritis
2. PAIN		
a. Onset	Acute	Trauma: fracture, dislocation, soft tissue (ligament/meniscus) injury, septic bursitis
	Chronic	Arthritis, infection, tendinitis/bursitis, tumor
b. Location	Anterior	Quadricep or patellar tear or tendinitis, prepatellar bursitis, patellofemoral arthritis
	Posterior	Meniscus tear (posterior horn), Baker's cyst, popliteal aneurysm
	Lateral	Meniscus tear (jointline), collateral ligament injury, arthritis, ITB friction syndrome
	Medial	Meniscus tear (jointline), collateral ligament injury, arthritis, pes bursitis
c. Occurrence	Night pain	Tumor, infection
	With activity	Etiology of pain likely from joint
3. STIFFNESS	Without locking	Arthritis, effusion (trauma, infection)
	With locking or catching	Loose body, meniscal tear (especially bucket handle), arthritis, synovial plica
4. SWELLING	Within joint	Infection, trauma
	Acute (post injury)	Acute (hours): ACL injury; Subacute (day): meniscus injury
	Acute (without injury)	Infection: prepatellar bursitis, septic joint
5. INSTABILITY	Giving away/collapse	Cruciate ligament injury, extensor mechanism injury
	Giving away,+/- pain	Patellar subluxation/dislocation, pathologic plica, osteochondritis dissecans
6. TRAUMA	Mechanism: valgus force	MCL injury (+/- terrible triad: MCL, ACL, medial meniscus injuries)
	Varus force	LCL injury
	Flexion/posterior force	PCL injury (e.g. dashboard injury)
	Contact injury	Non-contact: ACL injury, Contact: multiple ligaments

	Popping noise	Cruciate ligament injury (especially ACL), osteochondral fracture
	NONE	Degenerative and overuse etiology
7. ACTIVITY	Agility sports	Cruciate and/or collateral ligament injury
	Running, cycling, climbing	Patellofemoral etiology
	Squatting	Mensicus tear
	Walking	Distance able to ambulate equates with severity of arthritic disease
8. NEUROLOGIC SYMPTOMS	Pain, numbness, tingling	Neurologic disease, trauma
9. SYSTEMIC COMPLAINTS	Fevers, chills	Infection, septic joint
10. HISTORY OF ARTHRITIDES	Multiple joints involved	Rheumatoid Arthritis, gout, etc.

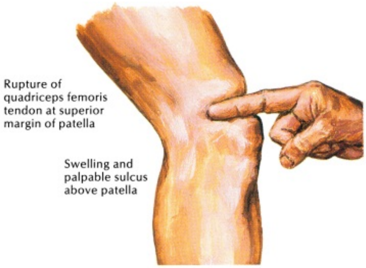
PHYSICAL EXAM

Prepatellar bursitis
(housemaid's knee)

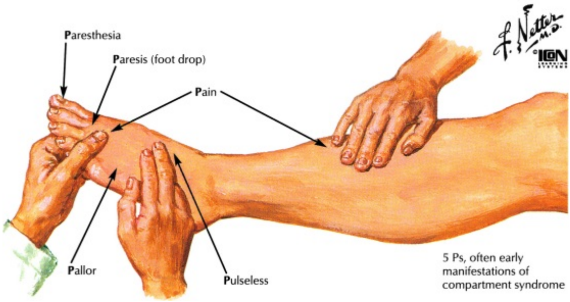
Osgood-Schlatter Disease
Clinical appearance. Prominence over tibial tuberosity partly due to soft-tissue swelling and partly to avulsed fragments

Iliotibial band
Area of diffuse pain and tenderness

EXAM	TECHNIQUE/FINDINGS	CLINICAL APPLICATION
INSPECION		
Gait	Observe patella tracking	Abnormal patella tracking can lead to patellofemoral problems
	Flexed knee gait	Tight Achilles tendon or hamstrings: patellofemoral problems
Anterior	Genu valgum (knock knee) Genu varum (bow leg)	Normal: 7 degrees valgus; varus or valgus deformity with ligamentous or osseous deficiency
	Swelling	Effusion (arthritis, trauma, infection/inflammation), bursitis (prepatellar, infrapatellar)
Posterior	Swelling, mass	Effusion (arthritis), Baker's cyst
Lateral	Back knee, high/low riding patella	Genu recurvatum (PCL injury), patella alta (patellar instability)
Musculature	Atrophy	Vastus medialis atrophy: can lead to patellofemoral problems
PALPATION		
Bony structures	Patella: medial lateral aspects	Tenderness at distal pole: tendinitis (Jumpers knee)
	Tibial tubercle	Tenderness with Osgood Schlatter disease
Soft tissues	Compress suprapatellar pouch ("milk" knee)	Ballotable patella (effusion): arthritis, trauma, infection
	Prepatellar/infrapatellar bursae	Edematous or tender bursae indicate correlating bursitis
	Pes anserine bursa	Tenderness indicates bursitis
	Plica (medial to patella)	Thickened, tender plica is pathologic
	Medial jointline MCL	Tenderness: medial meniscus tear or MCL injury
	Lateral jointline LCL	Tenderness: lateral meniscus tear or LCL injury
	Iliotibial band (anterolateral knee)	Pain or tightness is pathologic
	Popliteal fossa	Mass consistent with Baker's cyst, popliteal aneurysm
	Compartments of leg (anterior, posterior, lateral)	Firm or tense compartment: Compartment syndrome

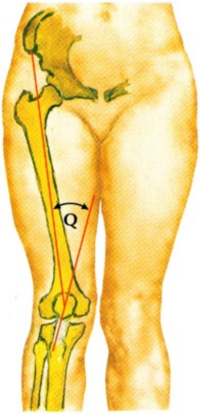


Acute Anterior Compartment Syndrome



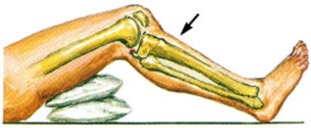
EXAM	TECHNIQUE/FINDINGS	CLINICAL APPLICATION
	RANGE OF MOTION	
Flexion extension	Supine: knee to chest, then straight	Normal: Flex 0 to 125-135°, Extend 0 to 5-15°;
		Extensor lag (final 20° difficult): weak quadriceps; Decreased extension with effusion
	Note patellar tracking, pain, crepitus	Abnormal tracking leads to anterior knee pain; pain crepitus: arthritis
Tibial IR ER	Stabilize femur, rotate tibia	Normal: 10-15° IR ER
	NEUROVASCULAR	
Sensory		
Femoral nerve (L4)	Medial leg (Medial cutaneous nerves)	Deficit indicates corresponding nerve/root lesion
Peroneal nerve (L5)	Lateral leg (common superficial)	Deficit indicates corresponding nerve/root lesion
Tibial nerve (S1)	Posterior leg (Sural nerves)	Deficit indicates corresponding nerve/root lesion
Motor		
Femoral nerve (L2-4)	Knee extension	Weakness = Quadriceps or nerve/root lesion
Sciatic: Tibial (L4-S3)	Knee flexion	Weakness = Biceps (LH) or nerve/root lesion
Peroneal (L4-S2)	Knee flexion	Weakness = Biceps (SH) or nerve/root lesion
Tibial nerve (L4-S3)	Foot plantarflexion	Weakness = TP, FHL, FDL or nerve/root lesion
Peroneal (deep) n. (L4-S2)	Foot dorsiflexion	Weakness = TA, EHL, EDL or nerve/root lesion

Reflex		
L4	Patellar	Hypoactive/absence indicates L4 radiculopathy
Pulse	Popliteal	



Q angle formed by intersection of lines from anterior superior iliac spine and from tibial tuberosity through midpoint of patella. Large Q angle predisposes to patellar subluxation

Apprehension (Fairbank) test As examiner displaces patella laterally, patient feels pain and forcefully contracts quadriceps femoris muscle



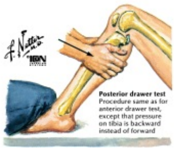
Posterior sag sign. Leg drops backward

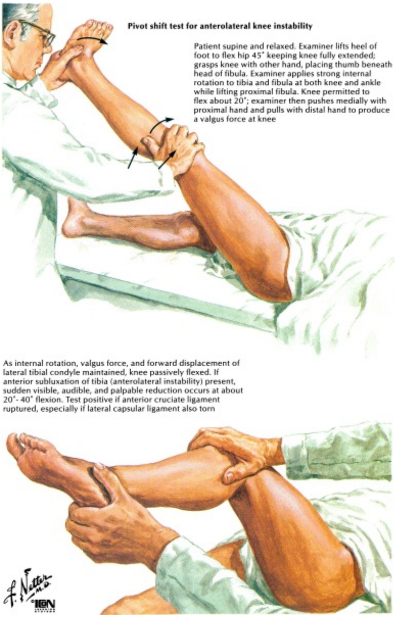
EXAM	TECHNIQUE/FINDINGS	CLINICAL APPLICATION
	SPECIAL TESTS	
Q (quadriceps) angle	ASIS to mid-patella to tibia tubercle	Normal: 13° male, 18° female; Increased angle: PF Syndrome, subluxation
Patella grind	Extend knee: fire quads, compress patella	Pain: patellofemoral joint pathology, patella chondromalacia
Patella apprehension	Relax knee: push patella lateral	Pain/apprehension: subluxation; Medial retinaculum injury
McMurray	Flex/ER leg/valgus force, then extend knee	Pop/click on extension indicates medial meniscal tear
	Flex/IR leg/varus force, then extend knee	Pop/click on extension indicates lateral meniscal tear
Apley compression	Prone: knee 90°, compress rotate tibia	Pain/popping: meniscal injury, arthritis
Ligament Stability Tests		
Valgus stress	Lateral force: knee at: 1) 30°, 2) 0°	Laxity at: 1) 30°: MCL, at 2) 0°: MCL/PCL/posterior capsule injury
Varus stress	Medial force: knee at 1) 30° 2) 0°	Laxity at: 1) 30°: LCL, at 2) 0° LCL/PCL/posterior capsule injury
Lachman	Flex knee 30°: anterior force on tibia	Laxity/displacement: ACL injury (most sensitive exam for ACL)
Anterior drawer	Flex knee 90°: anterior force on tibia	Laxity/displacement: ACL injury
Posterior drawer	Flex knee 90°: posterior force on tibia	Posterior translation: PCL injury

Posterior sag	Supine: hip 45°/knee 90°: lateral view	Posterior translation of tibia on femur: PCL injury
Quadriceps active	Supine: flex knee 90°, fire quadriceps	Posterior translated tibia will translate anterior when quadriceps fire: PCL injury
Pivot shift	Supine: extend knee, IR, valgus force on proximal tibia, then flex	Clunk with flexion: AnteroLateral Rotary Instability (ALRI): ACL and/or posterior capsule injury
Reverse pivot shift	Supine: knee at 45°, ER, valgus force on proximal tibia, extend	Clunk with extension: PosteroLateral Rotary Instability (PLRI): PCL and/or Posterolateral corner injury
Slocum	Knee 90°, ER foot 15°, anterior force	Displacement: AnteroMedial Rotary Instability
	Knee 90°, IR foot 30°, anterior force	Displacement: AnteroLateral Rotary Instability (ALRI): ACL injury
Posterior lateral drawer	Knee 90°, ER foot 15°, posterior force	Displacement: PosteroLateral Rotary Instability (PLRI): PCL/corner
Posterior medial drawer	Knee 90°, IR foot 30°, posterior force	Displacement: PosteroMedial Rotary Instability (PMRI): PCL
Prone ER at 30° 90°	Prone: ER both knees at: 1)30°, 2)90°	Increased ER at: 1) 30: PL corner, 2) 90: PCL PL corner injury

With one hand fixing thigh, examiner places other hand just above ankle and applies valgus stress. Degree of mobility compared with that of uninjured side, which is tested first. For varus stress test, direction of pressure reversed

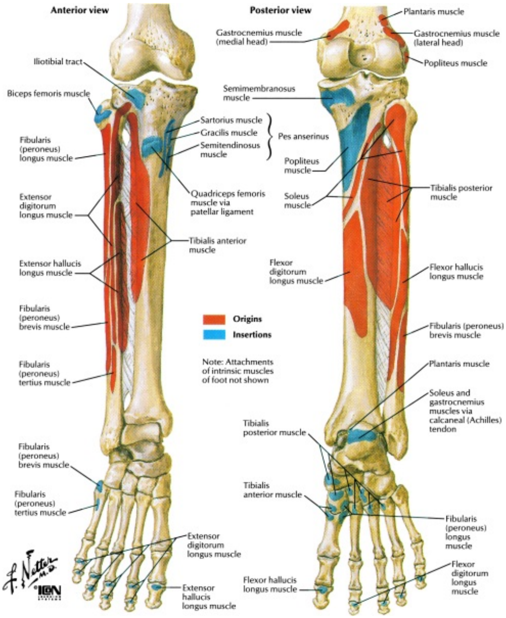
Lachman test
With patient's knee bent 20° - 30°, examiner's hands grasp limb over distal femur and proximal tibia. Tibia alternately pulled forward and pushed backward. Movement of 5 mm or more than that in normal limb indicates rupture of anterior cruciate ligament




Pivot shift test for anterolateral knee instability
Patient supine and relaxed. Examiner lifts heel of foot to flex hip 45° keeping knee fully extended; grasps knee with other hand, placing thumb beneath head of fibula. Examiner applies strong internal rotation to tibia and fibula at both knee and ankle while lifting proximal fibula. Knee permitted to flex about 20°; examiner then pushes medially with proximal hand and pulls with distal hand to produce a valgus force at knee
As internal rotation, valgus force, and forward displacement of lateral tibial condyle maintained, knee passively flexed. If anterior subluxation of tibia (anterolateral instability) present, sudden visible, audible, and palpable reduction occurs at about 20°- 40° flexion. Test positive if anterior cruciate ligament ruptured, especially if lateral capsular ligament also torn

Thompson: Netter's Concise Atlas of Orthopaedic Anatomy, 1st ed.

MUSCLES: ORIGINS AND INSERTIONS



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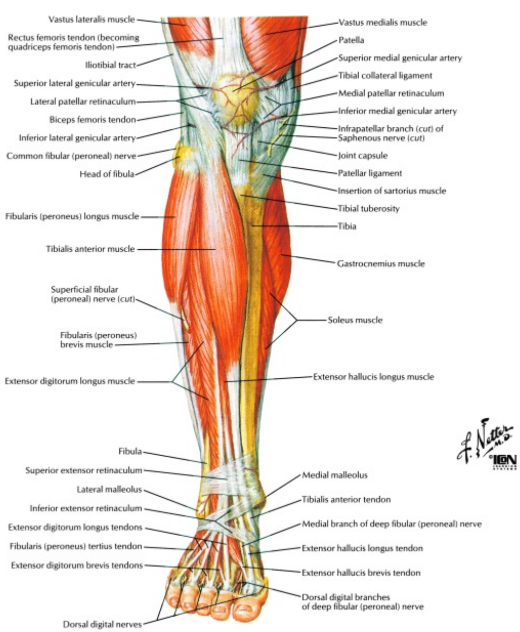
MUSCLES: ANTERIOR COMPARTMENT



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Tibialis anterior [TA]	Lateral tibia, interosseous membrane	Medial cuneiform, base of 1 st metatarsal	Deep peroneal	Dorsiflex invert foot	Test L4 motor function
Extensor hallucis longus [EHL]	Medial fibula, interosseous membrane	Base of distal phalanx of great toe	Deep peroneal	Dorsiflex extend great toe	Test L5 motor function
Extensor digitorum longus [EDL]	Lateral tibia condyle proximal fibula	Base of middle distal phalanges (4 toes)	Deep peroneal	Dorsiflex extend lateral 4 toes	Single tendon divides into four tendons
Peroneus tertius	Distal fibula, interosseous membrane	Base of 5 th metatarsal	Deep peroneal	Dorsiflex Evert foot	Often adjoined to the EDL

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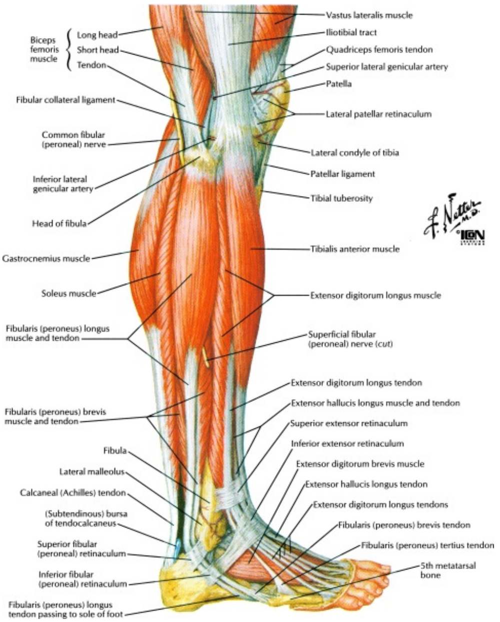
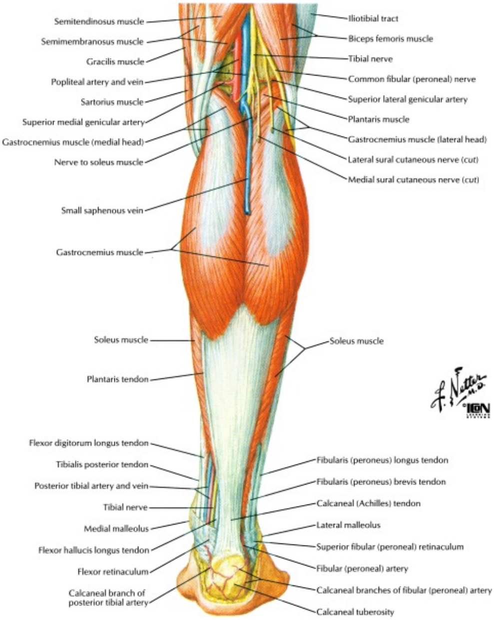
MUSCLES: LATERAL COMPARTMENT



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Peroneus longus	Proximal lateral fibula	Medial cuneiform, base of 1 st MT (plantarly)	Superficial peroneal	Evert, plantar flex foot	Test S1 motor function. Runs under the foot
Peroneus brevis	Distal lateral fibula	Base of 5 th metatarsal	Superficial peroneal	Evert foot	Can cause avulsion fx at base of 5 th MT

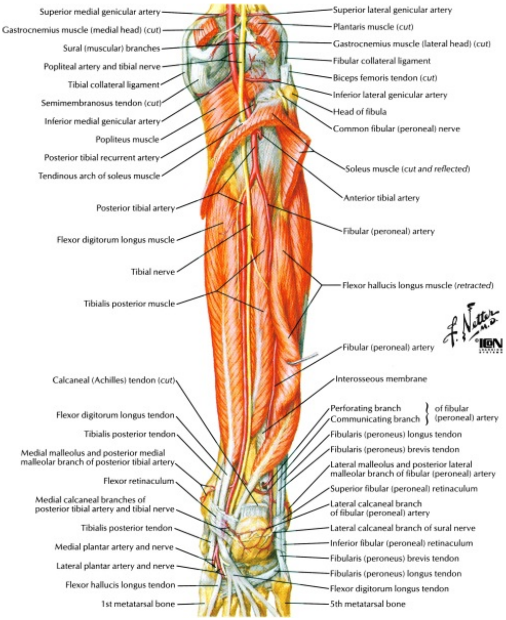
MUSCLES: SUPERFICIAL POSTERIOR COMPARTMENT



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Gastrocnemius	Lateral and medial femoral condyles	Calcaneus (via Achilles tendon)	Tibial	Plantarflex foot	Test S1 motor function Has two heads
Soleus	Posterior fibular head/soleal line of tibia	Calcaneus (via Achilles tendon)	Tibial	Plantarflex foot	Fuses to gastrocnemius at Achilles tendon
Plantaris	Lateral femoral supracondylar line	Calcaneus	Tibial	Plantarflex foot	Short muscle belly is proximal, has a long tendon.

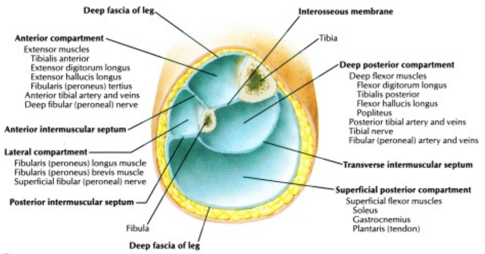
Thompson: Netter's Concise Atlas of Orthopaedic Anatomy, 1st ed.

MUSCLES: DEEP POSTERIOR COMPARTMENT

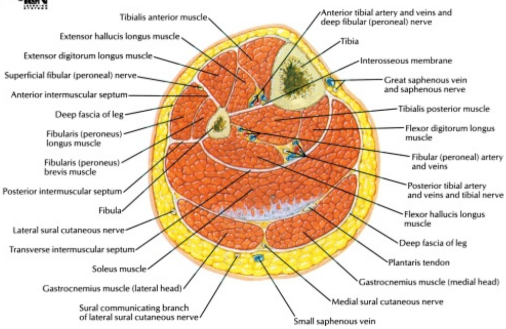


MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Popliteus	Lateral condyle	Proximal posterior tibia	Tibial	Flex (IR) knee	Anterior distal to LCL on femur
Flexor hallucis longus [FHL]	Posterior fibula	Base of distal phalanx of great toe	Tibial	Plantarflex great toe	Test S1 motor function
Flexor digitorum longus [FDL]	Posterior tibia	Bases of distal phalanges of 4 toes	Tibial	Plantarflex lateral 4 toes	At ankle, tendon is just anterior to tibial artery.
Tibialis posterior [TP]	Posterior, interosseous membrane, tibia, fibula	Navicular tuberosity, cuneiform, MT's	Tibial	Plantarflex invert foot	Tendon can degenerate rupture: 2° pes planus

MUSCLES: CROSS SECTIONS



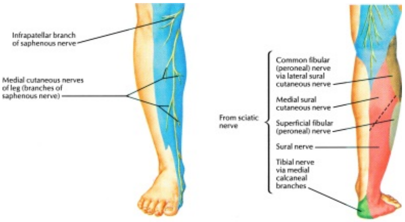
Cross section just above middle of leg

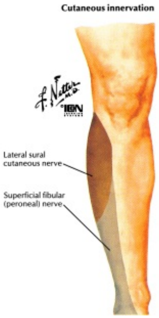


ANTERIOR	LATERAL	SUPERFICIAL POSTERIOR	DEEP POSTERIOR
		MUSCLES	
Tibialis anterior [TA]	Peroneus longus	Gastrocnemius	Popliteus
Extensor hallucis longus [EHL]	Peroneus brevis	Soleus	Flexor hallucis longus [FHL]
Extensor digitorum longus [EDL]		Plantaris	Flexor digitorum longus [FDL]
Peroneus tertius			Tibialis posterior [TP]
		NEUROVASCULAR	
Deep peroneal nerve	Superficial peroneal nerve	NONE	Tibial nerve
Anterior tibial artery and vein			Posterior tibial artery and vein
			Peroneal artery and vein

Thompson: Netter's Concise Atlas of Orthopaedic Anatomy, 1st ed.

NERVES

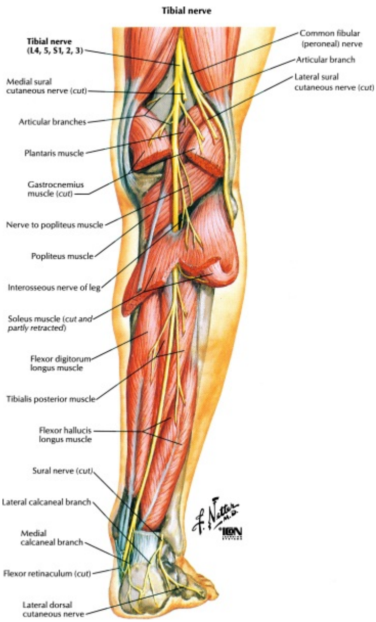




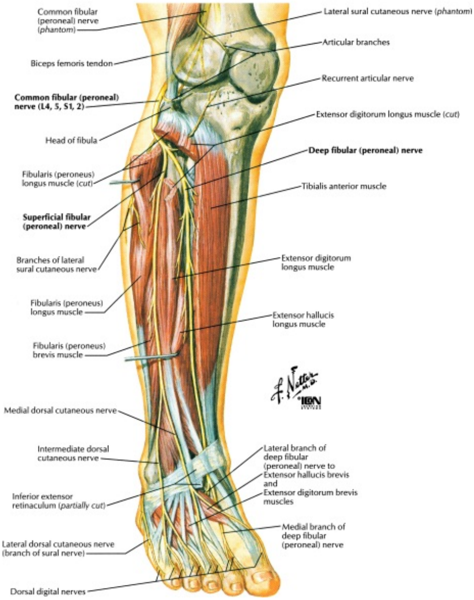
LUMBAR PLEXUS	
POSTERIOR DIVISION	
1. ***Femoral*** (L2-4):	
Sensory:	Medial leg: via medial cutaneous nerve (*Saphenous* N)
Motor:	NONE (in leg)

SACRAL PLEXUS	
ANTERIOR DIVISION	
2. ***Tibial*** (L4-S3): descends between heads of gastrocnemius to medial malleolus	
Sensory:	Posterolateral proximal calf: via Medial sural
	Posterolateral distal calf: via Sural
Motor:	SUPERFICIAL POSTERIOR COMPARTMENT OF LEG
	Soleus: via nerve to soleus
	Plantaris
	Gastrocnemius
	DEEP POSTERIOR COMPARTMENT OF LEG
	Popliteus: via nerve to popliteus
	Tibialis posterior [TP] (Tom)
	Flexor digitorum longus [FDL] (Dick)
	Flexor hallucis longus [FHL] (Harry)
POSTERIOR DIVISION	

3. **Common *peroneal*** (L4-S2): in groove between biceps lateral head of Gastrocnemius. Wraps around fibular head, deep to peroneus longus, then divides. Can be injured in lateral approach to the knee.	
Sensory:	Proximal lateral leg: via Lateral sural
	Distal lateral leg: via superficial peroneal
Motor:	ANTERIOR COMPARTMENT of LEG:
	Deep Peroneal Nerve
	Tibialis anterior [TA]
	Extensor hallucis longus [EHL]
	Extensor digitorum longus [EDL]
	Peroneus tertius
	LATERAL COMPARTMENT of LEG:
	Superficial Peroneal Nerve
	Peroneus longus
	Peroneus brevis



Common Peroneal Nerve



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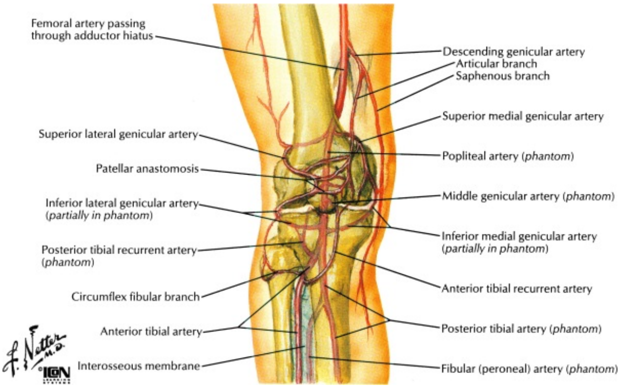
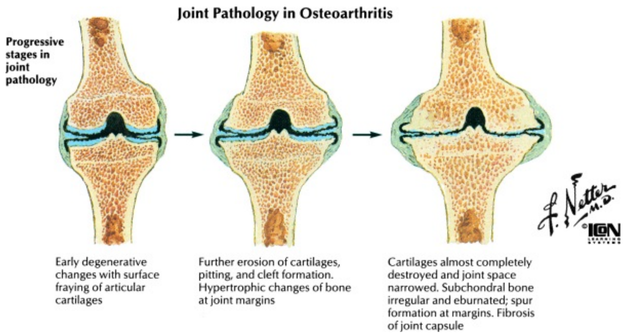
ARTERIES



COURSE	BRANCHES	SUPPLY/COMMENT
	POPLITEAL	
Through popliteal fossa. Terminates at the popliteus muscle.	Superior Inferior Medial Geniculate	All four arteries anastomose around knee patella (supply meniscus)
	Superior Inferior Lateral Geniculate	
	Middle Geniculate	Cruciate ligaments synovium
	Anterior Posterior *Tibial*	Terminal branches
	ANTERIOR *TIBIAL*	
	Supplies muscles of the ANTERIOR COMPARTMENT	
Through 2 heads of Tibialis Posterior interosseous membrane. Then lies on anterior surface of the membrane with deep peroneal nerve, between TA and EHL.	Anterior Tibial recurrent	Supplies knee
	Anterior Medial malleolar	Supplies ankle
	Anterior Lateral malleolar	Supplies ankle
	Dorsalis Pedis	Terminal branch in foot
	POSTERIOR *TIBIAL*	
	Supplies muscles of the POSTERIOR COMPARTMENT	
From popliteal, through posterior compartment with tibial nerve to behind medial malleolus (between FDL FHL).	Posterior Tibial recurrent	Supplies the knee
	Peroneal artery	LATERAL COMPARTMENT
	Posterior medial	

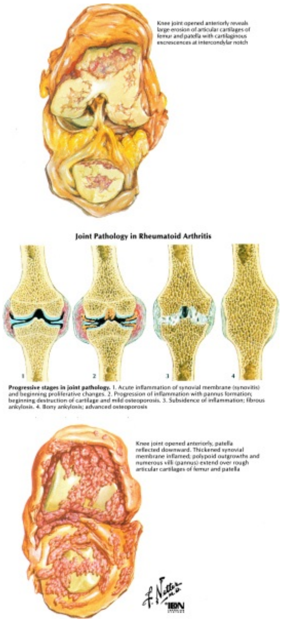
	malleolar	
	Perforating/muscular branches	
	Medial calcaneal	
	Medial Lateral plantar	Terminal branches in sole
	PERONEAL	
	Supplies muscles of the LATERAL COMPARTMENT	
From posterior tibial between tibialis posterior and FHL.	Posterior lateral malleolar	Terminal branch
	Lateral calcaneal Artery	

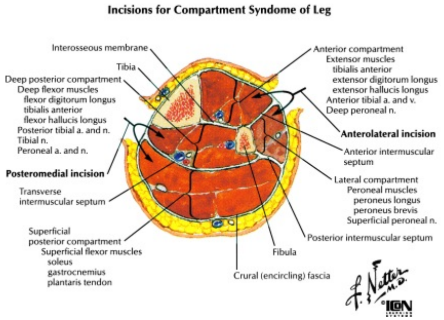
DISORDERS

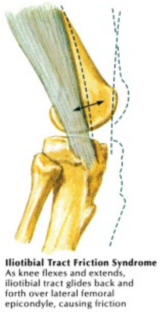


DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
ANTERIOR FAT PAD SYNDROME (Hoffa disease)			
• Fat pad (under patellar tendon) is pinched (2° to trauma)	Hx: Intermittent anterior knee pain	XR: AP/Lateral: possible patella baja	1. RICE, activity modification
	PE: +/- click with motion		2. Surgical excision (rare)
ARTHRITIS: INFLAMMATORY			
• Synovitis (pannus formation) destroys articular cartilage and joint	Hx: Any age (disorder dependent), female male, multiple joints, AM pain.	XR: Arthritis series	1. Early: medical management
• RA, Gout, SeroNegative arthropathy	PE: +/- warm, effusion, crepitus	Labs: RF, ESR, CRP, ANA, CBC, crystals, culture	**2.** Late: **a)** Conservative: like OA **b)** Operative: **1.** Synovectomy **2.** Total knee
ARTHRITIS: OSTEOARTHRITIS			
• Primary or posttraumatic	Hx: Elderly, pain (worse with activity or weight bearing), stiffness, sticking/grinding.	XR: Arthritis series	1. NSAIDs, Physical Therapy
• Loss or damage to articular cartilage	PE: Effusion, jointline tenderness, +/- angular deformity (varus #1) or contracture.	1. joint space narrowing	2. Injection, activity modification (cane)
• Knee (Medial compartment) #1 site		2. osteophytes	3. Fusion (young/worker)
• All 3 compartments are possible		3. subchondral sclerosis	4. High tibial osteotomy (young, 1 compartment disease)

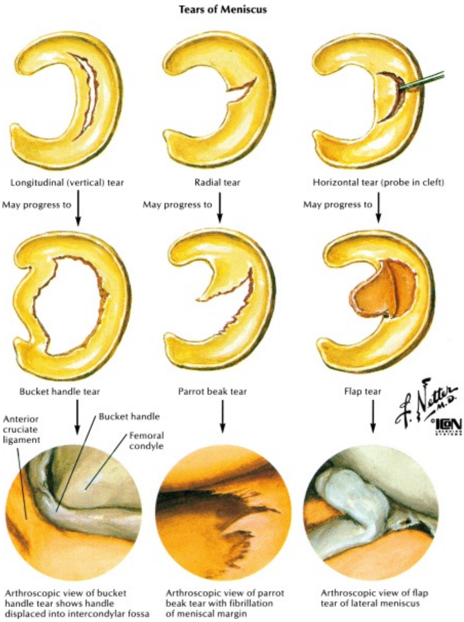
sites			
		4. bony cysts	5. Total Knee Arthroplasty (old, 1 compartment)
BAKER'S CYST			
• Posterior knee (popliteal fossal)	Hx: Stiffness, +/- knee tenderness	XR: AP/lateral: normal	1. Aspiration initially
• Arises from MM or hamstring tendon (may communicate)	PE: Mass in popliteal fossa	MR or aspiration: confirm diagnosis	2. Surgical resection for recurrence or pain
BURSITIS: PREPATELLAR (Housemaid's knee)			
• Continuous irritation of bursa leads to inflammation	Hx: Pain with activity	XR: AP/lateral: normal rule out infection (common problem)	1. NSAID, knee pads, injection
• Most common bursitis in knee	PE: “egg” shaped swelling over patella		2. Bursal removal (rare)
			3. Treat infection if present
BURSITIS: PES ANSERINE			
• Bursa under tendon insertion inflamed (overuse, runner, etc.)	Hx: Pain in medial knee	XR: AP/lateral: normal+/- OA, rule out tumor	1. NSAID, activity modification, stretch
	PE: Pes anserine tenderness		2. Partial excision (rare)



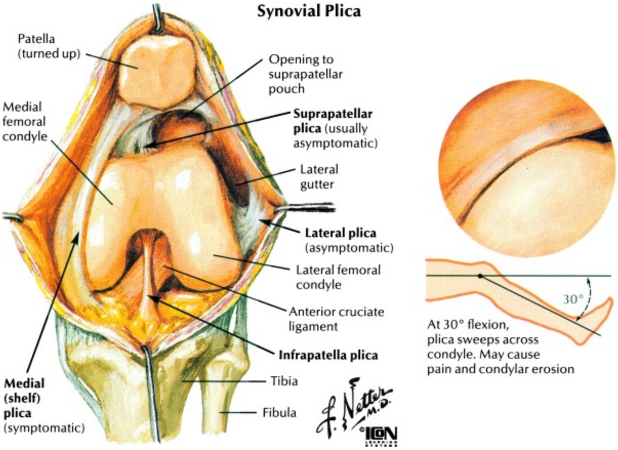




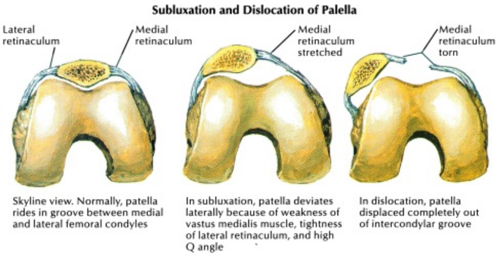
DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
CHONDROMALACIA: PATELLOFEMORAL SYNDROME [PFS]			
• Damage or softening of the patellar articular cartilage.	Hx: Anterior knee pain, worse with sitting (theater sign), and/or stairs	XR: AP/lateral/sunrise to evaluate alignment. Rule out patellofemoral OA	1. Physical therapy: quadricep strengthening stretching
• Multiple etiologies: trauma, dislocation, malalignment leads to patellofemoral OA	PE: +/- VMO atrophy, valgus deformity, high Q angle, patellar apprehension, + crepitus		2. Orthosis if patella subluxes
			3. Lateral release (early)
			4. Tibial tuberosity realignment
COMPARTMENT SYNDROME			
• Increased pressure in closed space	Hx: 5 P's: pain, parathesias, pulseless, pallor, paralysis.	Compartment pressures: 40 mmHg (normal: 0-10 mmHg)	1. Fasciotomy within 4 hours (Usually two incisions)
• From: trauma, (e.g. fracture, burn, vascular injury, overexertion)	PE: Firm compartments (check all three)		2. Debride nonviable soft tissue.
• Results in nerve injuries soft tissue necrosis			
ILIOTIBIAL BAND FRICTION SYNDROME			
• ITB rubs on lateral femoral condyle	Hx: Pain with activity	XR: AP/lateral: normal Rule out tumor	1. NSAID, activity modification, stretching
• Common in runners, cyclists	PE: Lateral femoral condyle TTP (knee at 30° flexion)		2. Partial excision (rare)

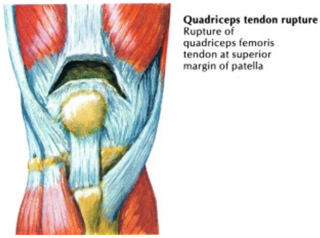


DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
MENISCUS INJURY: TEAR			
• Young: trauma/twisting injury	Hx: Pain, catching/locking (esp. bucket-handle tears)	XR: AP (extension 30° flexion)/lateral/sunrise, +/- arthrocentesis	1. Conservative for minor symptoms
• Old: Degeneration/squat injury	PE: Effusion, jointline tenderness, + McMurray test		2. Debride (inner 2/3 lesion)
• Seen with ACL injuries			3. Repair (outer 1/3 or longitudinal lesion)
• Medial lateral (cysts develop)			Improved results with ACL repair
OSTEOCHONDRITIS DISSECANS			
• Subchondral bone injury	Hx: Insidious onset knee pain	XR: AP/lateral: shows radiolucency, +/- fragment or loose body	1. Often spontaneously heals in children
• Unknown etiology: AVN, repetitive microtrauma	PE: Crepitus on flexion extension, femoral condyle tender to palpation		2. Adults: drill lesion vs. bone graft/chondroplasty
• Lateral aspect of medial femoral condyle #1			



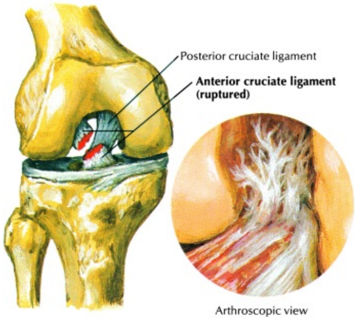
DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
	PLICA		
• Synovial tissue (embryonic remnant) thickens rubs medial femoral condyle.	Hx: Anteromedial knee pain, catching/popping	XR: AP/lateral Arthrography	1. NSAIDs
• Medial patellar plica: #1	PE: Palpable plica, jointline tenderness		2. Activity modification
			3. Arthroscopic debridement
	PATELLAR COMPRESSION SYNDROME		
• Compression of patella due to tight lateral retinaculum	Hx: Anterior knee pain	XR: AP/lateral: normal	1. Quadriceps strengthening
	PE: Lateral patella (facet) tender to palpation		2. Lateral release of retinaculum
	PATELLAR INSTABILITY		
• Spectrum: malalignment-recurrent subluxation-instability-dislocation	Hx: Knee buckles, +/- pain	XR: AP/lateral/sunrise: Lateral displacement of the patella. +/- patella alta	1. PT: VMO strengthening
• Usually lateral, leads to OA	PE: +/- genu valgum, increased Q angle, VMO atrophy, + patellar apprehension		2. Orthosis for subluxation
			3. Lateral release, realignment procedures (especially for MMS)
Miserable Malalignment Syndrome (MMS): associated with femoral anteversion, increased Q angle, genu valgum			





DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
PATELLAR TENDINITIS: JUMPER'S KNEE			
• Seen in jumpers (e.g. basketball volleyball players)	Hx: Sports, anterior knee pain	XR: AP/lateral: normal	1. NSAIDs, strengthen quadriceps [no steroid injection-tendon rupture]
	PE: Patella: inferior pole tender to palpation	MR: Increased signal in inferior pole	2. Debride tendon (rare)
PATELLAR TENDON (LIGAMENT) RUPTURE			
• Direct trauma (also systemic/metabolic disorders)	Hx: Young, history of trauma	XR: AP/lateral: relative patella alta	Primary surgical repair
• Quadriceps patella tendon rupture	PE: Decreased or no active extension, + palpable defect		
QUADRICEPS TENDON RUPTURE			
• Result of minor trauma	Hx: Older, cannot actively extend knee	XR: AP/lateral: relative patella baja	Primary surgical repair
• Metabolic disorders weaken tendon	PE: Palpable defect or sulcus		
TUMORS			
#1 in Adolescents: Osteosarcoma; #1 in Adults: Chondrosarcoma; #1 benign (young adult): Giant cell			

DISORDERS: LIGAMENT INJURIES

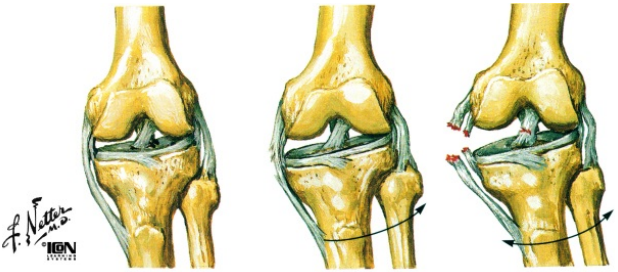


Terrible Triad
Rupture of tibial collateral and anterior cruciate ligaments plus tear of medial meniscus

DESCRIPTION	H P	WORK-UP/FINDINGS	TREATMENT
ANTERIOR CRUCIATE (ACL)			
• Twisting injury, often no contact	Hx: “Popping,” swelling	XR: AP/lateral/sunrise:+/- capsular avulsion	1. Closed chain exercises
• Associated with MCL meniscus tear (all 3 = Terrible Triad)	PE: Effusion. + Lachman, anterior drawer and pivot shifts tests (Lachman most sensitive)	Arthrocentesis (+ /-): 70% have hemarthrosis	2. Reconstruction needed (usually after several weeks of rehabilitation)
• Segond fracture: avulsion fx		MR: confirms diagnosis	
POSTERIOR CRUCIATE (PCL)			
• Anterior force on flexed knee (e.g. dashboard)	Hx: Pain, unable to ambulate	XR: AP/lat/sunrise: +/- avulsion fracture	1. Non-operative: crutches
• Also with other ligament njuries	PE: + posterior drawer, posterior sag, quad active tests	MR: confirms diagnosis	2. Quadriceps strengthening (Complication: OA)
MEDIAL COLLATERAL (MCL)			
• Valgus force (football clip)	Hx: Medial knee pain	XR: AP/lateral: possibly an avulsion.	1. Hinged knee brace
• Graded 1, 2 (partial), 3 (complete)	PE: Laxity and/or pain with valgus stress (at 30° flexion)		2. Physical therapy: early ROM strengthening
LATERAL COLLATERAL (LCL)			
• Varus force (isolated, rare)	Hx: Trauma. Pain swelling	XR: AP/lateral: possibly an avulsion.	1. Nonoperative: see MCL
• Associated with other ligament and peroneal nerve injuries	PE: Laxity pain with varus stress (at 30°). Test for foot drop		2. Surgical for grade III (usually combination injury)
Isolated PCL, MCL, and LCL injuries are primarily treated non-operatively; operative repair is			

used when these injuries occur in combination.			
POSTEROLATERAL CORNER COMPLEX (PLC)			
• Often with PCL injury	Hx: Pain, instability	XR: AP/lateral	Early surgical repair
• LCL torn	PE: Increased ER at 30° flexion, + posterolateral drawer test		
• Popliteofibular ligament torn			

DISORDERS



1st-degree sprain. Localized joint pain and tenderness but no joint laxity

2nd-degree sprain. Detectable joint laxity plus localized pain and tenderness

3rd-degree sprain. Complete disruption of ligaments and gross joint instability

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TOTAL KNEE ARTHROPLASTY

KEYS TO TOTAL KNEES

GENERAL INFORMATION

Implants: unlike hip, all are cemented (to reduce complications with loosening)

- Cement: Polymethylmethacralate
- Femoral condylar and tibia components are metallic
- Tibial component surface plate: Polyethylene

INDICATIONS

1. End stage DJD: results in disabling pain in knee secondary to arthritis in 2 + compartments (medial lateral patellofemoral).
   - Common etiologies: OA, RA, AVN
   - Most patients complain of PAIN, worsening over time (wakes them from sleep), and decreased ability to ambulate
   - Patient should have appropriate radiographic evidence of arthritis

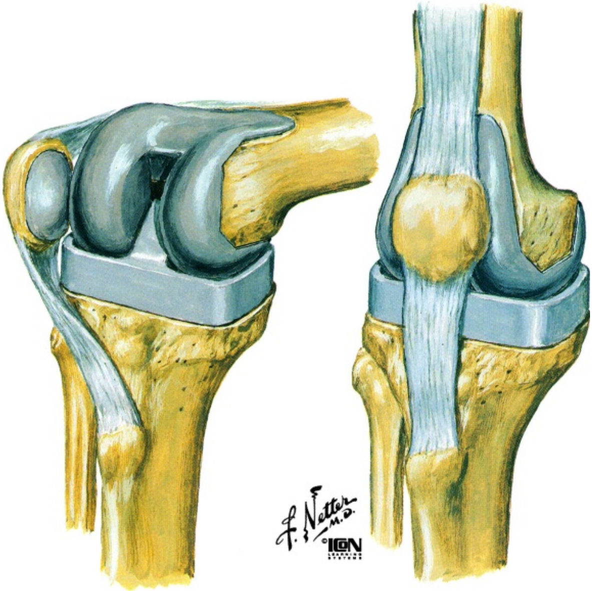
OSTEOARTHRITIS	RHEUMATOID ARTHRITIS
1. Joint space narrowing	1. Joint space narrowing
2. Sclerosis	2. Periarticular osteoporosis
3. Subchondral cysts	3. Joint erosions
4. Osteophyte formation	4. Ankylosis

   - It is preferable that the patient is elderly (needs only one replacement)
2. Failed conservative treatment: activity modification, weight loss, orthosis, physical therapy/strengthening, NSAIDs, ambulation assistance (cane, walker, etc.), injections.

CONTRAINDICATIONS

- Young, active patient (will wear out replacement many times)
- Knee extensor mechanism dysfunction
- Medically unstable (e.g. severe cardiopulmonary disease)
- Neuropathic joint
- Any infection

TOTAL KNEE ARTHROPLASTY



All components in place — Knee extended

KEYS TO TOTAL KNEES

ALTERNATIVES

- Considerations: Age, activity level, overall health
- Osteotomy: for unicompartmental disease, young, active (not in elderly patients)
  - Medial compartment (varus deformity): high tibial osteotomy
  - Lateral compartment (valgus deformity): distal femoral osteotomy
- Arthrodesis/Fusion: totally destroyed, neuropathic, or septic joint
- Unicompartment arthroplasty: for unicompartment disease. Only in selected patients not eligible for osteotomy.

PROCEDURE

- Medial parapatellar approach used (lateral parapatellar for severe valgus deformity)
- ACL is sacrificed
- Using specialized guides, the distal femur and proximal tibia are removed and replaced with metallic/plastic components.
  - Underside of patella also replaced.
- Flexion and extension gap should be equal

COMPLICATIONS

- Infection: often leads to removal of prosthesis (Staph #1)
- Loosening of components
- Patellofemoral joint pain

- Decreased ROM (usually from inadequate postoperative physical therapy)
- Patella fracture
- Superolateral geniculate artery is at risk
- Fat embolism
- Peroneal nerve palsy
- Deep Venous Thrombosis (DVT)/Pulmonary emboli: patients should be anticoagulated (Heparin/warfarin) postoperatively

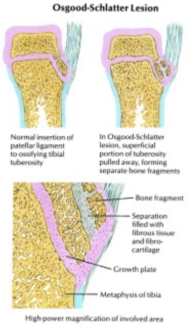
PEDIATRIC DISORDERS

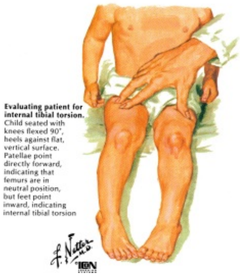
Bow Leg and Knock-knee

Two brothers, younger (left) with bowleg, older (right) with knock-knee. In both children, limbs eventually became normally aligned without corrective treatment

DESCRIPTION	EVALUATION	TREATMENT/COMPLICATIONS
GENU VARUM: BOW LEGS		
• Normal: neonate to 2 yrs old	Hx: Parents observe deformity	1. Most resolve spontaneously with normal development
• Etiology:	PE: Measure tibiofemoral angle	2. Night bracing rarely required
1. Blount's disease	XR: Only large deformity or if concerned about dysplasia.	3. Osteotomy if persistent (15°)
2. Rickets (nutritional)		
3. Skeletal dysplasia		
4. Trauma		
GENU VALGUM: KNOCK KNEES		
• Normal for 2 yrs to 4 yrs	Hx: Parents observe deformity	1. Most resolve spontaneously with normal development
• Adult: 5-10° valgus is normal	PE: Measure tibiofemoral angle	2. Surgery if persists past age 10
• Etiology:	XR: Only large deformity or if concerned about dysplasia.	
1. Rickets (renal)		
2. Skeletal dysplasia		
3. Trauma		
OSGOOD SCHLATTER DISEASE		
• Osteochondritis/traction apophysitis of tibial tubercle (at 2° ossification center)	Hx: Early adolescent. Knee pain worse after activity	1. Activity restriction/modification

• From repetitive extensor (quadriceps) pull on tubercle	PE: Pain, swelling at tubercle	2. Most resolve with fusion of apepnysis in midadolesence
	XR: Knee AP/lateral: may show heterotopic ossification	
	TIBIAL TORSION	
• Congenital IR of tibia (associated with intrauterine position)	Hx: 1-2 yo, often tripping, no pain	Will resolve spontaneously (between 24-48 months)
• Often bilateral	PE: Negative foot to thigh angle (normal 10-30°),with knee/patella pointed forward, intoeing gait observed	





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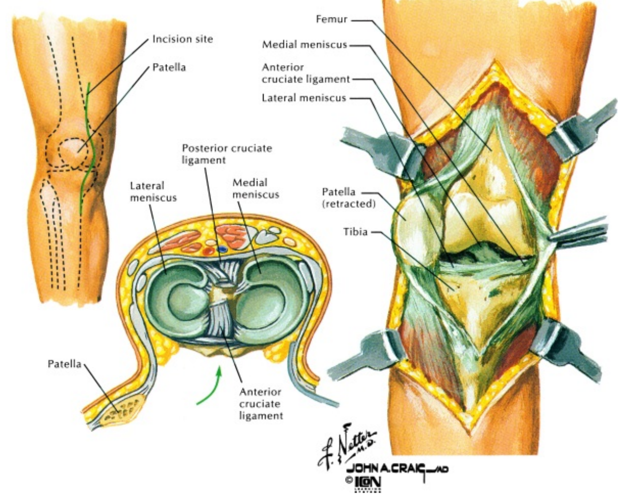
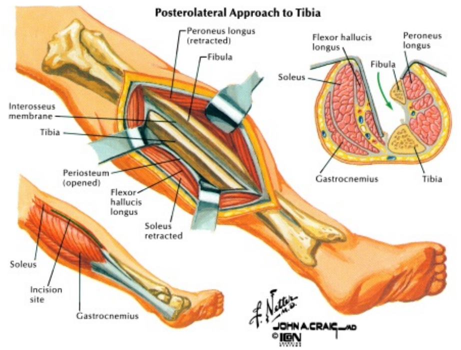
SURGICAL APPROACHES

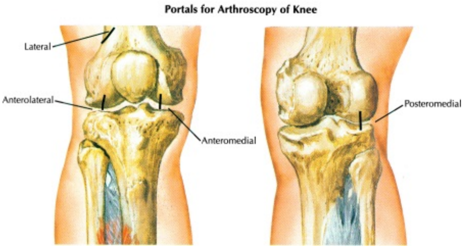
Anteromedial Approach to Knee Joint



USES	INTERNERVOUS PLANE	DANGERS	COMMENT
KNEE: MEDIAL PARAPATELLAR APPROACH			
1. Ligament reconstruction	No planes: Capsule is under skin	1. Infrapatellar branch of *Saphenous* Nerve	1. Most commonly used approach
2. Total knee arthoplasty			2. Most/best exposure
3. Meniscectomy			3. Neuroma may develop from cutaneous nerves
LEG/TIBIA: POSTEROLATERAL APPROACH (Harmon)			
1. Fractures	1. Gastrocnemius/soleus/FHL [Tibial]	1. Lesser saphenous vein	1. A technically difficult approach
2. Nonunions	2. Peroneus longus/brevis [Superficial peroneal]	2. Posterior tibial artery	2. Bone grafting of nonunion
ARTHROSCOPY PORTALS			
1. Anteromedial	Just above joint line,	Anterior horn of medial menicus	Used to view lateral compartment
	1 cm inferior to patella		
	1 cm medial to patellar ligament		
2. Anterolateral	Just above joint line,	Anterior horn of lateral meniscus	1. Used to view medial compartment, ACL, and menisci
	1 cm inferior to patella		
	1 cm lateral to patellar ligament		2. PCL posterior structures hard to see
3.	2.5 cm above joint line,		Used to view patellofemoral articulation, patella tracking,

Superolateral	lateral to quadricep tendon		etc.
4. Posteromedial	Flex knee to 90°, 1 cm posterior to femoral condyle		Used to view PCL, posterior horns of menisci





CHAPTER 9 - FOOT/ANKLE

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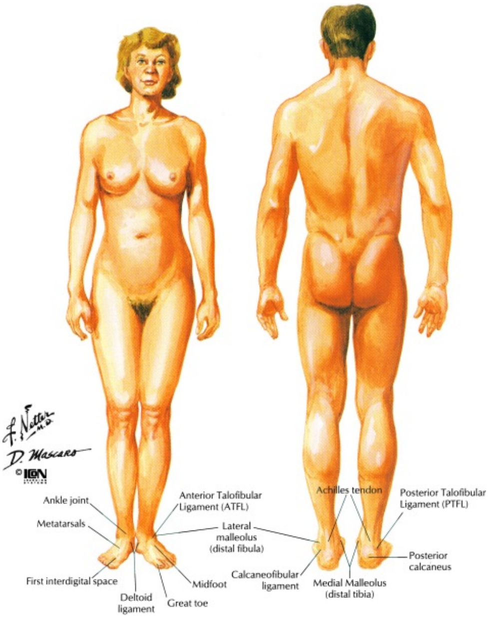
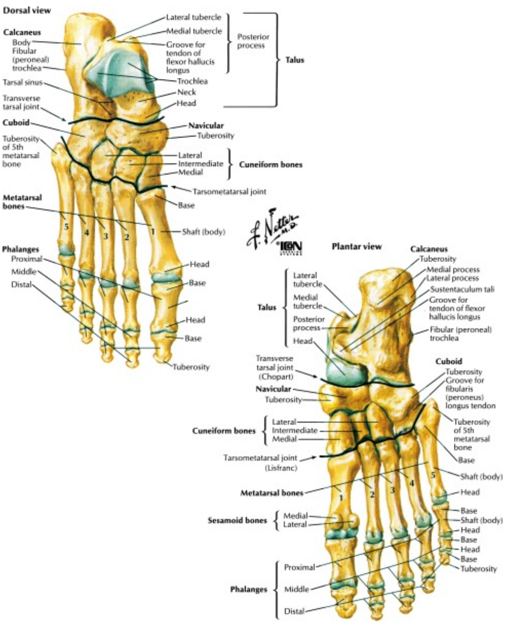
CHAPTER 9 – FOOT/ANKLE

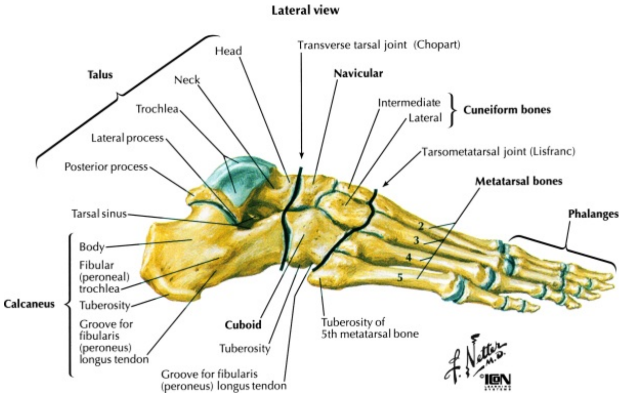
TOPOGRAPHIC ANATOMY



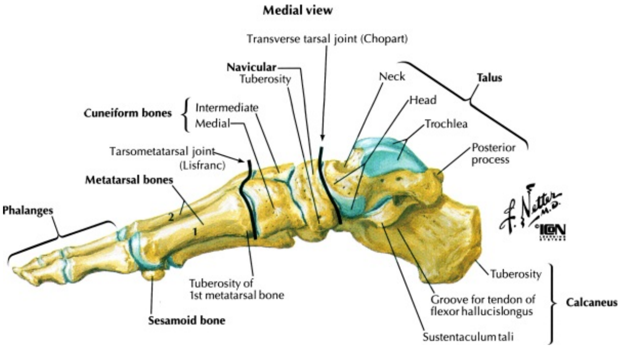
OSTEOLOGY



CHARACTERISTICS	OSSIFY		FUSE	COMMENT
See leg chapter for Tiba and Fibula				
TALUS				
• Head (anterior-navicular) • Neck: susceptible to fracture • Body/trochlea: in ankle mortise • Lateral process • Posterior process: medial lateral tubercles	Primary: Body	7mo. (fetal)	13-15 years	• Talus is only tarsal bone to articulate with tibia and fibula. No muscular attachments. • AVN a concern due to retrograde blood supply from branches of posterior tibial dorsalis pedis arteries • Weight from tibia is transmitted through the trochlea • FHL runs between medial lateral tubercle of posterior process • Unfused lateral tubercle: Os trigonum, not a fracture



CHARACTERISTICS	OSSIFY		FUSE	COMMENT
		CALCANEUS		
• Multiple facets: posterior largest • Sustentaculum tali: has the middle facet; supports talar neck	Primary: Body Secondary: Tubercle	6 mo. (fetal) 9 year	13-15 years	• Largest tarsal bone; posterior support for longitudinal arch • FHL runs under sustentaculum tali; spring ligament attaches to it • Painful spurs can develop on tuberosity
		NAVICULAR		
• “Boat-shaped” • Tuberosity (medial)	Primary:	4 years	13-15 years	• Tibialis posterior inserts on to the tuberosity • Articulates with talus, cuneiforms, cuboid • Shape of tarsals create transverse arch
		CUNEIFORMS		
• Three bones • Medial: largest • Intermediate: shorter than others • Lateral	Primary:	3 years 4 years 1 year	13-15 years	• 2nd MT is in “recess” of short intermediate bone; can lead to fracture of it's base, unstable TMT joint. • Peroneus longus partially inserts on plantar aspect of med. cuneiform



CHARACTERISTICS	OSSIFY		FUSE	COMMENT
CUBOID				
• Tuberosity inferiorly • Cuboid groove inferiorly	Primary:	Birth	13-15 yrs	• Most lateral tarsal bone • Peroneus longus tendon passes through groove on inferior surface
METATARSALS				
• Long bone characteristics • Base of 2nd MT in tarsal “recess” • Anterior support of longitudinal arch of the foot	Primary: Shaft Secondary: Epiphysis	9 wks (fetal) 5-8 yrs	Birth 14-18 years	• Numbered medial to lateral: I to V. • Only one epiphysis per bone: in the head except for the 1st MT [in the base] • Peroneus brevis inserts on base of 5th MT (avulsion can occur)
PHALANGES				
• Great toe has only two phalanges	Primary: Body	10 wks (fetal)	14-18	• 14 total phalanges in each foot • Only one epiphysis per bone: in the

• Great toe has two sesamoid bones	Secondary: Epiphysis	2-3 yrs	years	base • Sesamoid bones with other toes can occur as a normal variant

Ossification of each tarsal bone occurs from a single center

Borders of ankle mortise: Superior: tibia (plafond), medial: medial malleolus (tibia), lateral: lateral malleolus (fibula)

Tarsal Tunnel: A fibroosseous tunnel formed by the posterior medial malleolus, medial walls of calcaneus and talus, and flexor retinaculum. Contents: Tendons (TP, FDL, FHL), Posterior Tibial artery, Tibial nerve (can be compressed in tunnel)

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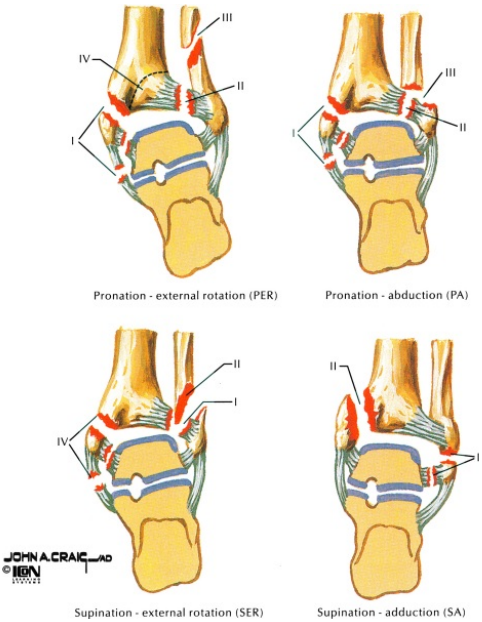
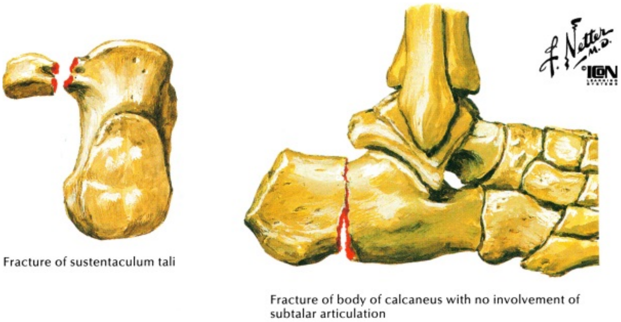
TRAUMA



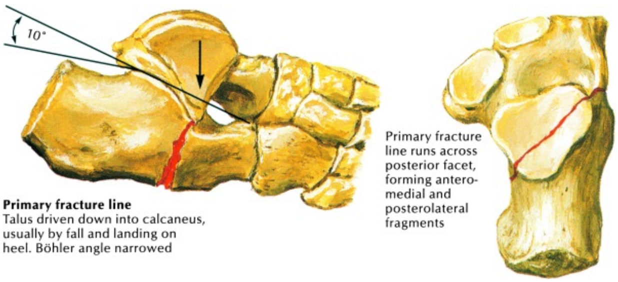
Lauge-Hansen Classification of Ankle Fractures

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
ANKLE FRACTURE			
(see Knee Trauma table for Maisonneuve fracture)			
• Very common in all ages • Malleoli and/or talar dome are involved • 1 malleolus fx: stable; • 2 malleoli and/or ligaments injured: unstable • Perfect symmetrical mortise reduction required • Also must correct fibular length	HX: Trauma. Pain, swelling PE: Effusion, intense tenderness at 1 or both malleoli +/- proximal fibula. Check posterior tibial pulse and tibial nerve function XR: Ankle trauma seriesCT: Good for intraarticularfractures needing repair	Lauge-Hansen – 4 types with subdivided stages • SA: supination/adduction stage I, II • SER: supination/external rotation: stages I-IV • PA: pronation/abduction stages I, II, III • PER: pronation/external rotation: stages I-IV	Dislocation: immediately reduce Stable/nondisplaced: short leg cast 4-6 weeks Unstable/displaced: ORIF, repair articular surface fibular length, +/- need for syndesmosis screw

COMPLICATIONS: Post-traumatic osteoarthritis/pain; Decreased motion and/or strength; Instability; Nonunion/malunion; RSD



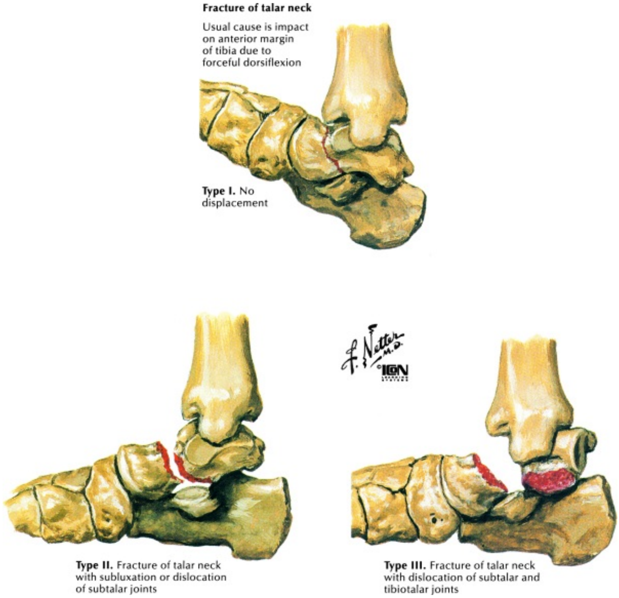
Extraarticular Fracture of Calcaneus



Intraarticular Fracture of Calcaneus

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
CALCANEUS FRACTURE			
• Most common tarsal fracture • Mechanism: large axial load (e.g. high fall or jump) • Must rule out spine injury • Subtalar joint affected • Most fractures are intraarticular (worse prognosis)	HX: Trauma. Cannot bear weight, pain, swelling. PE: Tender to palpation. Check Tibial nerve function, pulses arch swelling. XR: AP/lateral (+/- Harris) and spine films CT: Needed to better define fx	Extraarticular: Body Tuberosity Anterior/medial process Intraarticular: Nondisplaced Tongue-type Joint depression Comminuted	Extraarticular: Cast. ORIF if unstable Displaced/intraarticular: ORIF: plates and screws +/- bone graft Severely comminuted: Closed treatment.

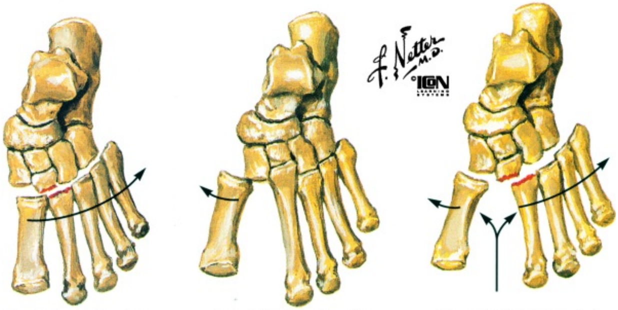
COMPLICATIONS: Osteoarthritis: subtalar; Decreased motion; Malunion/nonunion; Compartment syndrome; Sural nerve injury



Fracture of Talar Neck

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
TALUS FRACTURE			
• MVA, fall from height • Neck most common site, head body rare • Tenuous blood supply adds complications • Semi-emergent injury • Hawkins sign (on XR) resorption of subchondral bone indicates healing (no AVN)	HX: Trauma. Cannot bear weight, pain, swelling. PE: Tender to palpation. Check Tibial nerve function, pulses, arch swelling XR: AP/lateral (+/- Canale) CT: usually not needed	Hawkins types [neck] predicts osteonecrosis: I. Nondisplaced II. Displaced; subtalar subluxation/dislocation III. Displaced; talar body dislocation IV. Talar head (+/- body) dislocation	Type I: Cast 2 months. Manyprefer ORIF to reduce risk ofdisplacement Type II, III, IV: ORIF emergentlyto avoid necrosis +/- bonegraft Early ROM

COMPLICATIONS: Osteoarthritis: ankle and subtalar joints; Osteonecrosis of body (incidence decreased with ORIF); Delayed union/nonunion



Homolateral dislocation. All five metatarsals displaced in same direction. Fracture of base of 2nd metatarsal

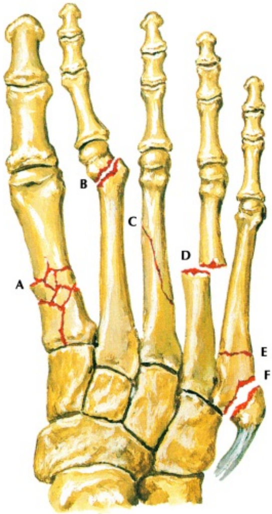
Isolated dislocation. One or two metatarsals displaced; others in normal position

Divergent dislocation. 1st metatarsal displaced medially, others superolaterally

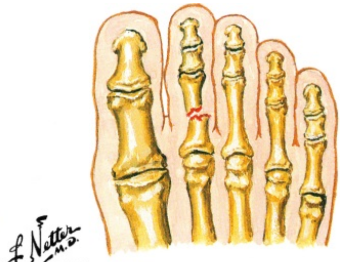
Injury to Tarsometatarsal (Lisfranc) Joint Complex

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
MIDFOOT FRACTURES			
• Involves tarsal bones • Usually high energy • Midtarsal joint injuries result from fractures of adjacent bones. • Cuneiform cuboid fractures are rare • 2nd MT in tarsal recess: fracture of its base destabilizes TMT joint, dislocation may result.	HX: Trauma. Dorsal pain. PE: Swelling, severe pain atMidtarsal or TMT jointincreases with midfootmotion. XR: AP/lateral/oblique,+/- foot stress filmMed. 2nd MT and middlecuneiform should align CT/MR: if unsure of fracture	Midtarsal: Navicular fracture Avulsion Tuberosity Body Cuboid fracture Cuneiform fracture Tarsometatarsal -LisfrancFracture (2ndMT) dislocationHomolateral, Isolated,Divergent	Midtarsal: Nondisplaced: cast. Other: ORIF Navicular: Reduce, +/- PCP. Many require ORIF Lisfranc injury: Close reduce fracture and/ordislocation (+/- PCP). ORIF: if displaced orirreducible- most

COMPLICATIONS: Neurovascular injury: Dorsalis pedis artery; Compartment syndrome; Decreased motion; Post-traumatic osteoarthritis or chronic pain.



Types of fractures of metatarsal: A. Comminuted fracture. B. Displaced neck fracture. C. Oblique fracture. D. Displaced transverse fracture. E. Fracture of base of 5th metatarsal. F. Avulsion of tuberosity of 5th metatarsal



Fracture of proximal phalanx

Fracture of phalanx splinted by taping to adjacent toe (buddy taping)

DESCRIPTION	EVALUATION	CLASSIFICATION	TREATMENT
METATARSAL AND PHALANGEAL FRACTURES			
• Common injuries: most are benign. • Fracture at metaphyseal/diaphyseal junction of 5th MT (Jones fracture) is not benign • Base of 5th MT avulsion fracture [PB]: benign • Toe fx: usually stub injury 5th toe most common	HX: Pain with weight bearing, swelling PE: Swelling, ecchymosis, bony pain (increases with motion) XR: MT: AP/lateral/oblique Toe: AP only	Metatarsal: Head neck fractureShaft Base (esp. of 5th)Phalanges: Shaft Joint injuries	Metatarsal Fractures:Undisplaced: hard soledshoe or walking cast. Displaced/angulated: ORIF5th MT Jones fx: Cast andNWB 6 weeks vs. ORIF Phalange Fractures:Great toe: Reduce. PCP jointinjuries. Others: splint or buddy tape

COMPLICATIONS: Neurovascular injury: Dorsalis pedis artery; Osteoarthritis/pain; Decreased motion; Nonunion, especially in 5th Metatarsal (Jones) fracture; Deformity

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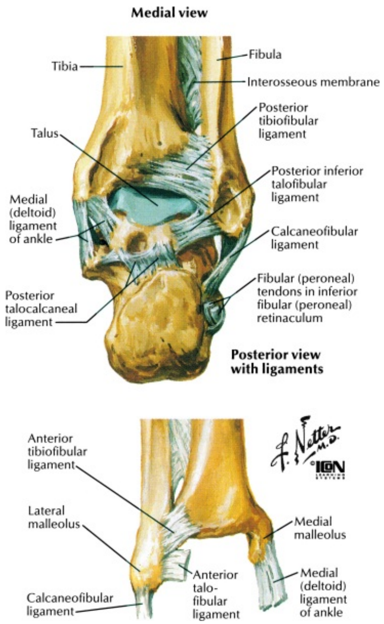
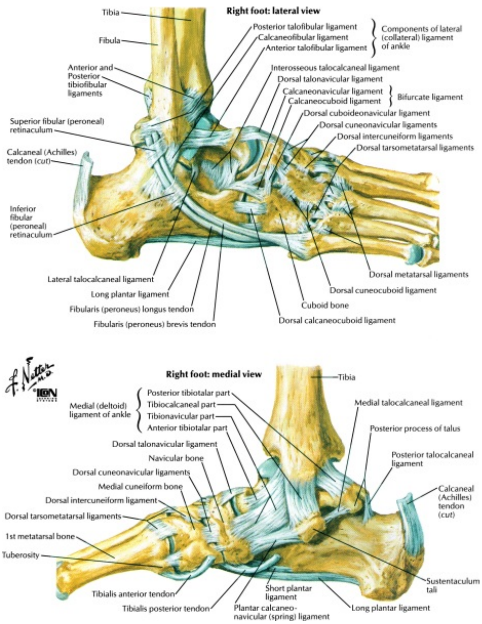
ANKLE JOINTS



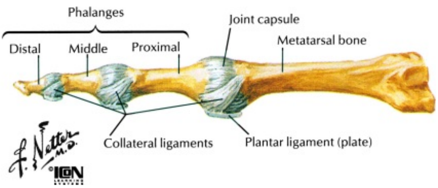
LIGAMENTS	ATTACHMENTS	COMMENTS
INFERIOR TIBIOFIBULAR		
SYNDESMOSIS:	Distal tibia/fibula support: must be stabilized if disrupted	
Anterior/inferior tibiofibular [AITFL]	Distal anterior tibia fibula	Oblique, connects bones anteriorly
Posterior/inferior tibiofibular [PITFL]	Distal posterior tibia fibula	Weaker, posterior support of mortise
Inferior transverse ligament	Inferior deep to PITFL	Strong posterior support of mortise
Interosseous ligament	Lateral tibia to med. fibula	A continuation of interosseous membrane, strong support; torn in Maisonneuve fracture
• Syndesmosis widening seen on radiographs if both the AITFL and PITFL are ruptured		
ANKLE (mortise/talus) (Ginglymus/hinge type)		
Capsule	Tibia to talus	Extends to interosseous ligament
MEDIAL: Deltoid ligament (4 parts)	Medial malleolus to:	Strong medial support: fewer sprains.
Tibionavicular	Navicular tuberosity	Overlaps the anterior tibiotalar ligament
Tibiocalcaneal	Sustentaculum tali	Oriented vertically
Posterior tibiotalar	Medial tubercle of talus	Thickest part of deltoid ligament
Anterior tibiotalar	Talus	Minimal support

LATERAL:	Lateral malleolus to:	Weaker lateral support: more sprains
Anterior talofibular [ATFL]	Neck of talus	Weak, most often sprained, positive anterior drawer test when ruptured
Calcaneofibular [CFL]	Calcaneus	Stabilizes subtalar joint
Posterior talofibular [PTFL]	Posterior process (talus)	Strong, seldom torn



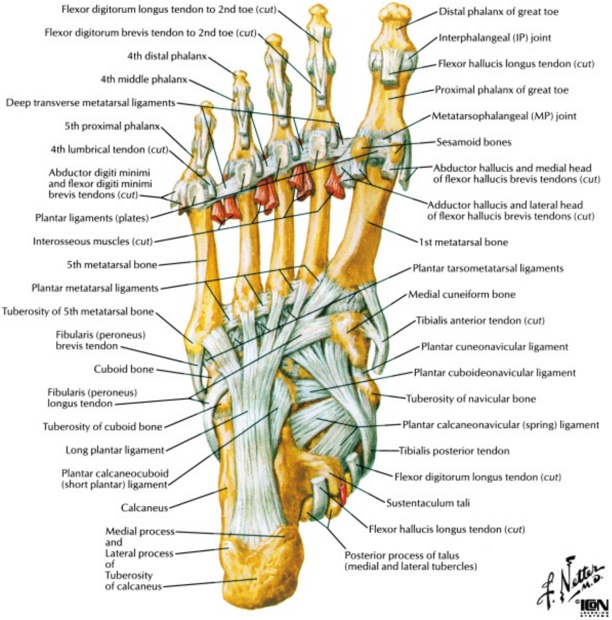
FOOT JOINTS

Capsules and ligaments of metatarsophalangeal and interphalangeal joints: lateral view



JOINT	LIGAMENTS	COMMENTS
INTERTARSAL		
Subtalar (talocalcaneal) Allows inversion/eversion of foot (e.g. walking on uneven surface)		
	Medial talocalcaneal	Medial tubercle to sustentaculum tali
	Lateral talocalcaneal	Deep to calcaneofibular ligament
	Posterior talocalcaneal	Short; Posterior process to calcaneus
	Interosseous talocalcaneal	Strong; in sinus tarsus
	Also supported by the ligaments of the ankle (see ankle joints)	
Transverse/Midtarsal (Chopart's Joint): assists subtalar joint with inversion eversion		
Talonavicular	Plantar calcaneonavicular (Spring)	Sustentaculum tali to navicular: plantar support for head of talus; Strong.
	Dorsal talonavicular	Dorsal support
	Calcaneonavicular (Bifurcate 1)	Lateral support
Calcaneocuboid	Calcaneocuboid (Bifurcate 2)	Stabilizes two rows of tarsus
	Dorsal calcaneocuboid	Dorsal support
	Plantar calcaneocuboid (short plantar)	Strong plantar support
	Calcaneocuboid MT (long plantar)	Additional plantar support
Cuboideonavicular Cuneonavicular Intercuneiform Cuneocuboid	Each of these four joints have dorsal, plantar, and interosseous ligaments, each bearing the name of the corresponding joint	These joints are small, have little motion or clinical significance. Share a common articular capsule.
Plantar ligaments are stronger than the dorsal ligaments		
TARSOMETATARSAL (Lisfranc) Gliding type		
	Dorsal, plantar, interosseous, tarsalmetatarsals (TMT) ligaments	Medial cuneiform to 2nd metatarsal: Lisfranc's ligament
INTERMETATARSAL		
	Dorsal, plantar, interosseous MT	Strengthen transverse arch
	Deep transverse metatarsal	Connect the MT heads
METATARSOPHALANGEAL Ellipsoid/condyloid type		
	Plantar plate and Intersesamoid	Part of weight bearing surface
	Collateral	Strong
Deep transverse metatarsal ligaments add support to this joint		

INTERPHALANGEAL Ginglymus/hinge type		
	Plantar plate	Similar to the IP joints of the hand
	Collateral	



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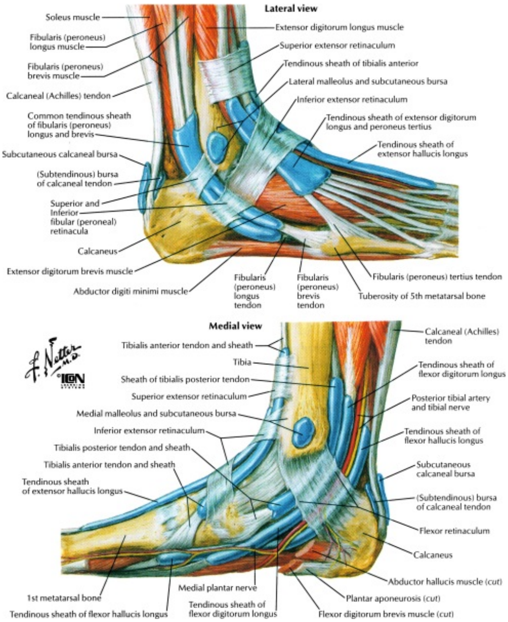
OTHER STRUCTURES

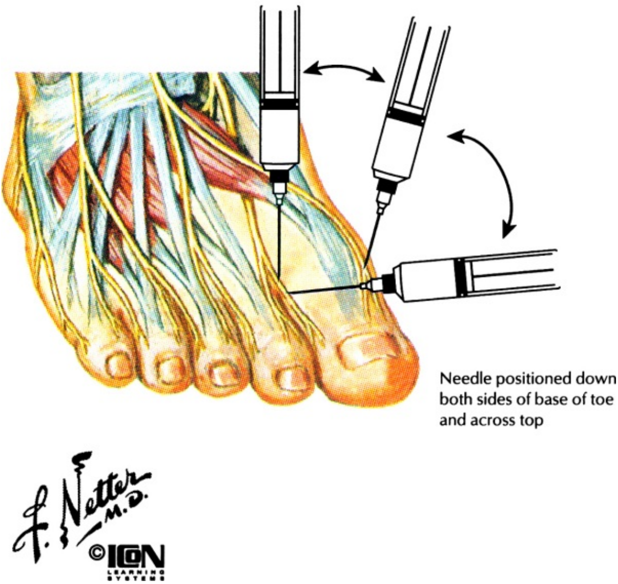


STRUCTURE	FUNCTION	COMMENT
Superior extensor retinaculum	Covers tendons, nerves vessels of anterior compartment at the ankle	Distal fibula to medial tibia
Inferior extensor retinaculum	Surrounds covers tendons, etc. of the anterior compartment in the foot	“Y” shaped; calcaneus to medial malleolus and navicular
Flexor retinaculum	Covers tendons of posterior compartment	Medial malleolus to calcaneus. Roof of tarsal tunnel.
Superior Inferior peroneal retinaculum	Covers tendons sheaths of the lateral compartment at the hindfoot	Superior: Lateral malleolus to calcaneus Inferior: Inferior extensor retinaculum to calcaneus
Plantar Aponeurosis (Plantar fascia)	Supports longitudinal arch	Inflammed: plantar fascitis. Can develop nodules

MINOR PROCEDURES

STEPS
ANKLE ARTHROCENTESIS
1. Ask patient about allergies
2. Plantarflex foot, palpate medial malleolus and sulcus
between it and the tibialis anterior tendon. Use the visible
EHL tendon if TA is not palpable.
3. Prepare skin over ankle joint (iodine/antiseptic soap)
4. Anesthetize skin locally (quarter size spot)
5. Insert 20 gauge needle perpendicularly into the
sulcus/ankle joint (medial to the tendon, inferior to distal
tibia articular surface, lateral to medial malleolus).
Aspirate fluid. If suspicious for infection, send fluid for
Gram Stain and culture. The fluid should flow easily if
needle is in joint.
6. Dress injection site
DIGITAL BLOCK
1. Same as in hand. See Hand chapter.

Great toe digital block



HISTORY OF THE FOOT/ANKLE

QUESTION	ANSWER	CLINICAL APPLICATION
1. AGE	Young	Sprain, fractures
	Middle age, elderly	Overuse injuries, arthritis, gout
2. PAIN		
a. Onset	Acute (less common)	Fracture, stress fracture
	Chronic	Most foot ankle disorders are chronic
b. Location	Ankle	Fracture, osteoarthritis, instability, posterior tibial tendinitis
	Hindfoot	Plantar fascitis, fracture, retrocalcaneal bursitis, Achilles tendinitis
	Midfoot	Osteoarthritis of tarsal joints, fracture
	Forefoot	Hallux rigidus, fractures, metatarsalgia, Morton's neuroma, bunions, gout
	Bilateral	Consider systemic illness, RA
c. Occurrence	Morning pain	Plantar fascitis (improves with stretching/walking)
	With activity	Overuse type injuries
3. STIFFNESS	Without locking	Ankle sprain, RA
	With locking	Loose body
4. SWELLING	Yes	Fracture, arthritis
5. TRAUMA	Mechanism/foot position	Inversion: ATFL injury/sprain
	Bear weight?	Yes: less severe injury;
		No: more severe (rule out fracture)
6. ACTIVITY/OCCUPATION	Sports, repetitive motion	Achilles tendinitis, overuse injuries
	Standing all day	Overuse injuries
7. SHOE TYPE	Tight/narrow toe box	Hallux valgus (bunion, overwhelmingly seen in women)
8. NEUROLOGIC SYMPTOMS	Pain, numbness, tingling	Tarsal tunnel syndrome
9. HISTORY OF SYSTEMIC DISEASE	Manifestations in foot	Diabetes mellitus, gout, peripheral vascular disease, RA, Reiter's syndrome

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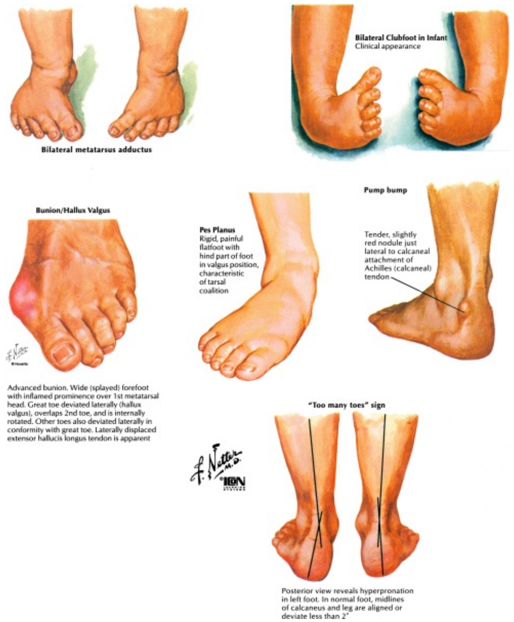
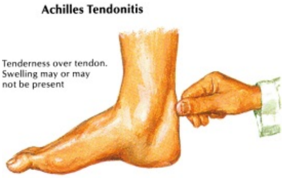
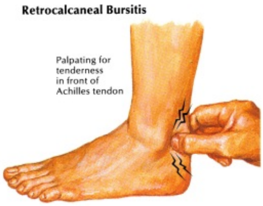
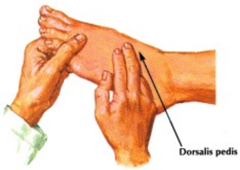
PHYSICAL EXAM



EXAM	TECHNIQUE	CLINICAL APPLICATION
	INSPECTION	
Foot (standing/weight-bearing)	Anterior view	Alignment/rotational deformities, toe deformities, bunions
	Posterior view	Minimal valgus is normal, "pump bump" exostosis
	Superior view	Bunion, bunionette
	Medial view	Flat foot (pes planus); high arch foot (pes cavus)
Foot (supine/sitting/ non-WB)	Inferior/plantar view	Callus, warts, ulcers (especially in diabetic foot)
Swelling	Foot and ankle	Swelling sign of infection, trauma (bilateral): cardiovascular etiology
Color	Change WB to non-WB	If foot changes color: pink to RED: arterial insufficiency
Shoes	All aspects of the shoe	Abnormal wear may indicate disease (e.g. scuffed toe, drop foot)







EXAM	TECHNIQUE	CLINICAL APPLICATION
	PALPATION	
Bony structures	1 st MTP joint (MT head)	Bunion, bursitis, callus; pain: gout, sesamoiditis, tendinitis
	Other MTP joint (MT head)	Pain: metatarsalgia, Freiberg's infraction, fracture, tailor's bunion (5 th MT head)
	Tarsal bones (Talus)	Tenderness suggests fracture, osteonecrosis, osteochondritis
	Calcaneus	Pain: fracture. Posterior: bursitis (pump bump); Plantar: spur, plantar fascitis; Medial pain: nerve entrapment
	Both malleoli	Pain indicates fracture, syndesmosis injury in leg
Soft tissue	Skin	Cool: peripheral vascular disease. Swelling: trauma or infection vs. venous insufficiency
	Between metatarsal heads	Mass pain: neuroma
	Medial ankle ligaments	Pain suggests ankle sprain (Deltoid ligament)
	Tendons at med. malleolus	Pain indicates tendinitis, rupture (sprain)
	Lateral ankle ligaments	Pain suggests ankle sprain ATFL, CFL, PTFL (rare)
	Peroneal tendons (lateral malleolus)	Pain indicates tendinitis, rupture/sprain, dislocation
	Achilles tendon	Pain: tendinitis. Defect suggests Achilles rupture
	RANGE OF MOTION	
Ankle: dorsiflex/plantarflex	Stabilize subtalar joint	Normal: Plantarflex 50°, Dorsiflex (extend) 25 °

Subtalar: inversion/eversion	Stabilize tibia	Normal: Invert 5-10°, Evert 5°
Midtarsal: adduction/ abduction	Stabilize heel/hindfoot	Normal: Adduct 20°, abduct 10°
Great toe:		
MTP: flex/extend	Stabilize foot	Normal: Flex 75°, extend 75°. Decreased in hallux rigidus
IP: flex/extend	Stabilize foot	Normal: Flex 90, extend 0°

Pronation: dorsiflexion, eversion, abduction. Supination: plantarflexion, inversion, adduction

EXAM	TECHNIQUE	CLINICAL APPLICATION
NEUROVASCULAR		
Sensory		
Saphenous (L4)	Med. foot (med. cutaneous)	Deficit indicates corresponding nerve/root lesion
Tibial nerve (L4)	Plantar foot (calcaneal/plantar)	Deficit indicates corresponding nerve/root lesion
Superficial Peroneal (L5)	Dorsal foot	Deficit indicates corresponding nerve/root lesion
Deep Peroneal (L5)	1 st dorsal web space	Deficit indicates corresponding nerve/root lesion
Sural nerve (S1)	Lateral foot	Deficit indicates corresponding nerve/root lesion
Motor		
Deep Peroneal nerve (L4)	Foot inversion/dorsiflexion	Weakness = Tibialis Anterior or nerve/root lesion
Deep Peroneal nerve (L5)	Great toe extension (dorsiflex)	Weakness = EHL or corresponding nerve/root lesion
Tibial nerve (S1)	Great toe plantarflexion	Weakness = FHL or corresponding nerve/root lesion
Superficial Peroneal (S1)	Foot eversion	Weakness = Peroneus muscles or nerve/root lesion
Reflex		
S1	Achilles reflex	Hypoactive/absence indicates S1 radiculopathy
Upper Motor Neuron	Babinski reflex	Upgoing toes indicates an Upper Motor Neuron disorder
Pulses	Dorsalis pedis	Decreased pulses: trauma or vascular compromise, peripheral vascular disease
	Posterior tibial	
SPECIAL TESTS		
Anterior drawer	Hold tibia, anterior force to calcaneus	Anterior translation: AnteriorTaloFibular Ligament (ATFL) rupture (sprain)
Talar tilt	Hold tibia, invert ankle	Increased laxity compared to contralateral: CFL/ATFL sprain
Eversion/abduct stress	Hold tibia, evert/abduct Ankle	Increased laxity compared to contralateral: Deltoid ligament sprain
“Too many toes” sign	Standing, view foot posteriorly	“Too many toes” (more seen laterally than other side): acquired flat foot

Squeeze	Compress distal tibia/fibula	Pain indicates a syndesmosis injury
Heel lift	Standing, raise onto toes	Heel into varus is normal. Decreased lift with posterior compartment pathology
Tinel's sign at the Ankle	Tap nerve posterior to medial malleolus	Tingling/parathesia is positive for posterior tibial nerve entrapment
Compression	Squeeze foot at MT heads	Pain, numbness, tingling: interdigital neuroma (Morton's)
Thompson	Prone: feet hang, squeeze calf	Absent plantar flexion indicates Achilles tendon rupture
Homans' sign	Knee extended: passively dorsiflex foot	Pain in calf suggestive of deep venous thrombophlebitis (DVT)

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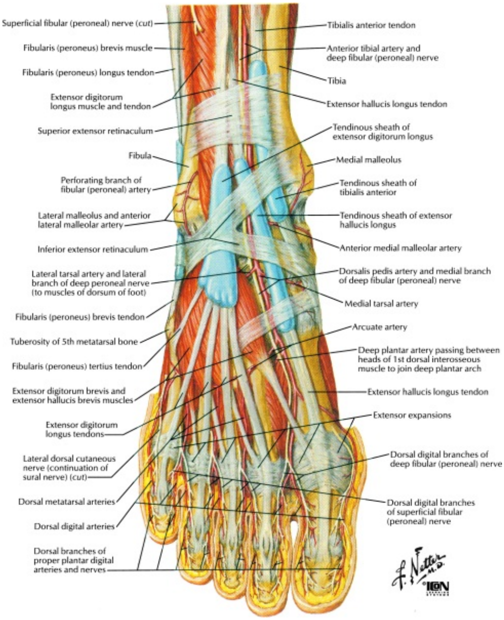
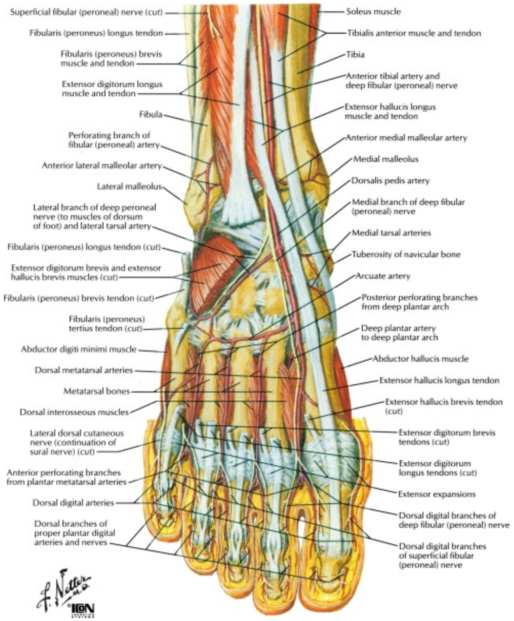
MUSCLES: DORSUM



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
Extensor hallucis brevis [EHB]	Dorsal calcaneus	Base of proximal phalanx of Great toe	Deep peroneal	Extends great toe	Assists EHL with its action
Extensor digitorum brevis [EDB]	Dorsal calcaneus	Base of proximal phalanx: 4 lateral toes	Deep peroneal	Extends toes	Injury can result in dorsal hematoma



Superficial fibular (peroneal) nerve (cut)
Fibularis (peroneus) longus tendon
Fibularis (peroneus) brevis muscle and tendon
Extensor digitorum longus muscle and tendon
Fibula
Perforating branch of fibular (peroneal) artery
Anterior lateral malleolar artery
Lateral malleolus
Lateral branch of deep peroneal nerve (to muscles of dorsum of foot) and lateral tarsal artery
Fibularis (peroneus) longus tendon (cut)
Extensor digitorum brevis and extensor hallucis brevis muscles (cut)
Fibularis (peroneus) brevis tendon (cut)
Fibularis (peroneus) tertius tendon (cut)
Abductor digiti minimi muscle
Dorsal metatarsal arteries
Metatarsal bones
Dorsal interosseous muscles
Lateral dorsal cutaneous nerve (continuation of sural nerve) (cut)
Anterior perforating branches from plantar metatarsal arteries
Dorsal digital arteries
Dorsal branches of proper plantar digital arteries and nerves
Soleus muscle
Tibialis anterior muscle and tendon
Tibia
Anterior tibial artery and deep fibular (peroneal) nerve
Extensor hallucis longus muscle and tendon
Anterior medial malleolar artery
Medial malleolus
Dorsalis pedis artery
Medial branch of deep fibular (peroneal) nerve
Medial tarsal arteries
Tuberosity of navicular bone
Arcuate artery
Posterior perforating branches from deep plantar arch
Deep plantar artery to deep plantar arch
Abductor hallucis muscle
Extensor hallucis longus tendon
Extensor hallucis brevis tendon (cut)
Extensor digitorum brevis tendons (cut)
Extensor digitorum longus tendons (cut)
Extensor expansions
Dorsal digital branches of deep fibular (peroneal) nerve
Dorsal digital branches of superficial fibular (peroneal) nerve
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ICON

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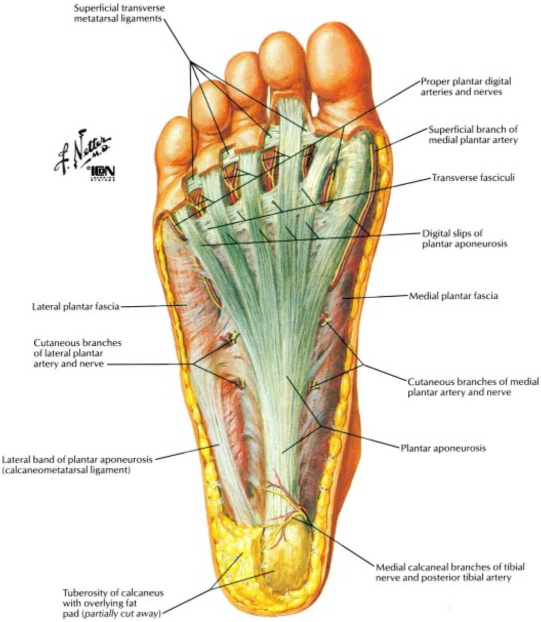
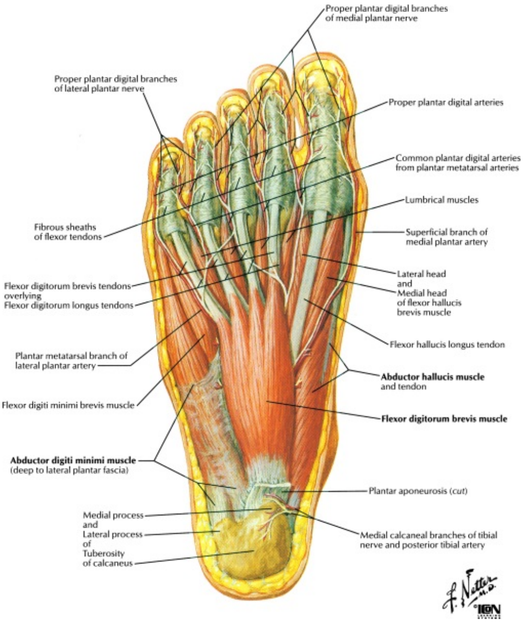
MUSCLES: FIRST PLANTAR LAYER





MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
FIRST LAYER					
Abductor hallucis	Calcaneal tuberosity medial process	Through med. sesamoid to proximal phalanx of great toe	Medial plantar	Abducts great toe	Supports longitudinal arch medially.
Flexor digitorum brevis [FDB]	Calcaneal tuberosity medial process	Sides of middle phalanges: lateral 4 toes	Medial plantar	Flex lateral 4 toes	Supports longitudinal arch
Abductor digiti minimi [ADM]	Calcaneal tuberosity medial lateral processes	Lateral base of proximal phalanx: 5th toe	Lateral plantar	Abducts small toe	Supports longitudinal arch laterally

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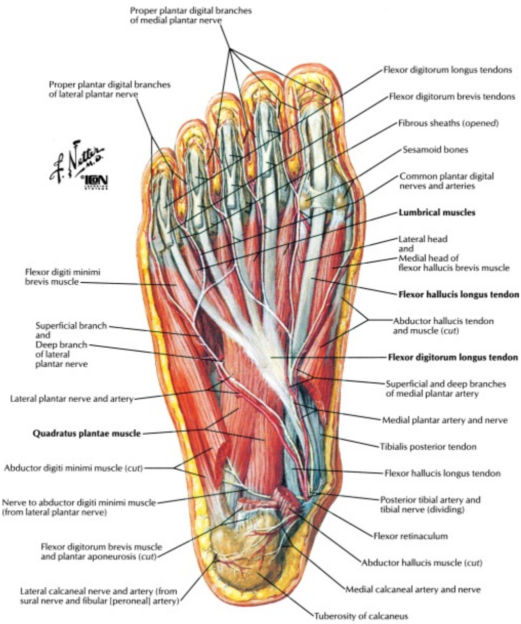
MUSCLES: SECOND PLANTAR LAYER



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
SECOND LAYER					
Quadratus plantae	Medial and lateral plantar calcaneus	Lateral FDL tendon	Lateral plantar	Assists FDL with toe flexion	Two heads/bellies join on FDL tendon
Lumbricals	Separate FDL tendons	Proximal phalanges, extensor expansion	1. Medial plantar 2-4. Lateral plantar	Flex MTP joint, extend IP joint	1st lumbrical attaches to 1 FDL tendon

Tendons of FHL and FDL also pass through in the second layer

Medial and lateral plantar nerves are terminal branches of the Tibial nerve: they run in the 2nd layer.

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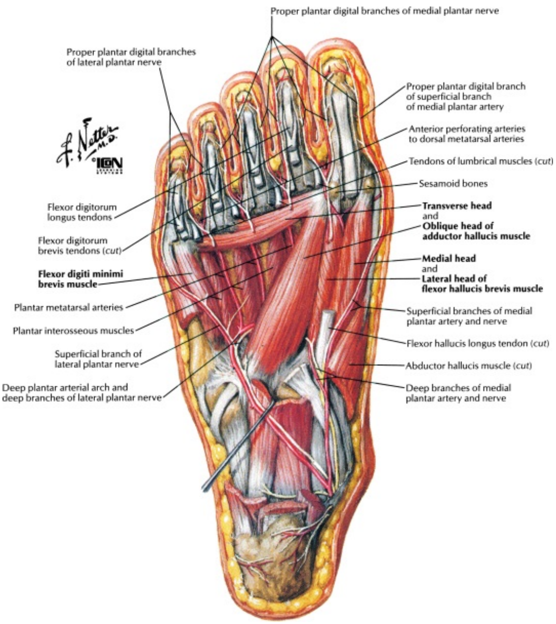
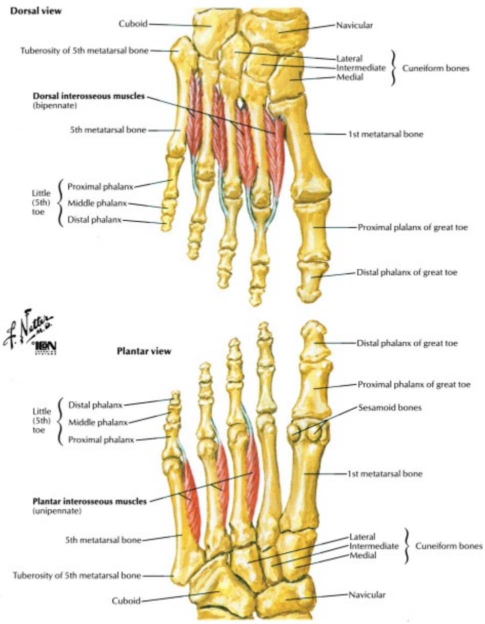
MUSCLES: THIRD PLANTAR LAYER



MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
THIRD LAYER					
Flexor hallucis brevis [FHB]	Cuboid, lateral cuneiform	Through sesamoids to proximal phalanx of great toe	Medial plantar	Assist great toe flexion	Sesamoid bones attach to each tendon
Adductor hallucis	Oblique: base 2-4 MT Transverse: Lateral 4 MTP	Through lateral sesamoid to proximal phalanx of great toe	Lateral plantar	Adducts great toe	Supports transverse arch. 2 heads have different orientations
Flexor digiti minimi brevis [FDMB]	Base of 5th metatarsal	Base of proximal phalanx small toe	Lateral plantar	Flex small toe	Small, relatively insignificant muscle

MUSCLES: FOURTH PLANTAR LAYER



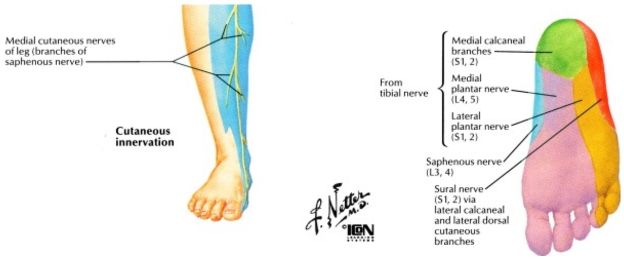
MUSCLE	ORIGIN	INSERTION	NERVE	ACTION	COMMENT
FOURTH LAYER					
Plantar interossei (3)	Med. 3, 4, 5th MTs	Medial proximal phalanges: toes 3-5	Lateral plantar	Adduct toes (*PAD*)	Attachment to MT is medial for all 3
Dorsal interossei (4)	Adjacent MT shafts	Proximal phalanges toes 2-5	Lateral plantar	Abduct toes (*DAB*)	Larger than the plantar interossei muscles

Peroneus longus and Tibialis posterior tendons pass through the fourth layer

Medial and lateral plantar nerves are terminal branches of the Tibial nerve.

PAD = 5 Plantar ADduct, DAB 5 = Dorsal ABduct; the second digit is used as the reference point for abduction/adduction in the foot

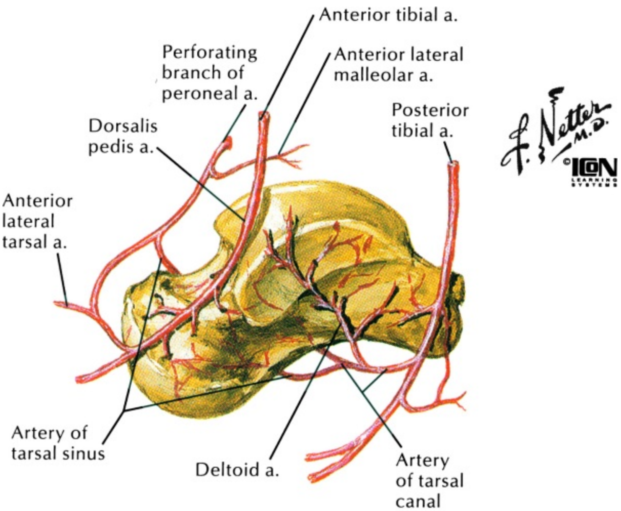
NERVES



LUMBAR PLEXUS	
POSTERIOR DIVISION	
1. ***Femoral*** (L2-4): Saphenous nerve branches in proximal thigh, descends in superficial medial leg, then anterior to medial malleolus in foot.	
Sensory:	Medial foot: via medial cutaneous nerve (*Saphenous* nerve)
Motor:	NONE (in foot or ankle)
SACRAL PLEXUS	
ANTERIOR DIVISION	
2. ***Tibial*** (L4-S3): behind medial malleolus, splits on plantar surface	
Sensory:	Medial heel: via Medial calcaneal
	Medial plantar foot: via Medial plantar
	Lateral plantar foot: via Lateral plantar
Motor:	FIRST PLANTAR LAYER of FOOT
	Abductor hallucis: Medial plantar
	Flexor digitorum brevis[FDB]: Medial plantar
	Abductor digiti minimi: Lateral plantar
	SECOND PLANTAR LAYER of FOOT
	Quadratus plantae: Lateral plantar
	Lumbricals: Medial Lateral plantar
	THIRD PLANTAR LAYER of FOOT
	Flexor hallucis brevis [FHB]: Medial plantar
	Adductor hallucis: Lateral plantar
	Flexor digiti minini brevis [FDMB]: Lateral plantar
	FOURTH PLANTAR LAYER of FOOT
	Dorsal interosseous: Lateral plantar
	Plantar interosseous: Lateral plantar
POSTERIOR DIVISION	
3. **Common *peroneal*** (L4-S2): Superficial peroneal divides into intermediate and medial dorsal cutaneous branches in leg. Deep peroneal divides under extensor retinaculum into medial lateral branches.	
Sensory:	Lateral foot: via Sural (lateral calcaneal dorsal cutaneous).
	Dorsal foot: Superficial peroneal.
	Dorsal (med.) (Med. dorsal cutaneous branch).

	1st/2nd interdigital space: Deep peroneal (med. branch)
Motor:	FOOT: **Deep Peroneal (Lateral branch)**
	Extensor hallucis brevis [EHB]
	Extensor digitorum brevis [EDB]

ARTERIES

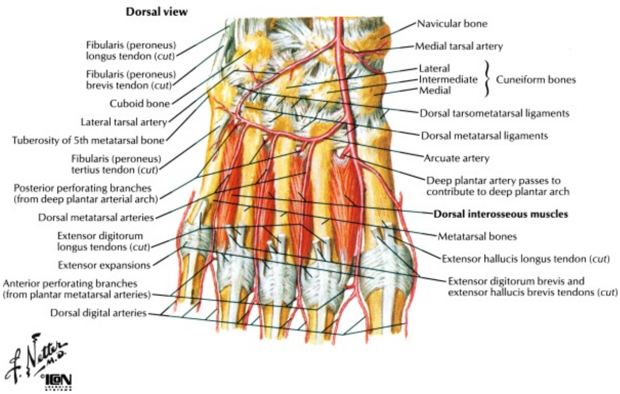


Blood supply of talus. Because of profuse intraosseous anastomoses, avascular necrosis commonly occurs only when surrounding soft tissue is damaged, as in types II and III fractures of talar neck

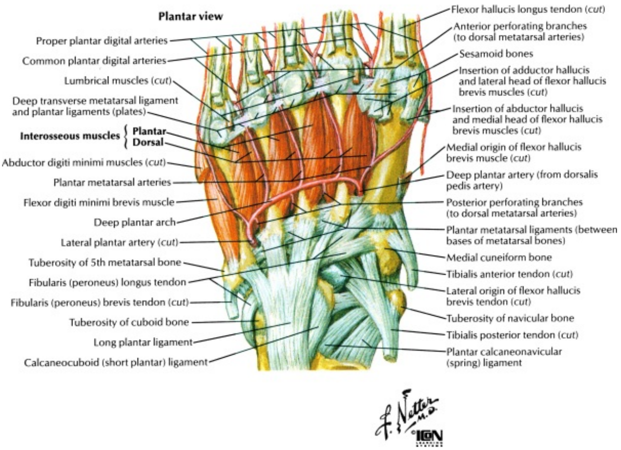
ARTERY	STEM ARTERY/ COMMENT
Artery to the Tarsal Sinus	Dorsalis pedis and Peroneal arteries
Artery to the Tarsal Canal	Posterior tibial artery
Deltoid artery	Posterior tibial artery; supplies medial body
Capsular ligamentous vessels	Multiple sources
Interosseous anastomosis	Extensive, protects against AVN

ARTERY	COURSE	COMMENT
(See Leg/Knee chapter for stem arteries)		
Anterior Medial Malleolar	Under TA EHL tendons to medial malleolus	From Anterior tibial artery, supplies medial malleolus
Anterior Lateral Malleolar	Under EDL tendon to lateral malleolus	From Anterior tibial artery, supplies lateral malleolus
Posterior Medial Malleolar	Under tendons of TP and FDL, not FHL, to medial malleolus	From Posterior tibial artery, supplies medial malleolus
Posterior Lateral Malleolar	Under Peroneus longus/brevis tendons to lateral malleolus	From Peroneal artery, supplies lateral malleolus
Perforating and communicating branches	Anastomosis with anterior lateral malleolar and posterior tibial arteries	From Peroneal artery, contributes supply to lateral malleolus

An anastomosis occurs at each malleolus between the above arteries



ARTERY	COURSE	BRANCHES	COMMENT/SUPPLY
(see Leg Knee chapter for stem arteries)			
Lateral Calcaneal	with *Lateral calcaneal* nerve (Sural nerve)	NONE	From Peroneal artery; supplies heel
Medial Calcaneal	with *Medial calcaneal* nerve (Tibial nerve)	NONE	From Posterior tibial artery; supplies heel
Lateral plantar	Between quadratus plantae FDB, runs w/ lateral plantar nerve	Deep plantar arch	Larger terminal branch of Posterior tibial artery
Medial plantar	Between Abductor hallucis FDB runs with medial plantar nerve	Superficial branch 1 *proper plantar digital* Deep branch	Smaller terminal branch of Posterior tibial artery; supplies medial Great toe Anastomose with plantar MT artery
Dorsalis Pedis	Dorsum of foot with medial branch of deep peroneal nerve	Supplies dorsum of foot via:	
		Medial Tarsal	No branches
		Lateral Tarsal	No branches
		Arcuate artery	3 Dorsal MT arteries branch off
		Deep Plantar	Descends to deep plantar arch
		1st dorsal metatarsal	Terminal branch of dorsalis pedis
		3 *dorsal digital* arteries	Supply dorsal great toe



ARTERY	COURSE	BRANCHES	COMMENT/SUPPLY
(see Leg Knee chapter for stem arteries)			
Medial Tarsal	Across tarsals, under EHL tendon	NONE	Supplies dorsum of foot (can be 2 or 3 of these arteries).
Lateral Tarsal	Across tarsals with lateral branch of Deep peroneal nerve	NONE	Supplies EDB, lateral tarsal bones, anastomoses laterally
Arcuate	Across bases of metatarsals, under extensor tendons	2nd, 3rd, 4th dorsal MT artery 7 *dorsal digital* arteries	
Deep plantar	Descends between 1st 2nd MT's	Deep plantar arch	Anastomosis with Lateral calcaneal
Deep plantar arch	On plantar interosseous muscles in 4th layer of foot.	4 posterior perforating	Join dorsal metatarsal arteries
		1 *Common/proper plantar digital*	Most lateral artery in foot toes
		4 plantar metatarsal	
		4 *anterior perforating*	Join dorsal metatarsal arteries
		4 *Common plantar digital*	
		8 *Proper plantar digital*	Supplies the distal tip of phalanx

Total of 4 Dorsal Metatarsal arteries leading to 10 dorsal digital arteries. They do not reach the distal tip of the digit.

Total of 4 Plantar Metatarsal arteries leading to 10 proper plantar digital arteries via common plantar digital arteries.

Each digit has 2 dorsal digital and 2 proper plantar digital arteries. Dorsal branch of proper plantar digital artery supply distal tip.

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DISORDERS

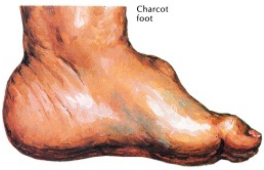
DESCRIPTION	HISTORY/PHYSICAL EXAM	WORK-UP/FINDINGS	TREATMENT
ACHILLES TENDINITIS			
• Occurs at or above insertion of Achilles tendon	Hx/PE: Heel pain, worse with push off. Tender to palpation	XR: Standing lateral: spur at Achilles insertion	1. Rest, NSAID, heel lift 2. Excise bone or bursa (rare)
ACHILLES TENDON RUPTURE			
• "Weekend warriors." Middle age men in athletics.	Hx: "hit with bat" sensation PE: Defect, + Thompson test	XR: Standing AP/lateral: usually normal	Casting (in equinus) vs. surgical repair
ACQUIRED FLAT FOOT (POSTERIOR TIBIALIS DYSFUNCTION)			
• Tibialis posterior tendon dysfunction: tears or degeneration • No arch support results in valgus foot	Hx: Pain and swelling PE: + "too many toes" sign, no heel varus on toe rise	XR: Standing AP/lateral: middle foot sag	1. Orthosis 2. Activity modification 3. Calcaneal osteotomy and FDC transfer 4. Arthrodesis
ANKLE INSTABILITY			
• Multiple/recurrent sprains • Also neurologic etiology decreased proprioception	Hx: Inversion instability esp. on uneven groundPE: + anterior drawer talar tilt test	XR: AP/lateral/stress view: gapping laterally	1. PT: strengthen peroneals 2. Surgical reconstruction if condition persists
ANKLE SPRAIN			
• #1 musculoskeletal injury • Lateral 90% - ATFL alone 60%, with syndesmosis 5% • Inversion most common mechanism	Hx: "Pop,"pain, swelling, +/- ability to bear weightPE: + Anterior drawer, +/- talar tilt test	XR: only if cannot bear weight or + bony point tenderness	1. RICE, NSAIDs 2. Immobilize grade III 3. PT ROM exercises 4. Surgery: athletes or severe injury
ARTHRITIS: OA/DJD			
• Can occur in any joint • Associated with trauma, obesity, overuse activity	Hx/PE: Older, pain at affected joint.	XR: Standing AP/lateral: classic OA findings	1. NSAID, activity modifcation, orthosis 2. Fusion/arthroplasty (rare)
CHARCOT JOINT: NEUROPATHIC JOINT			
• Neurologic disease results in decreased sensation • Joint destroyed/deformed by fx undetected by patient	Hx/PE: Patient is insensate-no pain. Red, warm, swollen joint	XR: Standing AP/lateral: fractures (callus or unhealed), joint destroyed	1. Immobilze (skin checks) 2. Bony excision or fusion
CLAW TOE			
• Deformity: MTP extended, PIP flexed. Usually all toes • Etiology: Neurologic disease	Hx: Toe painPE: Toe deformity, +/- callus corn, neurologic exam	XR: Standing AP/lateralMR/EMG/lab: to rule out neurologic disease	1. Shoes with extra deep toe box 2. Surgical reconstruction: based on

(e.g. Charcot-Marie-Tooth)			deformity
CORN			
• Two types: 1. Hard 2.Soft 1. Hyperkeratosis: pressure on bones (5th toe #1) 2. Interdigital maceration	Hx/PE: Tight shoes. Pain at lesion site.	XR: AP/lateral: look for bone spurs	1. Wide toe box shoe, pads 2. Debride callus 3. Excise bony prominence
DIABETIC FOOT: NEUROPATHIC FOOT			
• Neuropathy leads to unperceived injury (ulcer, infection) • Vascular insufficiency leads to decreased healing	Hx: Burning tingling, +/- painPE: +/-: skin changes, ulcers, deformity, swelling, warmth	XR: Standing AP/lateral: rule out osteomyelitis or Charcot jointDo Ankle Brachial Index	1. Skin care (prevention) 2. Protective shoe 3. Treat ulcers, infections 4. Amputation if necessary
GOUT (Podagra)			
• Purine metabolism defect • Urate crystals create synovitis • Great toe most common site	Hx: Men, acute exquisite pain PE: Red, swollen toe.	Labs: 1. Elevated uric acid 2. Negatively birefringent crystals	1. NSAIDs, colchicine 2. Rest 3. Allopurinol (prevention)

Achilles Tendinitis

Achilles tendon with inflammation at insertion into calcaneal tuberosity

Lateral view shows bone damage

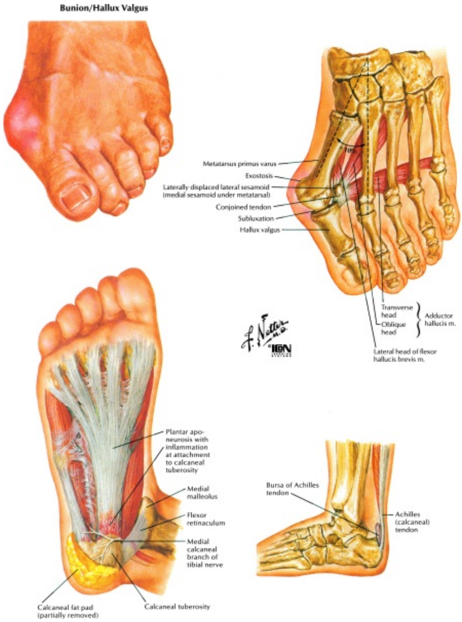


Anteroposterior radiograph of Charcot ankle joint

DESCRIPTION	HISTORY/PHYSICAL EXAM	WORK-UP/FINDINGS	TREATMENT
HALLUX RIGIDUS			

• DJD of MTP of Great toe • Often post traumatic	Hx: Middle age. Painful, stiff PE: MTP Tender to palpation, decreased ROM	XR: Standing AP/lateral OA findings at 1st MTP	1. NSAID, stiff sole shoe 2. Arthroplasty/fusion
HALLUX VALGUS (Bunion)			
• Great toe valgus; MTP bursitis • Multiple etiologies: genetic, flat feet, narrow shoes, RA • 10:1 women (shoes)	Hx: Pain, swelling (worse with shoe wear (narrow toe box) PE: Medial 1st MTP TTP, +/- decreased great toe ROM	XR: Standing AP: measure: 1. **D**istal **MT** **A**rticulation **A**ngle (normal 10°) 2. **I**nter **MT** angle (9°) 3. Hallux Valgus angle (15°)	1. Shoes: wide toe box 2. Refractory cases: multiple corrective surgical procedures based on deformity and severity
HAMMER TOE			
• Toe PIP flexion deformity • Associated with trauma, Hallux Valgus (shoes)	Hx: Toe pain, worse when wearing shoes PE: Toe deformity, +/- corn	XR: Standing AP/lateral: PIP deformity	1. Extra deep shoe toe box 2. Surgery: resect or fuse PIP
MALLET TOE			
• Lesser toe DIP flexion deformity • 2nd toe most common	Hx: Toe pain PE: Toe deformity, callus	XR: Standing AP/lateral: DIP deformity	1. Shoe modification 2. FDL release
METATARSALGIA			
• Metatarsal head pain • Etiology: flexor tendinitis, ligament rupture, callus (#1)	Hx/PE: Pain under MT head (2nd MT most common)	XR: Standing AP/lateral: look for short MT	1. Metatarsal pads 2. Modify shoes 3. Treat underlying cause
MORTON'S NEUROMA (Interdigital)			
• Fibrosis of irritated nerve • Usually between 2nd 3rd metatarsals • 5:1 female(shoes)	Hx: Plantar MT pain PE: MT TTP, +/- numbness, + compression test	XR: Standing AP/lateral: usually normal, not helpful	1. Wide toe shoes, steroid injections, MT pads 2. Nerve excision
PLANTAR FASCITIS			
• Inflammation and/or degeneration of fascia. Female 2:1 • Associated with obesity	Hx: AM pain, improves with ambulation or stretching PE: Medial plantar calcaneus tender to palpation	XR: Standing lateral: +/- calcaneal bone spur	1. Stretching, NSAID 2. Heel cup 3. Splint (night), casting
PLANTAR WARTS			
• Hyperkeratosis • Due to Papilloma virus	Hx/PE: Painful plantar lesions	Histopathology if necessary	1. Pads vs. freeze or debride lesion
RETROCALCANEAL BURSITIS: HAGLUND'S DISEASE			
• Bursitis at insertion of Achilles tendon on calcaneus	Hx: Pain on posterior heel PE: Red, tender to palpation, "pump bump"	XR: Standing lateral: spur at Achilles insertion	1. NSAID, heel lift, casting 2. Excise bone/bursa (rare)
RHEUMATOID ARTHRITIS			
• Synovitis destroys joints • More common in females	Hx: Forefoot: pain, swelling PE: Red, tender, +/- deformity (e.g. Hallux	XR: AP/lateral: joint destroyed Lab: positive	1. Medical management 2. Custom molded shoes

• Associated with HLA-DR4	deformity (e.g. Hallux Valgus)	RF, ANA	3. Fusion or resection
SERONEGATIVE SPONDYLOARTHROPATHY: REITER'S, AS, PSORIASIS			
• Multiple manifestations • Associated with HLA-B27 • Most common in males	Hx/PE: Young, forefoot/toe/ heel: red, swollen, tender	XR: AP/lateral: +/- calcification Lab: negative RF, ANA	1. Conservative treatment 2. Rheumatology consult
TAILOR'S BUNION: BUNIONETTE			
• Prominent 5th MT head Laterally • Bony exostosis/bursitis	Hx/PE: Difficulty fitting shoes, painful lateral 5th metatarsal prominence	XR: Standing AP: 5th toe medially deviated, MT head laterally deviated	1. Pads, stretch toe box 2. Metatarsal osteotomy



DESCRIPTION	HISTORY/PHYSICAL EXAM	WORK-UP/FINDINGS	TREATMENT
TARSAL TUNNEL SYNDROME			
• Tibial nerve trapped by flexor retinaculum and/or tendons	Hx/PE: Pain, tingling, burning on sole (made worse with activity)	XR: AP/lateral: normalEMG: confirms diagnosisMR: to find mass lesion	1. NSAID, steroid injection2. Surgical release (must follow plantar nerves also)

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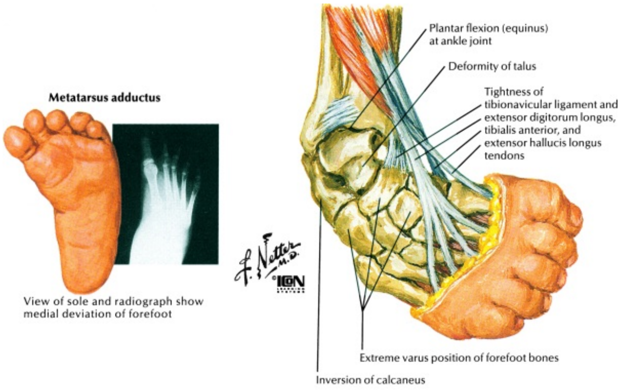
PEDIATRIC DISORDERS

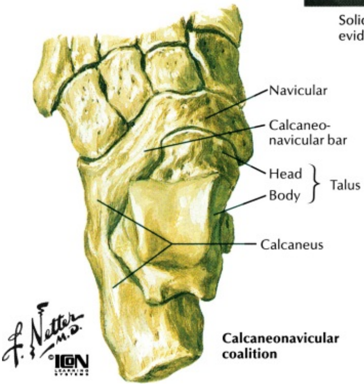


Pathologic changes in congenital clubfoot

DESCRIPTION	EVALUATION	TREATMENT/COMPLICATIONS
	METATARSUS ADDUCTUS	
• Forefoot adduction (varus) • #1 pediatric foot disorder • Associated with intrauterine position or other disorders	Hx: Parent notices deformity PE: "Kidney bean" deformity, negative thigh/foot angle, + intoeing gait	1. Most spontaneously resolve with normal development 2. Serial casting 3. Rarely, midfoot osteotomies
	TALIPES EQUINOVARUS: CLUBFOOT	
• Congenital, boys, 50% bilateral • Genetic environment factors • Idiopathic or associated with other disorders (neuromuscular, etc.) • 4 deformities with soft tissue contractures	Hx: Deformity at birth PE: Rigid foot with: 1. plantarflexed ankle (equinus) 2. inverted hindfoot (varus) 3. adducted forefoot 4. cavus midfoot XR: if diagnosis is unclear	1. Manipulation and casting 2-4 mo. 2. Surgical correction (release, lengthening, etc.) with post operative casting

COMPLICATION: recurrence of deformity

Solid, bony calcaneonavicular coalition evident on oblique radiograph

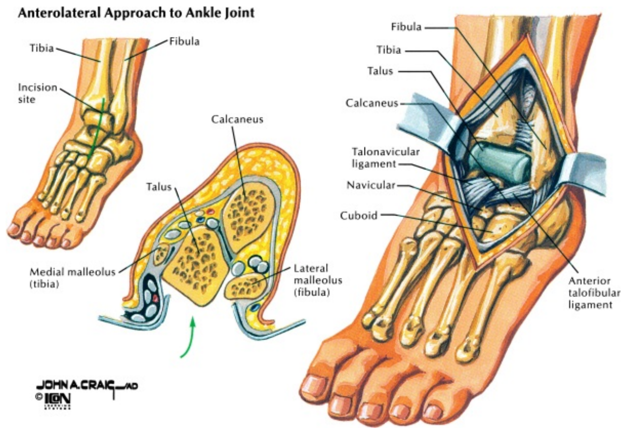


Calcaneonavicular coalition

DESCRIPTION	EVALUATION	TREATMENT/COMPLICATIONS
PES PLANUS: CONGENITAL FLATFOOT		
• Normal in infants (up to 6 yo) • No longitudinal arch • Ankle everted (valgus) • Classified: 1. Rigid (tarsal coalition/vertical talus) 2. Flexible (variant of normal)	Hx: Usually adolescent, 1/2 foot pain PE: Rigid: always flat Flexible: only flat when WB XR: AP/lateral: may see coalition/or vertical talus in rigid foot	Flexible: 1. Asymptomatic: no treatment 2. Symptomatic: arch supports, stretching Rigid: Treat underlying condition (see tarsal coalition)
PES CAVUS: HIGH ARCH FOOT		
• High arch due to muscle imbalance in immature foot (T. A. and peroneus longus) • Ankle flexed: causes pain • Must rule out neuromuscular disease (e.g. Charcot-Marie-Tooth)	Hx: 8-10 yrs, ankle pain PE: Toe walking, tight heel cord decreased ankle dorsiflexion XR: AP/lateral foot and ankle EMG/NCS: test for weakness MR: spine: r/o neuromuscular disease	1. Braces/inserts/AFO as needed (used with mixed results) 2. Various osteotomies 3. Tendon transfer balance
TARSAL COALITION		
• Connection (fibrous, cartilage then bony) of two tarsals • #1 Calcaneus/navicular (13-16yo) • #2 Talus/calcaneus (9-13yo)	Hx: Foot pain during adolescence PE: Stiff, decreased ROM (subtalar), flatfoot (peroneal spasm) XR: AP/lateral/oblique: coalitions can be	1. Mild: observe 2. Casting 3. Coalition resection 4. Triple arthrodesis

• Flatfoot deformity results	seen CT: often necessary to confirm PE	

SURGICAL APPROACHES TO THE ANKLE



USES	INTERNERVOUS PLANE	DANGERS	COMMENT
ANKLE: ANTERIOR LATERAL APPROACH			
1. Fusions/triple arthrodesis 2. Talar procedures 3. Intertarsal joint access	1. Peroneals [Superficial peroneal] 2. EDL [Deep peroneal]	1. Deep peroneal nerve 2. Ant. Tibial artery	1. Can access hindfoot 2. Preserving fat pad (sinus talus) helps wound healing.

CHAPTER 10 - BASIC SCIENCE

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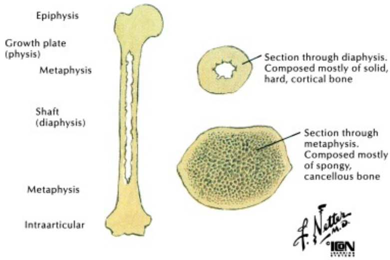
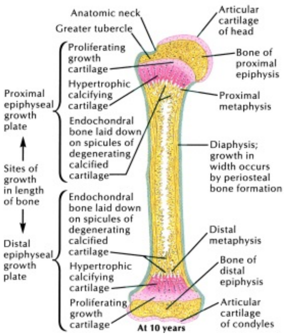
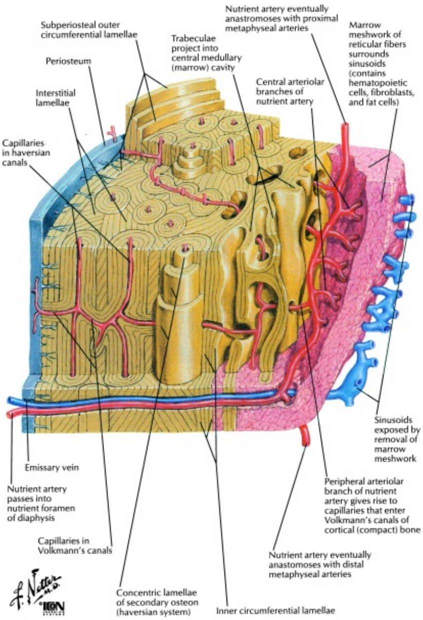
CHAPTER 10 – BASIC SCIENCE

BONES



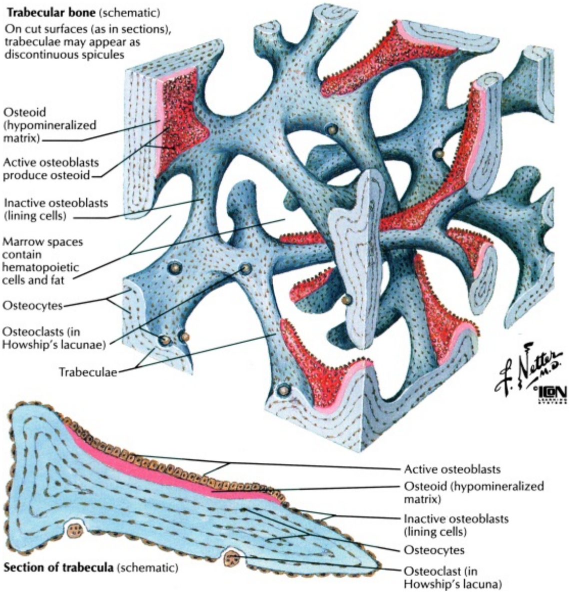


STRUCTURE	COMMENT
Bone function	Attachment of muscles Protection of organs Reservoir of minerals for body Hematopoiesis site
Bone Forms	
Long bones	Form by enchondral ossification, except clavicle Have a physis at each end (except in hand foot) 4 parts: epiphysis, physis, metaphysis, diaphysis Length is derived from the growing physis
Flat bones	Form by intramembranous ossification, (e.g., pelvis)
Physeal Anatomy	Divided into multiple zones
Reserve zone	Matrix production and storage
Proliferative zone	Cell proliferation, matrix production
Hypertrophic zone	Broken into 3 zones, calcification of matrix

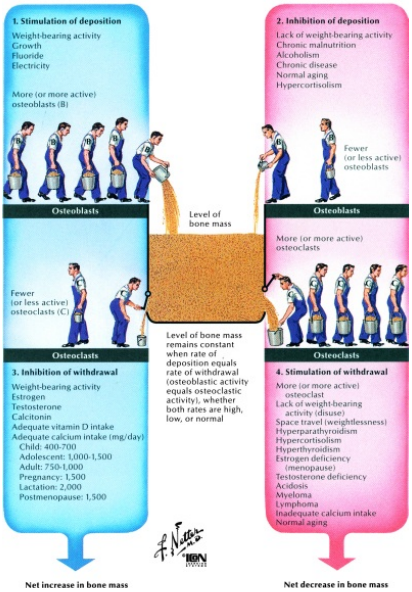


STRUCTURE	COMMENT
Microscopic Bone Types	
Woven	Immature bone; normal in infants, also found in callus tumors
Lamellar	Mature bone; well organized, normal both cortical cancellous after age 4
Structural Bone Types	
Cortical (compact)	80% of bone, highly organized (osteons), blood supply in haversian canal. Volkmann's canal has vessels connecting osteons.
Cancellous (spongy/trabecular)	20% of bone, crossed lattice structure, higher bone turnover

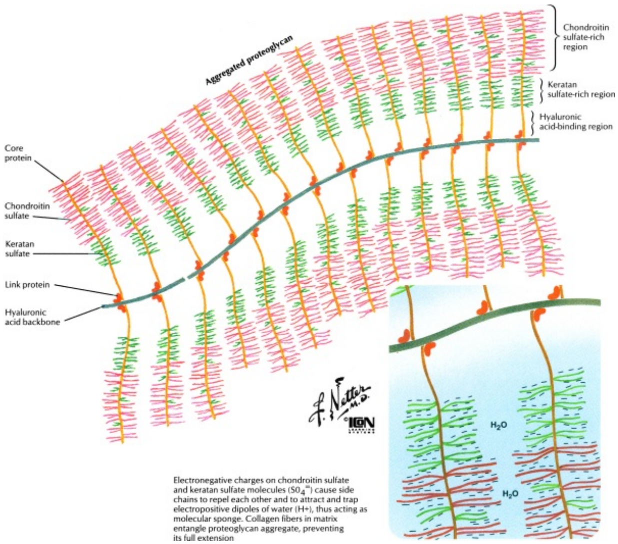
Structure of Cancellous Bone



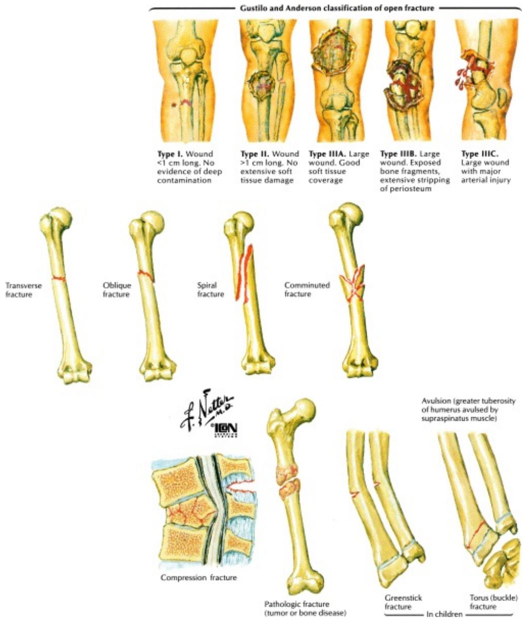
Four Mechanisms of Bone Regulation



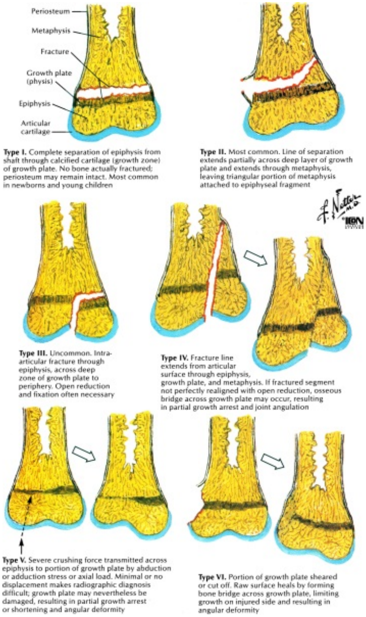
STRUCTURE	COMMENT
Cell Types	
Osteoblasts	Make bone (secrete matrix, collagen, GAG, stimulated by PTH)
Osteoclasts	Resorb bone (giant cells, mineralized bone found only in Howship's lacunae)
Osteocytes	Maintain bone (90% of cells, inhibited by PTH)



STRUCTURE	COMMENT
Bone Composition	
Organic matrix (40%)	Produced by osteoblasts—becomes osteocytes when trapped in matrix
Collagen (Type I)	90% of matrix, gives strength. Mineralization occurs at gaps at the end of each collagen fiber
Proteoglycan	Glycosaminoglycans structure (GAGs)
Non-collagen protein	Osteonectin is most abundant
Inorganic (60%)	Mineralized portion
Calcium Hydroxyapatite	Adds strength to bone, found in the collagen gaps
Types of Ossification	
Enchondral	Bone replaces a cartilage template in long bones
Intramembranous	Mesenchymal template in flat bones and clavicle



STRUCTURE	COMMENT
Fracture Types	Point tenderness and swelling are common findings
Open vs. closed	Break in skin is open. Gustilo classification (grade I, II, III A, B, C)
Direction	Transverse, spiral, oblique, comminuted
Displacement	Displaced or nondisplaced
Other	• Salter-Harris—fracture involving an open physis in adults, growth plate in children. • Greenstick—only one cortex disrupted • Torus—one cortex impacted, but intact • Pathologic results—from bone tumor/disease


Periosteum
Metaphysis
Fracture
Growth plate (physis)
Epiphysis
Articular cartilage
Type I. Complete separation of epiphysis from shaft through calcified cartilage (growth zone) of growth plate. No bone actually fractured; periosteum may remain intact. Most common in newborns and young children
Type II. Most common. Line of separation extends partially across deep layer of growth plate and extends through metaphysis, leaving triangular portion of metaphysis attached to epiphyseal fragment
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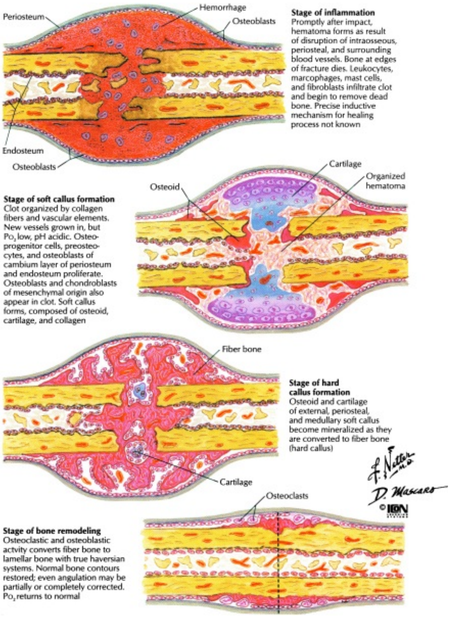
Type III. Uncommon. Intra-articular fracture through epiphysis, across deep zone of growth plate to periphery. Open reduction and fixation often necessary
Type IV. Fracture line extends from articular surface through epiphysis, growth plate, and metaphysis. If fractured segment not perfectly realigned with open reduction, osseous bridge across growth plate may occur, resulting in partial growth arrest and joint angulation
Type V. Severe crushing force transmitted across epiphysis to portion of growth plate by abduction or adduction stress or axial load. Minimal or no displacement makes radiographic diagnosis difficult; growth plate may nevertheless be damaged, resulting in partial growth arrest or shortening and angular deformity
Type VI. Portion of growth plate sheared or cut off. Raw surface heals by forming bone bridge across growth plate, limiting growth on injured side and resulting in angular deformity


Periosteum
Hemorrhage
Osteoblasts
Stage of inflammation
Promptly after impact, hematoma forms as result of disruption of intraosseous, periosteal, and surrounding blood vessels. Bone at edges of fracture dies. Leukocytes, marcophages, mast cells, and fibroblasts infiltrate clot and begin to remove dead bone. Precise inductive mechanism for healing process not known
Endosteum
Osteoblasts
Cartilage
Osteoid
Organized hematoma
Stage of soft callus formation
Clot organized by collagen fibers and vascular elements. New vessels grown in, but Po_2 low, pH acidic. Osteoprogenitor cells, preosteocytes, and osteoblasts of cambium layer of periosteum and endosteum proliferate. Osteoblasts and chondroblasts of mesenchymal origin also appear in clot. Soft callus forms, composed of osteoid, cartilage, and collagen
Fiber bone
Stage of hard callus formation
Osteoid and cartilage of external, periosteal, and medullary soft callus become mineralized as they are converted to fiber bone (hard callus)
Cartilage
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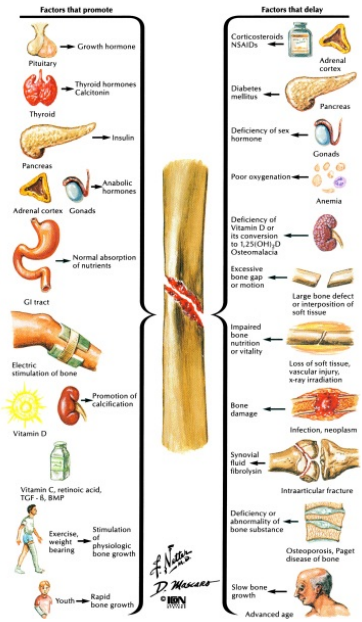
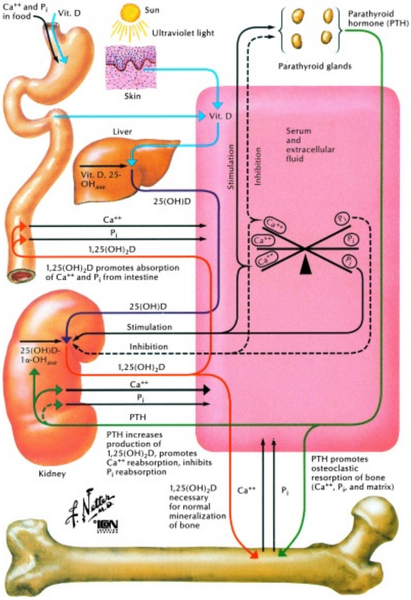
Osteoclasts
Stage of bone remodeling
Osteoclastic and osteoblastic actvity converts fiber bone to lamellar bone with true haversian systems. Normal bone contours restored; even angulation may be partially or completely corrected. Po_2 returns to normal

STRUCTURE	COMMENT
Stages of Bone Healing	
Inflammation	Hematopoietic cells, fibroblasts, osteoprogenitor cells
Repair	Callus formation (hard or soft), woven bone formation (enchondral)
Remodeling	Lamellar bone replaces woven, bone assumes normal shape, and repopulation of the marrow



STRUCTURE	COMMENT
Bone Healing Factors	
Minerals	Calcium, Phosphate

Normal Calcium and Phosphate Metabolism



Regulation of Calcium and Phosphate Metabolism

		Parathyroid hormone (PTH) (peptide)	$1,25(OH)_2D$ (steroid)	Calcitonin (peptide)
Hormone		From chief cells of parathyroid glands	From proximal tubule of kidney	From parafollicular cells of thyroid gland
Factors stimulating production		Decreased serum Ca^{++}	Elevated PTH Decreased serum Ca^{++} Decreased serum P_i	Elevated serum Ca^{++}
Factors inhibiting production		Elevated serum Ca^{++} Elevated $1,25(OH)_2D$	Decreased PTH Elevated serum Ca^{++} Elevated serum P_i	Decreased serum Ca^{++}
End organs for hormone action	**Intestine**	No direct effect Acts indirectly on bowel by stimulating production of $1,25(OH)_2D$ in kidney	Strongly stimulates intestinal absorption of Ca^{++} and P_i	?
	Kidney	Stimulates $25(OH)D\text{-}1\alpha\text{-}OH_{ase}$ in mitochondria of proximal tubular cells to convert $25(OH)D$ to $1,25(OH)_2D$ Increases fractional reabsorption of filtered Ca^{++} Promotes urinary excretion of P_i	?	?
	Bone	Stimulates osteoclastic resorption of bone Stimulates recruitment of preosteoclasts	Strongly stimulates osteoclastic resorption of bone	Inhibits osteoclastic resorption of bone ? Role in normal human physiology
Net effect on calcium and phosphate concentrations in extracellular fluid and serum		Increased serum calcium Decreased serum phosphate	Increased serum calcium Increased serum phosphate	Decreased serum calcium (transient)

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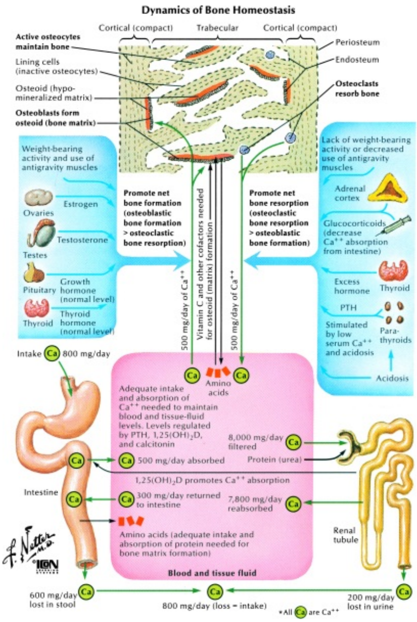
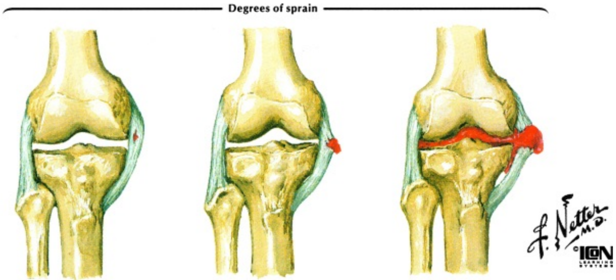
STRUCTURE	COMMENT
Main Hormones	Parathyroid hormone (PTH), Vitamin D, Calcitonin (see fig.__)
Other Hormones	
Estrogen	Inhibits bone resorption
Corticosteroids	Increases bone loss
Thyroid hormone	Normal levels promote bone formation, increased levels enhance resorption
Growth hormone	Promotes bone formation



STRUCTURE	COMMENT
Metabolic Disorders	
Hypercalcemia	Symptoms: constipation, nausea, abdominal pain, confusion, stupor, coma
1° hyperparathyroidism	Increased urine calcium, decreased serum phophate, “brown tumors” result
2° hyperparathyroidism	Malignancy #1, Multiple Endocrine Neoplasm (MEN) syndromes
Hypocalcemia	Symptoms: hyperreflexia, tetany +Chvostek's/Trousseau's sign, papilledema, prolonged QT interval
1° hypoparathyroidism	Hair loss, vitiligo
Renal osteodystrophy	Chronic renal failure, “Rugger jersey” spine
Rickets/osteomalacia	Decreased/failed mineralization, Vitamin D deficiency
Osteoporosis	Decreased bone mass, elderly
Scurvy	Vitamin C deficiency results in defective collagen
Osteopetrosis	Increased bone density due to reduced osteoclast activity
Paget's Disease	Simultaneous osteoblast osteoclast activity results in dense, but more brittle bones



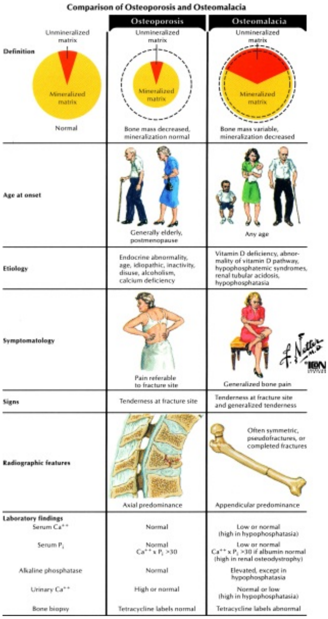
Grade I. Stretching of ligament with minimal disruption of fibers

Grade II. Tearing of up to 50% of ligament fibers; small hematoma. Hemarthrosis may be present

Grade III. Complete tear of ligament and separation of ends, hematoma, and hemarthrosis

STRUCTURE	COMMENT
Cartilage	Several types:
Hyaline	Articular surfaces, physeal plates
Fibrocartilage	Annulus fibrosis, meniscus, pubic symphysis
Elastic	Nose, ears
Articular Cartilage	
Function	Distribute load over large surface, low friction motion surface
Components	Water, collagen **type II**, proteoglycans, chondrocytes
Water content	Decreases with age, increases in osteoarthritis
Osteoarthritis	**#1 form of arthritis**, articular cartilage defect/damage. Primary, “wear and tear”; or secondary, (e.g., posttraumatic.) Often found in hands and weight-bearing joints, **knees #1 site** **Classic radiographic findings**: 1. Osteophytes 2. Subchondral cysts 3. Subchondral sclerosis 4. Joint space narrowing
Inflammatory Arthritis	**Rheumatoid, SLE, spondyloarthropathy, gout**
Rheumatoid Arthritis	Immune disorder targeting the synovium. Chronic synovitis and pannus ormation lead to articular surface and joint destruction.
	3: 1 women, associated with **HLA-DR4**, +RF, increased ESR/CRP Multiple joints affected: **MCPs: ulnar deviation, feet: claw toe common** Findings: morning stiffness, nodules, radiographs: 1. Bone erosions (periarticular) 2. Osteopenia 3. Swelling
Reiter's Syndrome	Triad: Urethritis, conjunctivitis, asymmetric arthritis; + HLA-B27
Gout	Mono-sodium urate crystals in the joint induce an inflammatory rxn Old men, great toe #1 site, elevated uric acid levels often seen Crystals: negatively birefringent
Ligaments	Attach one bone to another
Ligament bone attachment	1. Ligament to fibrocartilage 2. Fibrocartilage to calcified fibrocartilage, (most injuries occur here) 3. Calcified fibrocartilage to bone (Sharpey's fibers)
Sprain	Tear of a ligament.
Grade I	Stretching of, or minor tear in, ligament; no laxity
Grade II	Incomplete tear, laxity is evident (usually swelling)

Grade III	Complete tear, increased laxity (swelling/hematoma)
Ligament Strength	Relative strength difference between ligament and one predict injury
Pediatrics	Stronger than physis. Injury will occur at physis first
Adult	Bone stronger than ligament. Ligament will rupture first
Geriatrics	Ligament stronger than bone. Bone will fracture first



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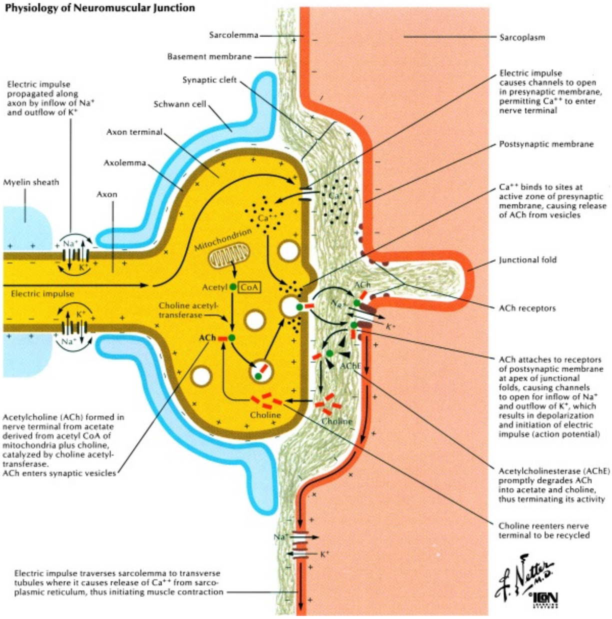
NERVES

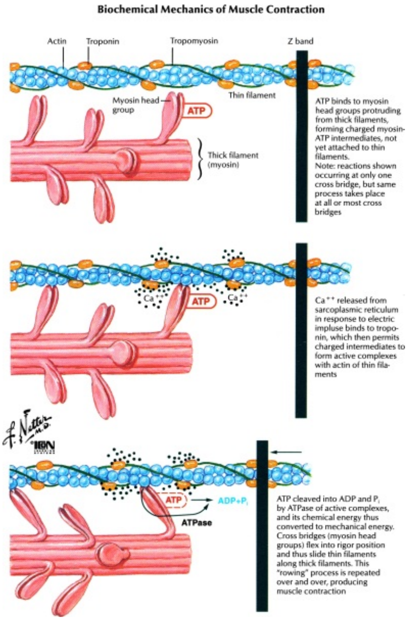
STRUCTURE	COMMENT
Cellular Anatomy	
Neuron	Cell body. Dendrites receive signal, axon conveys signal
Glial cells	Schwann cells produce myelin to cover the axon
Microanatomy	Peripheral nerve has both afferent and efferent fibers
Afferent fibers (axon)	Transmits sensory signals from peripheral nerve endings to the CNS Cell bodies are in the dorsal root ganglion (DRG)
Efferent fibers (axon)	Transmits motor signals from CNS via ventral horn/ventral root to peripheral muscles.
Endoneurium	Surrounds each individual fiber (axon)
Fascicles	Group of endoneurium coated fibers
Perineurium	Surrounds each fascicle
Peripheral nerve	Groups of fascicles, blood vessels, and connective tissue
Epineurium	Surrounds the groups of fascicles (nerves)
Nerve Injuries	Based on microanatomy
Neuropraxia	Conduction disruption, axon intact; resolves in days to weeks
Axonotmesis	Axon disrupted, endoneurium intact allows axon regeneration; recovery is slow, growth 1mm/day, but usually full
Neurotmesis	Nerve transection, recovery requires surgical repair
Poliomyelitis	Viral destruction of ventral horn (motor) cells resulting in weakness/paralysis, but normal sensation. Vaccine for prevention.
Nerve Conductions	Facilitated by myelin coating on axon (larger/coated fibers are faster)
Resting potential	Maintained by a polar difference between intra/extracellular environments
Action potential	Change in permeability of Na+ ions depolarizes cell.
Nodes of Ranvier	Gaps between Schwann cells that facilitate conduction
Nerve Conduction	Evaluates motor and sensory peripheral nerves
Studies (NCS)	Stimuli is given and followed by surface electrodes. Latency (delay) and amplitude (strength of signal) are measured.
	Conduction velocities, 50m/s are abnormal
Guillain-Barré Syndrome	Ascending motor weakness/paralysis. Caused by demyelination of peripheral nerves following viral illness. Most self-limiting.
Charcot-Marie-Tooth	Autosomal dominant disorder. Demyelinating disorder affecting motorsensory nerves. Onset 5-15yrs, peroneal muscles first, then hand foot intrinsics. Can result in cavus foot, claw toe, intrinsic minus hand.
Neuromuscular junction	Axon of motor neuron synapses with the muscle (motor end plate)
Neurotransmitter	Acetylcholine stored in axon crosses synaptic cleft and binds to receptors on sarcoplasmic reticulum and depolarizes
Pharmacologic agents	Nondepolarizing agents (e.g., vecuronium) competively bind Ach receptor
	Depolarizing agents (e.g. succinylcholine) bind short term to Ach receptor
	Toxins/nerve gas: also bind these receptors competively; treat with anticholinesterase agents (increase Ach levels in cleft)
Myasthenia gravis	Relative shortage of acetylcholine receptors due to competitive binding by thymus derived antibodies. Treat with thymectomy or anti-acetylcholinesterase agents (increase acetylcholine levels in cleft)
Motor Unit	All the muscles innervated by a single motor neuron

Physiology of Neuromuscular Junction

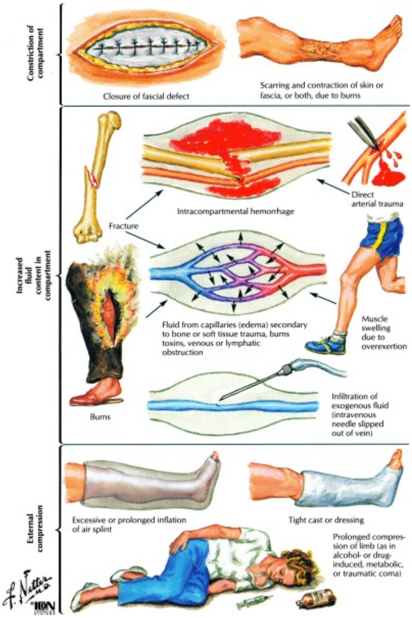


MUSCLES (SKELETAL)

STRUCTURE	COMMENT
Types of Muscle	Smooth, cardiac, skeletal
Skeletal	Voluntary control, have an origin and insertion
Anatomy	Muscles cells have two types of contractile filaments: actin, myosin
Muscle	Comprised of multiple bundles or fascicles; surrounded by epimysium
Bundle/Fascicle	Comprised of multiple muscle fibers (cells); surrounded by perimysium
Fiber (cell)	Comprised of multiple myofibril; surrounded by endomysium
Myofibril	Comprised of multiple sarcomeres, end to end; no surrounding tissue
Sarcomere	Comprised of interdigitated thick and thin filaments; organized into bands. Z line to Z line defines the sarcomere A band: length of thick filaments, does not change with contraction I band, H zone, and sarcomere length all shorten with contraction
Myosin	Thick filament: have “heads” that bind ATP and attach to thin filaments
Actin	Thin filaments: fixed to Z bands; associated with troponin and tropomyosin
Troponin	Associated with actin and tropomyosin, binds Ca++ ions
Tropomyosin	Long molecule, lies in helical groove of actin and blocks myosin binding
Contraction	Initiated when Acetylcholine binds to receptors on sarcoplasmic reticulum and depolarizes them. Depolarization causes a release of Ca++ which then binds to troponin molecules. This binding causes the tropomyosin to move and the “charged” head (ATP bound) of myosin can bind to actin. Breakdown of ATP causes contraction of filaments, (shortening of sarcomere), and the release of the myosin from the actin filament.
Electromyography (EMG)	Intramuscular electrodes used to evaluate muscle function. Increased frequency, decreased duration, decreased amplitude indicate myopathy; opposite findings indicative of neuropathy.
Types of Contraction	
Isometric	Muscle fires against increasing resistance, muscle length is constant
Isotonic	Resistance is constant through contraction
Isokinetic	Muscle contracts at a constant speed
Eccentric	Muscle lengthens when it fires; can cause injury
Concentric	Muscle shortens when it fires
Strength	Related to cross sectional area of muscle
Duchene Muscular Dystrophy	X-linked recessive disorder affecting boys. Progressive, noninflammatory process affecting proximal muscles (increased CPK). Birth and development to age 3-5 usually normal, then weakness, clumsy walking, + Gower's sign (uses hands to rise from floor) and calf pseudohypertrophy. Most wheelchair bound by 15. Multiple associated deformities, contractures, scoliosis, etc.

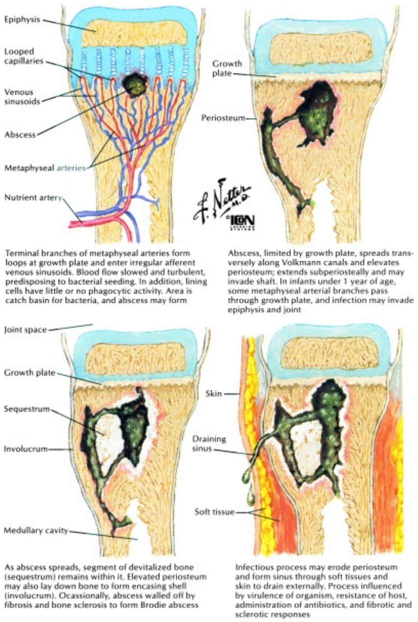


STRUCTURE	COMMENT
Compartments	Muscles are located within confined fibroosseous/fascial spaces
Compartment Syndrome	Multiple causes of increased compartment pressures. Increased pressures and decreased perfusion resulting in myonecrosis.
	5 P's: Pain, parathesias, paralysis, pallor, pulselessness (not all needed for diagnosis). Firm tense compartments on exam.
	Fasciotomy within 6 hours needed. Contracture can result.
Musculotendinous	Weakest portion of muscular attachment to bone (injuries occur here)
Junction	Muscle strain is a partial tear of this unit
Tendon Anatomy	Attaches muscles to bones
Fibril	Type I collagen grouped into microfibrils, then subfibrils, then fibrils, surrounded by endotenon
Fascicle	Fibroblasts and fibrils surrounded by peritenon
Tendon	Groups of fascicles surrounded by epitenon
Vascular Tendon	Vascular paratenon surrounds tendon to supply vascularity; no sheath
Avascular Tendon	These tendons are in a sheath, have a vincula to supply vascularity
Tendon bone Junction	**1.** Tendon to fibrocartilage **2.** Fibrocartilage to calcified fibrocartilage (Sharpey's fibers) **3.** Sharpey's fibers to bone.



Constriction of compartment
Closure of fascial defect
Scarring and contraction of skin or fascia, or both, due to burns
Increased fluid content in compartment
Fracture
Intracompartmental hemorrhage
Direct arterial trauma
Fluid from capillaries (edema) secondary to bone or soft tissue trauma, burns toxins, venous or lymphatic obstruction
Muscle swelling due to overexertion
Burns
Infiltration of exogenous fluid (intravenous needle slipped out of vein)
External compression
Excessive or prolonged inflation of air splint
Tight cast or dressing
Prolonged compression of limb (as in alcohol- or drug-induced, metabolic, or traumatic coma)

MICROBIOLOGY



Terminal branches of metaphyseal arteries form loops at growth plate and enter irregular afferent venous sinusoids. Blood flow slowed and turbulent, predisposing to bacterial seeding. In addition, lining cells have little or no phagocytic activity. Area is catch basin for bacteria, and abscess may form

Abscess, limited by growth plate, spreads transversely along Volkmann canals and elevates periosteum; extends subperiosteally and may invade shaft. In infants under 1 year of age, some metaphyseal arterial branches pass through growth plate, and infection may invade epiphysis and joint

As abscess spreads, segment of devitalized bone (sequestrum) remains within it. Elevated periosteum may also lay down bone to form encasing shell (involucrum). Ocassionally, abscess walled off by fibrosis and bone sclerosis to form Brodie abscess

Infectious process may erode periosteum and form sinus through soft tissues and skin to drain externally. Process influenced by virulence of organism, resistance of host, administration of antibiotics, and fibrotic and sclerotic responses

INFECTION	COMMENT
Osteomyelitis	Bacterial infection of bone or bone marrow. *Staph. aureus* #1 organism.
	Hematogenous spread most common. Classified as acute, subacute, or chronic.
	Pain, swelling, increased WBC, ESR, positive blood cultures. XR shows radiolucencies, +/-sequestrum (dead cortical bone), involucrum (periosteal new bone). Bone scan helps diagnosis. I D abscess/sequestra, IV antibiotics followed by a course of oral antibiotics
Septic Joint	Infection of joint space (and synovium). *Staph. aureus* #1 organism. Hematogenous or extension of osteomyelitis common routes. Knee #1, hip #2 most common sites. Painful, warm swollen joint.
	Requires aspiration/surgical drainage IV antibiotics.
Tetanus	Neuroparalytic disorder caused from exotoxin from *Clostridium tetani*
	Vaccine prophylaxis: Tetanus and diphtheria toxoid (Td); Tetanus immunoglobulin (TIG)
	Previously vaccinated (5yrs), clean wound: no treatment
	Previously vaccinated (5yrs), clean or dirty wound: 0.5mg Td
	Unknown vaccination status or “dirty” wound: Td and TIG

Thompson: Netter's Concise Atlas of Orthopaedic Anatomy, 1st ed.

IMAGING

STUDY	COMMENT
X-ray (plain film)	Standard study, multiple views needed, shows bones well, but soft tissues poorly. The joint above and below a fracture should always receive plain films.
CT	Best study for bony anatomy. Soft tissue seen, but not as well as MRI. Often used for comminuted fractures and preoperative planning.
MRI	Best study for soft tissues including intervertebral discs, ligaments, tendons. Also highly sensitive for osteonecrosis; T1 images weighted for fat (good for normal anatomy), T2 images weighted for water (better for pathology). Also used for preoperative planning
Bone scan	Radioactive isotope injected into blood. Imaging of the whole body allows visualization of areas of increased uptake. Good for identifying tumor, fractures, infections, and heterotopic bone activity (HO).
Arthrography	Contrast injected into joint followed by plain films to evaluate capsular integrity (e.g. used for rotator cuff tears)
Myelography	Contrast injected into epidural space; evaluates disc herniation, cord tumors
Discography	Contrast injected into nucleus pulposus to evaluate disc degeneration. Not a common procedure.
Ultrasound	Good for evaluating rotator cuff pathology

ABBREVIATIONS USED IN THIS BOOK

A

Abd *abduct*

AC *acromioclavicular*

ACL *anterior cruciate ligament*

ADM *abductor digitiminimi*

AGRAM *arthrogram*

AIIS *anterior inferior iliac spine*

AIN *anterior interosseus nerve*

ALL *anterior longitudinal ligament*

AMBRI *atraumatic, multidirectional, bilateral instability*

ANA *antinuclear antibody*

Ant. *anterior*

AP *anteroposterior*

APB *abductor pollicis brevis*

APC *anterior-posterior compression*

APL *abductor pollicis longus*

ASIS *anterior superior iliac spine*

AVN *avascular necrosis*

B

BR *brachioradialis*

C

Ca^{++} *ion calcium*

CBC *complete blood cell count*

CL *capitate-lunate joint*

CMC *carpal-metacarpal*

CPK *creatine phosphokinase*

CRP *C-reactive protein*

C-spine *cervical spine*

CT *computed tomography*

CTL *capitotriquetral ligament*

CTS *carpal tunnel syndrome*

D

DDD *degenerative disk disease*

DIO *dorsal interossei*

DIP *distal interphalangeal*

DISI *dorsal intercalated segment instability*

DJD *degenerative joint disease*

DRC *dorsal radiocarpal ligament*

DRUJ *distal radioulnar joint*

DVT *deep vein thrombosis*

E

ECRB *extensor carpi radialis brevis*

ECRL *extensor carpi radialis longus*

ECU *extensor carpi ulnaris*

EDC *extensor digitorum communis*

EDL *extensor digitorum longus*

EDM *extensor digiti minimi*

EHL *extensor hallucis longus*

EIP *extensor indicis proprius*

EMG *electromyogram*

EPB *extensor pollicis brevis*

EPL *extensor pollicis longus*

ER *external rotation*

ESR *erythrocyte sedimentation rate*

F

FCR *flexor carpi radialis*

FCU *flexor carpi ulnaris*

FDB *flexor digitorum brevis*

FDL *flexor digitorum longus*

FDMB *flexor digiti minimi brevis*

FDP *flexor digitorum profundus*

FDS *flexor digitorum superficialis*

FHB *flexor hallucis brevis*

FHL *flexor hallucis longus*

FPB *flexor pollicis brevis*

FPL *flexor pollicis longus*

Fx *fracture*

G

GAG *glycosaminoglycans*

GI *gastrointestinal*

GU *genitourinary*

H

HNP *herniated nucleus pulposus*

Hx *history*

I

ID *incision and drainage*

IF *index finger*

IJ *internal jugular*

IM *intramedullary*

Inf. *inferior*

IP *interphalangeal*

IR *internal rotation*

ITB *iliotibial band*

IV *intravenous*

L

Lat. *lateral*

LBP *lowback pain*

LC *lateral compression*

LCL *lateral collateral ligament*

LE *lower extremity*

LFCN *lateral femoral cutaneous nerve*

LH *long head*

LT *lunotriquetral*

M

MC *metacarpal*

MCL *medial collateral ligament*

MCP *metacarpophalangeal*

MDI *multidirectional instability*

Med. *medial*

MF *middle finger*

MRI *magnetic resonance imaging*

MT *metatarsal*

MVA *motor vehicle accident*

N

N. *nerve*

NCS *nerve conduction study*

NSAID *non-steroidal anti-inflammatory drug*

O

OA *osteoarthritis*

OP *opponens pollicis muscle*

ORIF *open reduction, internal fixation*

P

PAD *palmar adduct*

PCL *posterior cruciate ligament*

PCP *percutaneous pinning*

PE *physical examination*

PFCN *posterior femoral cutaneous nerve*

PFS *patellofemoral syndrome*

PIN *posterior interosseus nerve*

PIP *proximal interphalangeal*

PL *palmaris longus*

PLC *posterolateral corner complex*

PLL *posterior longitudinal ligament*

PLRI *posterolateral rotary instability*

PMHx *past medical history*

PMRI *posterolateral rotary instability*

PO *postoperatively*

Post. *posterior*

PQ *pronator quadratus*

PSIS *posterosuperior iliac spine*

PT *pronator teres*

PTH *parathyroid hormone*

PVNS *pigmented villonodular synovitis*

Q

Q *quadriceps*

R

RA *rheumatoid arthritis*

RAD *radiation absorbed dose*

RC *rotator cuff*

RCL *radioscaphocapitate ligament*

RF *rheumatoid factor, ring finger*

RICE *rest, ice, compression, and elevation*

ROM *range of motion*

RSD *reflex sympathetic dystrophy*

RSL *radioscapholunate ligament*

RTL *radiolunotriquetral ligament*

S

SC *sternoclavicular*

SCM *sternocleidomastoid*

SF *small finger*

SFA *superficial femoral artery*

SH *short head*

SI *sacroiliac*

SL *scapholunate*

SLAC *scapholunate advanced collapse*

SLAP *superior labrum anterior/posterior*

STT *scaphotrapezoid-trapezial*

Sup. *superior*

Sx *symptom*

T

TA *tibialis anterior*

TCL *transverse carpal ligament*

Td *tetanus and diphtheria toxoid*

TFCC *triangular fibrocartilage complex*

TFL *tensor fascia lata*

THA *total hip arthroplasty*

TIG *tetanus immunoglobulin*

TLSO *thoracolumbosacral orthosis*

TP *tibialis posterior*

TTP *tenderness to palpation*

TUBS *traumatic, unilateral instability, and Bankart lesion*

U

UE *upper extremity*

UMN *upper motor neuron*

V

VIO *volar interosseus*

VISI *volar intercalated segment instability*

VMO *vastus medialis obliquus*

W

WB *weight bearing*

WBC *white blood cell count*

X

XR *x-ray*