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Volume III

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Sandia Orthopaedics Alumni Society (SOAS) provides services that enhance and enrich the educational experience of current residents and fellows in orthopaedics training at UNM. With more than 40 years of alumni to call on, SOAS is a vital and dynamic contributer to the program. We thank them for their generous support of the *University of New Mexico Orthopaedics Research Journal*.

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Report from the Chair

Robert C Schenck Jr MD

I'm pleased to present the third edition of the University of New Mexico Orthopaedics Research Journal. As the only academic orthopaedic training program in the state, we provide service and information that benefit the people of New Mexico and the community of orthopaedic practitioners who care for them, something we've done with distinction for 45 years now. One of the ways we accomplish this goal is through sharing orthopaedic information with our many partners in New Mexico and the Southwest. I'm proud to give you this report of some of what we've done in the past year.

Our faculty continues to grow. We welcomed Dr. Bryon Hobby and Dr. James Clark this year. Both Bryon and Jimmy are alums of UNM Orthopaedics and we are happy to have them back. We are also adding Dr. Cory Carlson, Dr. Jess McMichael, Dr. Dustin Briggs and Dr. Charlotte Orr to the team during the course of next year.

We wish our senior residents well as they end this phase of their careers and begin new ones. Taylor Jobe is leaving for a hand surgery fellowship at the University of Virginia in Charlottesville. Nate Morrell is going to Brown University in Rhode Island for a hand surgery fellowship. Jenna Godfrey will do a pediatric fellowship at Children's Hospital of Los Angeles. Seth McCord will join the Air Force team at Elmendorg Air Force Base in Anchorage, AK. Charlotte Orr will be joining the orthopaedic team at Sandoval Regional Medical Center in Rio Rancho. They all have contributions in this issue of the journal, something which I am most proud of.

I want to thank Dean Smith, MD (Class of 2000) and John Franco, MD (Class of 2003) and all of our loyal alumni for their great efforts and support through the Sandia Orthopaedic Alumni Society (SOAS). SOAS brings UNM's orthopaedic surgeon training program full circle for former and current residents, fellows, and faculty. We have two annual events each year to honor former residents hosted by SOAS. The Eric Thomas Memorial Golf Tournament is held each September in honor of Eric Thomas (Class of 2004). We see alumni from all over the country back in Albuquerque, on the UNM Championship Golf Course enjoying the great fall weather. The second event was the Joel Lubin Visiting Lectureship held in the spring to honor Joel Lubin (Class of 2001). Dr. John Kelly from Pennsylvania University talked about finding the 'Sweet Spot and Stress Rx for Orthopaedic Surgeons'. Dr. Brian Robinson (Class of 1998) talked about 'Life Skills' and Dr. Dean Smith (Class of 2000) discussed 'Financial Management'. In the afternoon, a reverse-shoulder cadaveric course for the residents was proctored by Dr. Robinson along with our faculty.

The assistance of alumni becomes more important to the department every year. SOAS, created exclusively for graduates of our program, has a new lifetime membership available for a pledge of $25,000, $5,000 each year for 5 years. I'm a proud donor and lifetime member of SOAS, and invite you to join me in becoming one too. This is an exciting time to participate in the growth and success of UNM Orthopaedics.

In addition to supporting the publication of this journal, you at SOAS will be supporting the residents as follows:

PGY-I will be given jackets with Ortho logos

PGY-II will be given Loupes costing up to $700

PGY-III will be given iPads costing up to $800

PGY-IV will get reimbursement for interview expenses up to $1000

PGY-V will have the registration fee for their board examinations covered.

I am pleased to announce that Burke Gurney, PhD, has accepted the position of Division Chief for Physical Therapy. The Physical Therapy Division is celebrating their 40th anniversary this year. To date, we have graduated nearly 800 physical therapists, the majority of whom have stayed to practice right here in NM! In addition to teaching, clinical practice, and doing research, the faculty is busily preparing for their 10 year accreditation cycle which is coming up next year.

It has been another great year at UNM Orthopaedics and we thank all of you for your continued support, Alumni, Faculty and the Community!

Thank you,

Robert C Schenck Jr MD
Professor and Chair

Letter from the Co-editors

Deana Mercer MD and Gehron Treme MD

Greetings!

We welcome you to the third edition of the University of New Mexico Orthopaedic Research Journal, featuring research and educational efforts of UNM Department of Orthopaedics faculty, alumni, fellows, residents and students.

We thank all the contributors to this production as well as Mary Jacintha, Department Administrator and Joni Roberts, Residency Coordinator whose work and dedication were instrumental in bringing it to fruition.

We invite you to explore this selection of recent department publications and hope that they inspire thought and discussion, as well as future research ideas and contributions.

Agel J, Evans AR, Marsh JL, **Decoster TA**, et al. The OTA open fracture classification: a study of reliability and agreement. *J Orthop Trauma*. 2013 Jul;27(7):379-84; discussion 384-5.

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Moneim MS, **Morrell NT**, **Mercer DM**. Partial Trapeziectomy With Capsular Interposition Arthroplasty (PTCI): A Novel Technique for Thumb Basal Joint Arthritis. *Tech Hand Up Extrem Surg*. 2014 Apr 29.

Morrell NT, Fitzpatrick J, **Szalay EA**. The use of the Tsuge procedure for pedal macrodactyly: relevance in pediatric orthopedics. *J Pediatr Orthop B*. 2014 May;23(3):260-5

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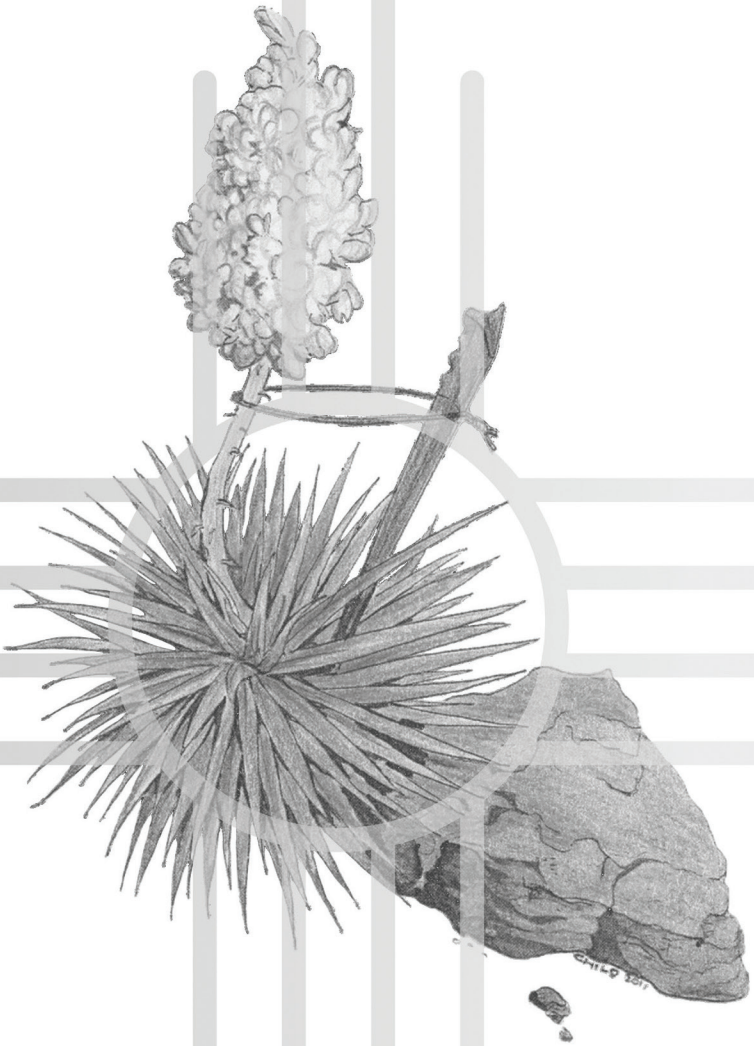
Stewart D, Cheema A, **Szalay EA**. Dual 8-plate technique is not as effective as ablation for epiphysiodesis about the knee. *J Pediatr Orthop*. 2013 Dec;33(8):843-6.

Johnson AC, Wyatt JD, **Treme G**, **Veitch AJ**. Incidence ofassociated knee injury in pediatric tibial eminence fractures. *J Knee Surg*. 2014 Jun;27(3):215-20.

Outcome of Chronic Isolated Anterior Cruciate Ligament Reconstruction. McAllister DR, Foster B, Martin DE, **Veitch AJ**, Dorey FJ, Petrigliano F, Hame SL. *J Knee Surg*. 2014 Jan 17.

Sincerely,

Deana Mercer MD
Gehron Treme MD
Co-editors



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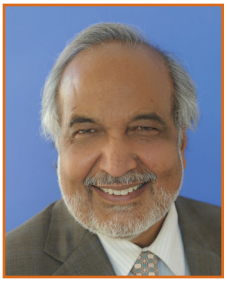

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Research Award Winners

CTH Winter Conference Research Award

Seth McCord MD
The Pediatric Orthopaedic Trauma Season — Does it Exist?

Resident Research Award

Aaron Dickens MD

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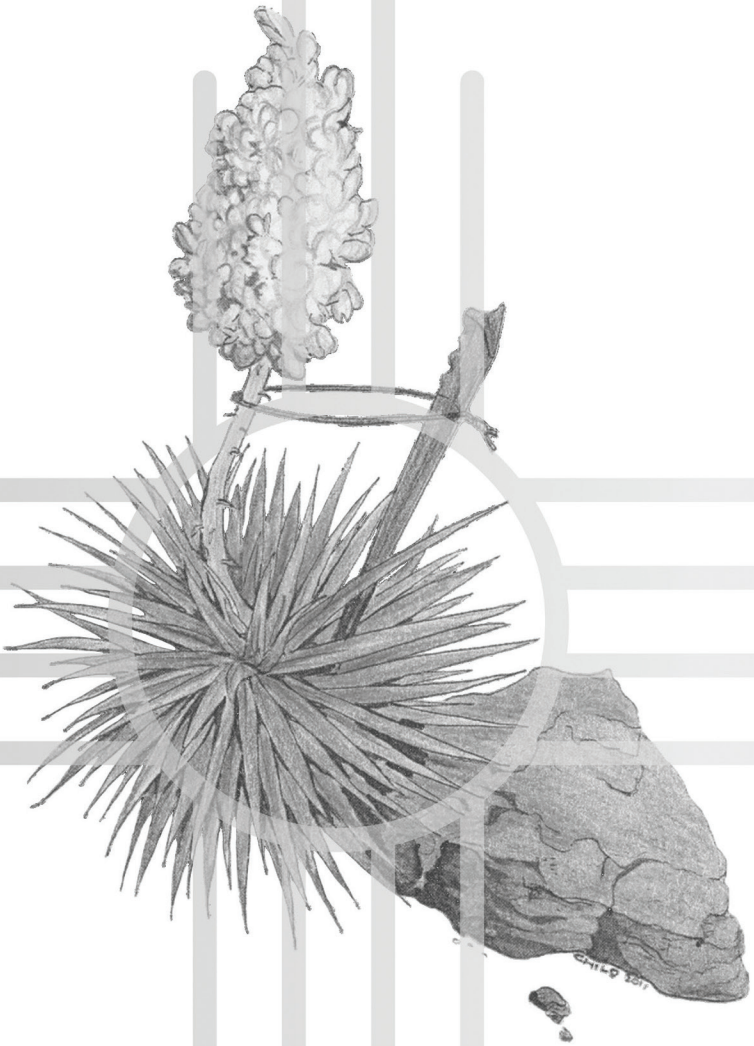
University of New Mexico
Center for Biomedical
Engineering



Report from the Residency Director

Gehron Treme MD, Assistant Professor and Residency Director

A job well done. Congratulations to Drs. Godfrey, Jobe, McCord, Morrell, and Orr, our graduating residents this year. Because I joined the UNM faculty in May of 2009, the graduation of this year's group marks the first resident class that I have seen move through the whole intern to graduate cycle. As clinicians and educators, few things in our profession are more rewarding than observing the maturation of a surgical physician. Watching the growth from a new medical school graduate to a confident and talented surgeon happens often enough to risk becoming common place but should be appreciated and respected for the accomplishment that it is.

For the surgical resident in training, the only acceptable direction is forward. Forward for five years. There is no built in time to tread water, move laterally, or rest long enough to regain bearings. Excellence is the goal and perfect will do just fine. Progress must be made in the OR, with clinical assessments, on research projects, and in preparation for the occasional quiz that rears its head from time to time. To stop is to fall behind and as hard as this constant forward movement can be, catching up proves nearly impossible.

During this progression life happens. Relationships are formed. Families grow. Balancing life in medicine with life outside may be the most daunting task of all for a physician and learning this process starts in training for most of us. Taking care of ourselves (and that includes taking care of those important to us) so we can take care of others should be the first skill that we learn. It isn't, but it should be. These requirements change as quickly as we do but to not consider it does us, our families, and our patients a disservice. We best serve our patients by having a long, effective, and fruitful career. "Professional burn out" has removed many talented physicians from service long before their time.

This year's graduates have done well to balance their lives both in and out of the hospital. It has been instructive for me to see how each accomplishes this goal and I am confident that they will continue this approach during their career. They have also, as a class, shown an interest in improving our residency so that they leave it better than they found it. Who has time to improve a program when the requirements noted above are so difficult? The easiest path is to ride the wave of those that have come before. Picking the vegetables without tending the garden. I appreciate the many contributions that the Class of 2014 has made to the UNM Orthopaedic Program and their work will benefit the residents that follow them here.

Nate, Seth, Taylor, Jenna, and Charlotte, your work is most greatly appreciated and admired. I know you will make us proud as graduates and I look forward to your continued involvement in your program.

Rehab and the Kinetic Chain: An Orthopaedic Surgeon's Guide to Diagnosing and Treating Overuse Injuries

Jenna Godfrey MD†

†UNM Department of Orthopaedics and Rehabilitation

Introduction

As surgeons, we undoubtedly enjoy operating. Surgery is what we "do." Fixing things gives us satisfaction, and for the most part our patients are happy as well. However, there is another group of patients that we see in clinic too: patients with non-operative problems. For example, overuse injuries. These visits can be quite frustrating, not only for us, but also for the patient. If we don't have a surgical "fix" we often feel like we didn't "do" anything to help, leaving both us and the patient feeling let down.

The purpose of this article is to provide a background on some concepts rarely discussed during orthopaedic training: overuse injuries, biomechanics, kinesiology, fascia, and a functional exam of the kinetic chain. Using these concepts, I have outlined five fundamental points to cover with a patient presenting with an overuse injury. The goal being that both you, the practitioner, and the patient have a more satisfying and productive encounter because you will have done something: educate.

Please note that as a runner, I chose to use running as my example throughout the article, while the specific injuries differ between sports, many of the concepts I present will be generalizable.

Overuse Injuries

Overuse injuries, generally speaking, are a group of disorders related to overdoing physical activity. Overuse injuries have many pseudonyms including cumulative trauma disorder. A cumulative trauma disorder is defined as a harmful and painful condition caused by overuse or overexertion.[1] About.com defines overuse injury as "an injury to a part of the body that is caused by overusing or exerting too much stress on that body part".[2] Medscape defines overuse injuries as "tissue damage that results from repetitive demand over the course of time".[3]

Overuse injuries are due to "overdoing" an activity, but how much is too much?

Clearly this differs by sport, but overall, there is no standard definition of "too much." In a systematic review of running related injuries by Lopes et al, the incidence of running injuries was 6.5-59 injuries per 1,000 hours of training.[4] This number was not chosen as a magical number of hours where the incidence running injury increases, instead it is a commonly used quantification of the incidence in running injuries.

While defining overuse is problematic, we do know that there are many commonly seen injuries that fall into this category. According to a systematic review, the top eight most common overuse injuries seen in runners include[4]:

1. Medial tibial stress syndrome (shin splints)
2. ITB
3. Achilles tendinopathy
4. Plantar Fasciitis
5. Patellafemoral syndrome
6. Patellar Tendonopathy
7. Hip and Lower Leg tendonopathies
8. Stess fractures

The study included a heterogeneous population of runners; from amateur runners, to marathon runners, to ulta marathon runners. However, there were no significant differences in the types of injuries between these different levels of runners.

According to the website "Stop Sports Injuries", sponsored by the AAOS, overuse injuries can be classified into four stages based on presenting symptoms[5]:

Stage 1: Pain after activity, no functional impairment

Stage 2: Pain during and after activity with minimal functional impairment

Stage 3: Pain during and after activity that persists throughout the day, significant functional impairment

Stage 4: Significant functional impairment with all daily activities

While the site did not provide an algorithm for treatment based on the classification, they do point out that treatment "early" (stage 1 or 2) results in a shorter duration of symptoms and faster return to sport.[5]

This point is important to note because it is a shift in our typical paradigm. Acute severe injuries such as fractures

and dislocations require immediate treatment. Overuse injuries, which are cumulative traumas, often present less severely, but require the same aggressive treatment. The sooner you catch a LESS severe overuse injury and treat it, the sooner the individual will get better. This requires the physician to be aggressive EARLY in the course of the disease, as opposed to waiting for a catastrophic injury to initiate treatment.

The Mayo Clinic defines two common causes of overuse injuries: training errors and technique errors.[6] Training errors involve doing too much, too soon, too fast, or too much of one type of activity. Technique errors involve poor form or technique in repetitive activities. With these two concepts in mind, they suggest that participants: pace themselves with gradual increase in activity, use proper form and gear, include coaching when necessary, and mix up a training routine.

Point #1

Overuse injury is a poorly defined and non-specific term that we, as clinicians, use to describe a group of injuries we tend to see in patients who participate in endurance sports or sports with repetitive activity. They are usually the result of over training or training with poor technique. Understanding where the breakdown in the training is, and treating the injury aggressively early can lead to a quick recovery and return to play.

Biomechanics and Kinesiology

In order to understand overuse injuries, it is important to understand some important principles relating to biomechanics and kinesiology.

Biomechanics is the application of the mechanics of motion to biologic systems.[7] Biomechanics involves taking principles from mechanics and physics and applying it to biologic systems. The body is made up of a system of levers (bones) rotating on fulcrums (joints). Torque is the force that rotates a lever arm around a fulcrum.[8] A moment arm is the perpendicular distance from the axis of the force to the fulcrum. A larger moment arm has a better mechanical advantage when it comes to creating torque at the joint of interest. Both the moment arm and torque are affected by the angle at which they are applied. Maximal torque is always created when the force is applied at 90 degrees to the lever.[8]

In human anatomy, a muscle with a larger moment arm gives a better mechanical advantage when it comes to creating torque at the joint of interest. Conversely, a larger moment arm can also result in a greater force through a joint (compression), which can be a disadvantage in repetitive activities. Two examples would be lifting a dumbbell and running with a shorter stride. Imagine the brachialis crossing the elbow joint. The moment arm is the distance from the center of rotation of the elbow joint to the bracialis.[9] This distance is short when the arm is extended and at its longest with the arm at 90 degrees. This means that the brachialis is at its greatest mechanical advantage to lift a heavy weight at 90 degrees of elbow flexion. In contrast, the moment arm of the lower extremity during foot strike is a line parallel to the ground running between the knee and the center of the foot strike. The longer the distance between the knee and foot (seen in long gait patterns), the higher the moment arm and the more force on the lower extremity. Shorter stride distances are therefore more energy efficient and in long distance running conserve more energy and likely prevent injury.[10]

Dr. Arthur Steindler, the chair of the Department of Orthpaedics at the University of Iowa between 1919-1949, introduced the idea of the kinetic chain.[7] Dr. Steindler envisioned limbs as "rigid overlapping segments" in a series.

"Each bony segment in the lower extremity such as the foot, lower leg, thigh and pelvis can be viewed as a rigid link with the subtalar, ankle, knee and hip joints acting as the connecting joints."

The idea behind the kinetic chain is that a break in the chain could effect the movement and function in other areas of the chain or the entire chain itself. Dr. Steindler identified the importance of looking at the entire chain when addressing pathology and rehabilitation.

The biomechanics of running differs from walking because there is a period of time in running where neither foot is on the ground, and because there is more energy in the system.[11] The foot and ankle see three times the body weight on impact. Starting from the bottom, the foot and ankle act as the energy absorbers, the knee helps place the foot in space and the hip is for propulsion.[11] During impact the subtalar joint is everted, the foot is in pronation, the forefoot is abducted and the ankle is dorsiflexed approximately 90 degrees. During toe off the subtalar joint inverts, the foot is supinated, the forefoot is adducted and the ankle is plantar flexed. It is important to recognize that these motions work in concert to lock and unlock the midfoot joints. An inverted subtalar joint with the forefoot in adduction locks the transverse tarsal joints, providing a stable platform for push off. An everted subtalar joint with the forefoot in abduction unlocks the transverse tarsal joint, allowing for a supple foot to absorb energy during heel strike.[12] The muscles of the lower extremity are working in concert with the joint motion. The gastrocnemius and posterior tibialis are eccentrically contracting during heel strike to help absorb energy and prevent over pronation. The tibialis anterior contracts during toe off to dorsiflex the ankle during swing.

The knee is in valgus and flexion during foot strike and in varus and extension during toe off. On impact, the quadriceps eccentrically contracts to resist the ground reactive force and to prevent the knee from collapsing. During the late swing phase the quadriceps contract to extend the knee to prepare for impact. Foot position can greatly impact the amount of knee varus and valgus during the cycle; the more pronation in the foot, the more valgus in the knee.

The hip joint provides propulsion during running. The hip adducts during stance phase and abducts during swing phase. The psoas muscle pulls the leg forward during swing phase. The hamstrings and gluteus maximus contract at the end of swing phase to place the foot under the center of gravity and during the beginning of stance phase to pull the body over the leg. The hip abductors and adductors work in concert during stance phase to stabilize the stance leg, with more abduction of the hip during swing phase and adduction during stance.

The concert of movement required to run efficiently and effectively can therefore be greatly affected by a break in the chain, resulting in a variation in the running cycle, and ultimately injury.

Hip biomechanics have a powerful influence on knee mechanics, and abnormalities can result in knee injury.[13] Overall, the knee is the most common site for overuse injuries. A systematic review found 51 articles linking impaired trunk control (due to hip weakness) with knee injury. Some common patterns of injury relate to weak external rotators, weak abductors, and increased hip adduction and internal rotators.

When patients with weak external rotators and excessive hip adduction and internal rotation perform a box jump, they land with the knee center of rotation moved medial to the foot and valgus collapse at the knee.[13] The result of this faulty gait pattern includes patelofemoral syndrome, MCL tears/sprains, ACL tears, posterior tibialis tendonitis (as a result of trying to control over pronation of the foot), and lateral ankle impingement. Weak hip abductors can lead to increased pelvic tilt, resulting the center of gravity moving medially. This creates a varus moment at the knee, and increased internal rotation of the tibia. If this pattern is coupled with over pull of the adductors, iliotibial band syndrome (ITB) often results.

ITB syndrome tends to be related to adduction coupled with weak abductors and internal rotation of the tibia. A prospective study of 100 female runners found that excessive lower extremity adduction and internal rotation of the tibia were the strongest predictors of ITB syndrome. A case control study comparing injured and uninjured sides in patients with ITB syndrome found weaker abductors on the injured side.[14]

Studies have also indicated increased patellofemoral syndrome in patients with weak external rotators and abductors and over pull of the adductors.[15,16] Females with patellofemoral syndrome had greater peak internal rotation while running and jumping when comparted to controls.[15,16] Females with patelofemoral syndromes also had three and a half times greater adduction during running, hopping and single leg squat when compared to controls.[17]

Point #2

The human body is made up of a series of joints that work together to cause motion called the kinetic chain.

Although you have pain at one point in the chain (ex patellar tendon pain), it may be caused by faulty movement in another point in the chain, such as weak external rotators at your hip.

Fascia

Fascia, otherwise known as connective tissue or extra cellular matrix is made up of collagen produced by fibroblast and held together by glycoaminoglycans (GAGs).[18,19] Fascia makes up tendons, ligaments, and sheaths throughout the body. Depending on the environment, the glue, or GAGs, can be thick, sticky, fluid, or lubricating as a result of the chemical properties of the GAGs. "Stretch" or lengthening of your fascia is likely creep due to change in the GAGs allowing for movement.[18,19] Manual therapy involves manipulation of the fascia to make it more compliant, elastics, and resilient, resulting in more healthy and fluid movement.

Fascia is alive and it is important, biomechanically. Fascia was long believed to be an inert covering, however it is now believed to be an import structure capable of remodeling. Langevin et al noted that fibroblasts repair and build fascia and hypothesized that fibroblast remodeling contributes to viscoelastic behavior of fascia.[20] The basic science work indicates that fibroblasts can change stiffness of fascia with production of matrix proteins.

Modern neurophysiology recognizes that the brain see movement patterns, instead of individual muscles movements. It is hypothesized that fascia plays a significant role in this due to a larger number of mechanoreceptors in the fascia, almost ten times as many as in muscle. These receptors include golgi, pacini, ruffini, and interstitial receptors.[20] Mechanoreceptors relay information on stretch, proprioception, blood flow and can change from tonic to relaxed with pressure (e.g. massage).

Since fascia is alive and pliable, it is also trainable.[18] Fascia responds best to cyclic, quick repeated movements like running and bouncing. Preparatory counter movements load fascia, for example flexing down before extending

up to stand or jump, or moving the kettle bell into body before moving it quickly away. Winding up fascia uses the elasticity in the fascia to its maximum. Metabolically, using fascia's elasticity is more efficient than muscle contractions alone. Engaging long myofascial chains in one exercise, such as in kettle bells, TRX, physioballs, pilates, and yoga are efficient ways to train fascia. Some important rules for training fascia include: start proximally in the direction of the movement, then terminally extend, mix up the routine as fascia can adapt to one routine and no gains will be made, and finally exercise the receptors by including balance, agility in work outs.

Point #3

Fascia is the connective tissue that ties together the kinetic chain. It is also a common site of injury (eg. tendonitis, ITB syndrome, joint contractures). Therefore fascial health is key to your recovery as well. Fascia training, myofascial release, massage, and/or foam rolling are all important parts of injury recovery and maintenance.

Physical Exam

The Functional Movement Screen (FMS) developed by Gray Cook, a PT and trainer, is a series of exams used to help identify weak links in the kinetic chain. The goal was to create a reliable exam that could be reproduced by any individual who was appropriately trained in order to guide treatment or prevention on an individual basis. The inter and intrarater reliability for the FMS is 0.7.[22]

While the entire FMS screening exam is cumbersome, requires specific materials and training and can be too much for a standard visit in an orthopaedics office, a few simple maneuvers from this test can give the physician some valuable information in diagnosing the cause of an overuse injury in a patient.

Core strength is hugely important as a stabilizer against which the hip can flex and extend. Have the patient stand and look at them from the side to assess their sagittal balance while standing. Look specifically at the pelvis for anterior or posterior tilt.

Anterior tilt is common and can indicate several things: a weak core, quadriceps dominance pulling down on the pelvis, or psoas tightness. A lying straight leg raise can rule in or out core strength. If hyper lordosis occurs with a straight leg raise, it is likely that the patients core is weak and unable to provide counter stability against the strong hip flexors.

A deep squat is another simple test that can be done in the office. With a deep squat, watch specifically the feet and the trunk. Are the feet pointed forward or do they splay out or in? Are the feet symmetrical? Does the heels rest on the ground or lift off? Where is the trunk, straight up and down or is it pulled forward over the feet towards the knee? What is their terminal knee flexion, is it symmetrical? If a patient splays one foot out, it is possible they have a contraction of the external rotators at the hip on that side. If their heels are off the ground, they likely have a tight achilles tendon or soleus. Patients who fall forward and can not place their trunk straight up and down usually have hip flexor contractures. Terminal knee flexion should allow the patient to nearly sit on the ground, but decreased knee flexion can result in the patient not being able to squat fully.

Finally, a one legged squat provides a good side to side comparison. Have the patient perform a one legged squat (they may need to hold on to the table). Watch their balance, depth and the squatting knee. Weak abductors and external rotators results in increased knee valgus and foot pronation during a one legged squat. Pelvic obliquity can be due to weak abductors on the contralateral side. After an injury, patients tend to loose proprioception on the injured side and will likely find a one legged squat much more difficult on that side.

Point #4

These three simple exam maneuvers (lying straight leg raise, deep squat and single leg squat) may help you identify a break in the kinetic chain and will help you SHOW the patient that there is an imbalance which needs to be addressed.

Use this as an opportunity to educate patients and to introduce the idea of therapy as treatment.

"As we saw in your exam today you have X (ex. weak hip abductors as was indicated by the drop in your hip with a one legged stance, or weak abdominal muscles and over pull of your quads as we can see with your increased anterior tilt and increased lordosis on your straight leg raise)."

Point #5

Here's your prescription for physical therapy. My goals for you would be: to work on some of the asymmetries and weaknesses we saw today. Remember, neglecting these areas are what got you here today and will bring you back again so maintenance will be key for you. Cross train so that you stay symmetrically fit and hopefully prevent injury.

Conclusion

In conclusion: overuse injury is a poorly defined catch all term that we use to describe injuries due to deficiencies in training or technique and typically do not require a surgical intervention. Biomechanics and the kinetic chain can help us better understand these injuries. A break in the

chain (hip external rotator weakness) can result in injury at a different level in the chain (patellofemoral syndrome or posterior tibialis tendonitis). It is important to address this break in the chain when treating the injury. Fascia is alive and important, and should not be neglected when treating the kinetic chain. Finally, a straight leg raise, deep squat and one legged squat can help us, the physician, identify some areas of weakness in patients presenting to us with overuse injury which both builds their confidence in us, but increases our own satisfaction that we are treating these patients, even if that treatment just involves sending them to a physical therapist that we know and trust.

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The Aging Athlete

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Introduction

As the general population ages, it is the duty of the orthopaedic surgeon to meet the challenges of an older, athletic patient. Throughout the aging process the physiology of the body changes. This occurs at different rates in different people.

Organ functions gradually become impaired and decrease in efficiency. Our bodies become more vulnerable to environmental stresses, metabolic disturbances and disease.[1] Recent evidence suggests that effects of aging may be more of a result of unhealthy living and a sedentary lifestyle. As we see an increase in life-expectancy, we also see a portion of the population that desires higher activities at older ages than has ever been seen before. Ever.

Between 1900-1988, the life expectancy in western countries increased from 47 years to 75 years. The number of people living over the age of 85 increased 232% between 1960 and 1990, compared to just a 35% growth of the general population. Now, 25% of Americans are over the age of 55. Looking at really old people (age over 65), today there are 38.6 million Americans, and that number will skyrocket to 54.8 million by 2020.[2]

These numbers are somewhat astounding. Now more than ever it is the role of the orthopedic surgeon to understand the anatomy and physiology of aging, as well as be able to outline expectations for these older athletes. Because, let's face it, sometimes we don't know what's best for ourselves as athletes.

Dr. Nicholas DiNubile coined the term "Boomeritis" in 1999. It refers to injuries in older amateur athletes. These can be acute injuries (i.e. ACL tears) or overuse injuries (i.e. tendonitis). He notes a significant increase in these injuries presenting to his clinic in the last 2 decades. His general recommendation for prevention is to schedule balanced routines, change the muscle groups being used, and perform sport-specific preparation.

A simple step for the orthopedic surgeon in treating the aging athlete is to identify the aging athlete. This tends to make up a significant portion of our patient base. It can include "Weekend Warriors", who are people who participate in usually physically strenuous activity only on weekends or part-time. A more competitive group of aging athletes are known as "The Masters Athlete". Think of these as washed-up Olympians. Another category is older professionals who still are involved in sports but no longer as athletic participants. This includes coaches and trainers, who often push themselves to their physical limits as a means of motivation for their players. Military personel should also be considered aging athletes, given their requirements to remain active duty.[3]

The Effects of Aging the Body

The human body changes at the molecular level during the aging process, thus affecting every organ system in the body. These changes have been well-documented. For example, the oxygen utilization in a 60-year-old is 80% of that of a 20-year-old. Peripheral vascular resistance increases due to atherosclerosis. There is also a decrease in pulmonary efficiency because lung compliance decreases, thoracic cage elasticity decreases, and gas exchange becomes limited. The result of these cardio and pulmonary effects is an increased risk of myocardial events. This risks are exacerbated in the person who suddenly begins intense training from a previously sedentary lifestyle.

Changes affect the kidneys as well. The number of glomeruli decrease by half from age 40 to age 70. There is also insensible water loss in the aging population. Intravascular depletion affects cardiac output and athletic performance. This depletion usually precedes thirst. Sensorimotor coordination is also affected. Peripheral nerves can be affected even more by common diseases such as diabetes.

On a subject that is far more comfortable to the orthopedic surgeon, the musculoskeletal system undergoes sufficient changes as well. Bone density decreases as we age. Men lose .75% per year of their density after the age of 40, compared to women who lose 3% per year after menopause. These changes can be slowed with regular exercise, Calcium

and Vitamin D supplementation, hormone replacement therapy and medical therapy such as bisphosphonates.

Ligaments and tendons undergo a loss of compliance and become more stiff, thus also making them more susceptible to catastrophic failure. They also are affected by the decreased vascularity that happens to them as they age. Regular exercise and activity-specific warm-ups can help prevent these injuries.

The meniscus, the most common indication of orthopaedic elective procedures also ages. There is appreciable intrasubstance degeneration. It loses the ability to dissipate stress and eventually undergoes degenerative tears. There is no good prevention for this known to us, but is it treatable with arthroscopic debridement.

Articular cartilage certainly is no stranger to the aging process. Theses affects are seen daily in orthopaedic clinics. The concentration of chondroitin sulfate relative to keratin sulfate increases in articular cartilage. We also diminished amounts of synovial fluid. Nutrition and metabolic waste occur via diffusion, thus resulting in hypertrophy of the surrounding tissues. Treatment and prevention for cartilaginous wear is multifactorial and numerous options exist. Glucosamine chondroiton and hyaluronic acid injections have not had resounding results, but there is some favorable literature out there. Kanzaki et al reported on the effect of a dietary supplement containing glucosamine chondroitin compared to a placebo. Their 16 week follow up showed that patients that took 1200mg glucosamine and 60mg chondroitin had improved symptoms and functional knee scores. They also had improvement of their Type II collagen synthesis/degradation balance.

Skeletal muscle undergoes sarcopenia as we age, a .5% to 1% loss of muscle mass per year starting at age 25. There is a volumetric loss of individual fiber size as well as some unfortunate muscle denervation. There is also a decreased mitochondrial volume in the muscles themselves, and we all know what that means. Muscle also becomes less flexible as we age, so think twice about that gymnast girlfriend of yours. The great news, is that Regular exercise and muscle training can actually REVERSE the loss of muscle volume seen with aging. Warming up also helps prevent tears, and nutritional supplementation is good stuff.

The Negative Consequences of Sports and Fitness

The orthopedic surgeon does see numerous complaints as a result of sports participation. These include overuse injuries such as patellar tendinits, impingement and stress fractures. It's also noted that patients that are more active as teenagers have higher hip and knee osteoarthritis rates when older. We are seeing more injuries in sports especially since female participation has increased over the last few decades. However, we do not have a lot of long-term effects on sports injuries, as trainers and doctors often lose track of their athletes. We do know that modest to intense running regiments do not correlate with increased osteoarthritis later on in life. And most studies have shown a positive effect of sports. They help control weight, contribute to cardiovascular health and slow osteoporosis.

Sports Participation in the Elderly

One question that we face is whether or not participating in sports at an older age is beneficial to one's health. Kallinen et al did a review of 11,581 patients, all over the age of 65, looking at their level of sports participation. None of these patients were disabled. The divided these people into four groups, including active particpants in sports, people that only exercise, passive participant in sports, and sedentary. They found that incidental functional disability is better prevented when a person actively participates in sports.[4]

Care of the Aging Athlete

Since a high proportion of the population demands to be active at older ages now, orthopedic surgeons must be able to offer advice for all aspects of the patients training. This include from the preinjury level to the severe disease level. Sixty-three percent of triathletes are over the age of thirty-five.[5] Advice that physicians provided to these patients in the past used to be "quit" or "slow down". But we have to understand that this is no longer the culture in our country. We must meet the demands of these people.

As the athlete ages, we are more likely to see more chronic/overuse injuries. 70% of all sports injuries in patients older than 60 are of a chronic nature. That is compared to 40% for the 21 - 25 year olds. By the seventh decade of life the 5 most common sports injuries are degenerative, and 20% of these injuries last more than 2 years and alter the athletes training and competition levels.

Tendinosis is caused by cumulative microtrauma to the tendons. Tendons have less elasticity as we age, and are slower to heal. This is seen in nearly every type of athlete, including golfers, who at risk for rotator cuff pain, medial epicondylitis and wrist tendonitis. In joggers we often see iliotibial band syndrome and Achilles tendinitis.

The acronym FACE is a simple reminder for the orthopedic surgeon to remember simple goals to set forward for patients that want to remain active. Flexibility. Aerobic intensity. Carry a load. Equilibrium and Balance.[6] Remind patients to perform sport specific warm-ups and stretch in the end. Dynamic stretching is better for preworkout; this is where the muscle is lengthened and then contracted. Traditional stretching is reserved for the end of a workout. Cardio workouts and weight-lifting or resistance exercise

should be worked into their routine, taking care to not focus too much on one and ignore the other. Exercises that work on balance will also be preventative to future injuries. When patients do sustain an injury, RICE is a well known acronym to treat sprains Remind them to go with Active RICE, not just RICE. They still have 3 good extremities that need attentions.

Dynamic, or sport-specific, warmup has become more popular and more and more literature is supporting it's use. In a study in which half of 943 professional soccer players underwent dynamic warmups for their hamstrings over a soccer season, there was over a 50% reduction risk of injury compared to the traditional warmup group.[7]

The aging athlete cannot be symptom free forever. Once they do develop symptoms, steroid injections have long been a clinical procedure that can provide good results. Cole et al looked at the use of steroid injections in modern practice. The most common extraarticlur sites that are injected in modern practice are the lateral epicondyle of the elbow (93% of surgeons), subacromial space (91%) and the greater trochanteric burse (91%). He saw no proven benefit of extraarticular injections lasting over six weeks. The results for the lateral epicondyle were inconclusive. The most successful sites were for trigger finger (60% resolution), DeQuervain's (90% symptomatic relief) and the greater trochanteric bursa in which 61% had ongoing relief for at least 26 weeks. The most common complications are post-injection flare, facial flushing and skin or fat atrophy. A septic joint occurs 1:3000 to 50,000 injections. Only 12.6% of rheumatologists and orthopedic surgeons have seen a septic joint in their career that they relate to an injection.[8]

Osteoarthritis

Potentially the most feared diagnosis for our aging athletes is osteoarthritis. Eventually the joints wear down, cartilage is degraded, pain is severe and motion becomes limited. We are often asked about the causes and potential preventions of arthritis in our clinic. To some degree there is thought to be a genetic predisposition.

Chakravarty et al compared 45 long distance runners to a control group of 53, with a mean age of 58. These patients were followed for 18 years and studied with serial radiographs. They were controlled for age, gender, BMI, education, initial radiographs and disability scores. They saw less osteoarthritis develop in the long-distance runners (20% vs 32%), as well as a lower incidence of sever osteoarthritis (2.2% vs 9.4%). They concluded that long-distance running does not result in accelerated osteoarthritis or more severe osteoarthritis.[7]

Cole et al also looked at intraarticular steroid injection in the treatment of osteoarthritis. Pain was provided from 1 to 13 weeks in his study sample. These injections also helped with rehab and decreased the need for rescue analgesia after knee scopes. They appreciated that it did not cause progression of osteoarthritis if given every 3 months for two years. These patients also had better motion compared to a placebo group. Results still vary for viscosupplementation. It is more costly that steroids, and it seems to be less effective for severe DJD.[8]

Eventually patients who have failed nonoperative treatment of osteoarthritis will undergo a joint replacement. It is generally recommended that they pursue lower-intensity and lighter impact activities after the surgery. They have a better chance of returning to an old sport than starting a new one. Table 1 guides the physician in answering questions on what they think patients can do after a certain type of joint replacement.

Conclusion

The aging athlete walks into an orthopedic surgeon's office every day. It is imperative that we have a broad knowledge set for these patients. It includes advice to prevent injury, treatments for small acute and chronic injuries and, of course, surgical options that can help them maintain their maximal level of competitiveness.

Table 1: Athletic Activity after Joint Arthroplasty: Summary of the 1999 Surveys of the Hip Society, the Knee Society, and the American Shoulder and Elbow Society

Activity	Hip	Knee	Shoulder
Aerobics—High Impact	—	0	0
Aerobics—Low Impact	—	++	++
Baseball/softball	—	0	0
Basketball	—	—	0
Bicycling—road	+	+	++
Bicycling—stationary	++	++	++
Bowling	+	++	++
Canoeing	+	+	++
Croquet	++	++	++
Dancing—ballroom	++	++	++
Dancing—jazz	0	++	++
Dancing—square	0	++	++
Fencing	0	0	0
Football	—	—	—
Golf	++	++	+
Gymnastics	—	—	—
Handball	—	—	0
Hiking	+	+	+
Hockey	—	—	—
Horesback riding	+	++	0
Horseshoes	++	++	++
Ice skating	0	+	+
Jogging	—	—	++
Lacrosse	—	—	0
Racquetball	—	—	0
Rock climbing	—	—	—
Roller/in-line skating	0	0	0
Rowing	0	+	0
Shooting	++	++	+
Shuffleboard	++	++	++
Skiing—cross-country	+	+	++
Skiing—downhill	0	0	+
Skiing—stationary (machine)	0	+	++
Soccer	—	—	0
Speed walking	0	+	++
Squash	—	—	0
Swimming	++	++	++
Tennis—doubles	++	+	++
Tennis—singles	—	—	0
Volleyball	—	—	0
Walking	++	++	++
Weightlifting—free-weights	0	0	0
Weightlifting—machines	0	+	0

++ = allowed
+ = allowed with experience
— = not recommended
0 = no conclusion

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Tourniquets—A Review with Recommendations

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This presentation focused on the following topics : Increased battlefield survivorship with tourniquet use, a review of morbidity due to use of tourniquets, and current surgical tourniquet recommendations.

A very different war was fought after September 11th, 2001. The US military had to adapt to a different style of fighting than it had previously seen and extremity war injury was at the forefront of casualty control. In fact, one of the first casualties of the war was due to an isolated limb injury and exsanguination so the natural question posed was - how do we prevent this from happening?

A rather rapid transition was then made from the long-held belief that tourniquet use was something of a "last resort" due to its morbidity. Tourniquets became a form of "first aid" on the battlefield. It is estimated that almost 2000 lives were saved due to an increase in tourniquet use over the ten years of conflict from 2001-2011 (Anderson et al).

Tien et al reported on tactical combat casualty interventions including needle decompressions for pneumothorax and use of tourniquets for exsanguinating injuries, amongst others. They found in patients with injuries where tourniquets were indicated, one half of those patients needing tourniquets had them properly applied, saving their life. Others where tourniquets were used had venous tourniquets or tourniquets applied for improper indications. This led to a push for better education of soldiers and medics in tourniquet indications and use.

Schreiber et al described the historical fatality rates from World War II, the Vietnam War and Operation Iraqi Freedom(OIF). While quite different conflicts, the trend was toward fewer fatalities with 19.1%, 15.8%. and 9.1%, respectively. This was attributed to improvements in body armor, hypotensive resuscitation, tourniquet use as well as IV and topical hemostatic agents with improved correction of coagulopathy.

Beekley et al performed a retrospective review of 165 patients during 1 year of OIF. 67 had tourniquets for severe extremity injury, 98 did not. Injury scores were approximately the same. They found that 57% of the deaths were due to hemorrhage, potentially preventable by tourniquet use.

Kragh et al surveyed the indications for use of emergency tourniquets. They recorded 728 casualties with 953 limbs injured with a tourniquet used. The found that 70% were applied pre-hospital, 11% applied in hospital and that 51% sustained major bleeding pre-hospital. They concluded that the current indication should be any compressible limb wound with the potential for lethal hemorrhage.

In another study, the same group looked at survival rates with emergency tourniquet use to stop bleeding in major limb trauma. This prospective survey of 2838 patients found that 232 had tourniquets on 309 limbs. There were 31 deaths in the study group. They reported that no amputations were required from tourniquet use. More importantly there was an 11% death rate with tourniquet use compared to 24% death rate without.

Lakstien et al reported in the Journal of Trauma on the Israel Defense Forces and their 4-year experience with tourniquet use for hemorrhage control on the battlefield. This 4-year long retrospective analysis showed that ischemic time ranged from 1-305 minutes and that 78% of the tourniquet applications were effective. There were higher rates of effective use when performed by medical staff when compared with use by soldiers. There were also higher rates of effective use in the upper extremity when compared with the lower extremity.

In the JAAOS supplement put out on extremity war injury, Mamczak et al wrote on the evolution of orthopedic care. They found that exsanguination was the most common cause of death and that buddy aid and the use of the Combat Application Tourniquet (CAT) (Figure 1) was crucial in the reduction of fatality from exsanguination.

A historical paper from the Sino-Japanese War from 1938-1941 reported in the Annals of Surgery in 1944 by Adolph PE outlined the preoperative measures taken that improved outcomes after surgery for for life threatening limb injury. He states that the "delimiting tourniquet" (Figure 2) afforded time for transport, stabilization of patient systemically before amputation.

King et al looked at 79 patients with prehospital battlefield tourniquets used in the current war. They assessed the quality of tourniquet application in forward settings and

found that 83% of limbs had palpable distal pulses present at arrival to the hospital. 14/79 had arterial injuries but only 5/14 had effective arterial tourniquets applied. Reportedly, the medics transporting the patients were surprised by the force required to create an effective tourniquet as demonstrated by the researchers.

Kragh et al then examined the effectiveness of different types of tourniquets. They compared the CAT with the Emergency & Medical Tourniquet (EMT). The CAT tourniquet uses a turn down strap style with attached rod to achieve compression while the EMT employs the more widely used in hospital pneumatic tourniquet. While the EMT was more effective at 92% in achieving complete occlusion when compared to the CAT at 79%, they both were much better than other styles of tourniquet. The CAT was easier and faster to apply with one hand and was more reliable while the EMT was most effective at occlusion and had a steeper learning curve for effective use.

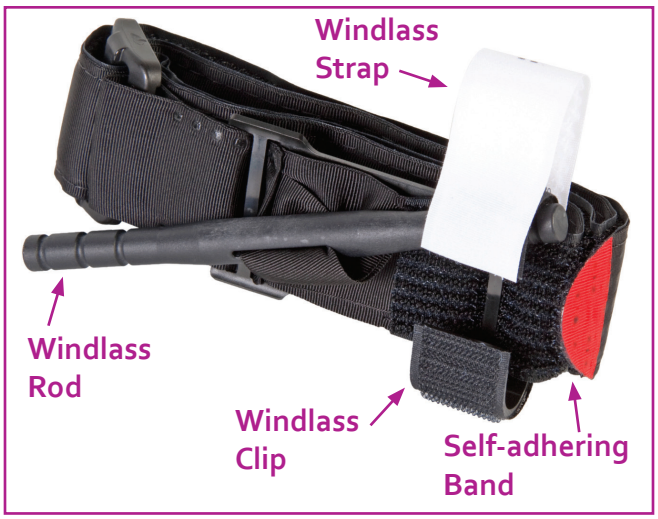
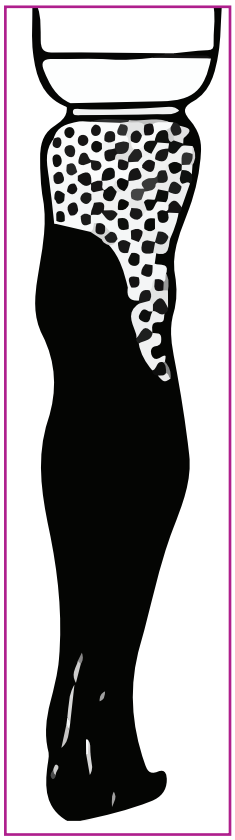


Figure 1: The Combat Application Tourniquet (CAT). A tourniquet that can be self- administered effectively which began to be standard issue. *Image courtesy of Grey Industries.*

Figure 2: The single transverse line indicates the level of the proposed amputation (upper thigh). The double transverse line indicates the level of application of the delimiting tourniquet. The stippled area is that induced by the placement of the tourniquet. The black shaded area is the area of original gangrene and infection. *Image courtesy of Adolph PE.*



Kragh, Baer, and Walters also published a case report on a 16-hour tourniquet application to a forearm on a pilot after combat wounds were sustained. There were no reperfusion breaks though the efficacy of the tourniquet was questioned. The pilot had enough function preserved to return to flying and one of the theorized reasons was the hypothermic conditions experienced after tourniquet application.

Holcomb et al reported that the majority of current war battlefield deaths are non-survivable and due to non-compressible bleeding. They found that current trauma training can cover almost 50% of potentially preventable deaths however they recommended improved intravenous or intracavitary non-compressible hemostatic agents.

Kragh et al also performed a literature review and market survey of current battlefield junctional hemorrhage control and found that the pelvic area is the most common cause of preventable death from bleeding.

Cox et al performed a retrospective cohort review of QuikClot versus HemCon, two new hemostatic agents used for the combat setting. By surgeon report they found a 95% survival directly related to hemostasis. The main indication was reported as pelvic or truncal hemorrhage and QuikClot caused some superficial burns from the exothermic reactions.

Surgical Tourniquet Use

After review of several articles and books on the subject, the summary of complications with tourniquet use are as follows:

Nerve Injury

Transient (50 days avg)
Increased with tourniquet times >120min

Muscle Injury

Transient (2days-3wks)
Histological changes
Both worse at site of compression vs. distal

Clinical Recovery, Pain

Decreased strength, increased pain, swelling, atrophy at 4-12 wks

Resolves with time

Coagulopathy, DVT

Minimal evidence of clinically significant PE, DVT, fibrinolysis

Metabolic Dysfunction

Transient, minor in humans

Cox et al in the Journal of Hand Surgery in 2011 looked at forearm versus upper arm and wrist, finger tourniquets. They recommend padding or stockinette with tourniquet use as well as occlusive draping to prevent chemical burns from the sterilizing solution. They state that squeezing is approximately as effective as using an Esmarch. Also reported was that Doppler occlusion pressures needed actually decreased with higher cuff width and arm circumference.

Pressures 200-230 were adequate based on their calculations and they also looked at the 120 minute "rule" from the often quoted Norwegian study. The 15-20 minute reperfusion downtime was largely due to pH findings in that study.

Recommendations on Surgical Tourniquet Use

Duration

No hard evidence to support "2 hour rule"

Reperfusion Interval = Good Idea if surgery to go over 2.5 hrs

Tourniquet Design

Confusion on width of cuff, no strong recommendations

Inflation Pressure

Most animal studies were well outside of clinical range (> 300 mmHg)

Limb Occlusion Pressure recommendations can be established with Doppler plus a safety margin

200mmHg Upper Extremity, 250mmHg Lower Extremity usually adequate

Limb girth probably the biggest determining factor on adequacy of tourniquet

Summary

Tourniquets save lives in the field. Use them if your patient has bright red bleeding.

Tighten the tourniquet until arterial bleeding stops.

If venous bleeding, try a compressive bandage first.

For surgical tourniquet use 200mmHg for the Upper Extremity and 250mmHg for the Lower Extremity.

Increase the pressure as the limb girth increases.

If surgery is likely to be over 2.5 hours, take a 15-20 minute reperfusion interval.

Dupuytren's Disease: Past, Present, and Future

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Introduction

Dupuytren's Disease is a benign, inherited, fibroproliferative disease of the hand and fingers that leads to the formation of nodules and cords, and can lead to significant contractures of the palmar fascia. While discussed by Dupuytren in the early 19th century, references to the condition have likely been around for over 1500 years. An understanding of the anatomy of the palmar fascia is critical to an understanding of the disease, where normal fascia becomes abnormal Treatment options have changed little since the time of Dupuytren, though a deeper understanding of the pathophysiology may lead to effective, non-surgical treatments in the future. The history, epidemiology, clinical presentation, pathophysiology, anatomy, and treatments of Dupuytren's Disease are reviewed herein.

History

The hand of benediction, or "manus apostolicus," is a hand with flexed ring and small fingers and extended long and index fingers. The earliest known portrayal of this position is in a mosaic at the Basilica of Sant'Apollinare Nuovo in Ravenna, Italy dated to c500 A.D.[1] A drawing by Albrecht Dürer around 1508 A.D. called the "Study of the Hands of an Apostle" depicts praying hands where the right small finger is slightly flexed, unable to press flat against the left hand. Perhaps an early Pope was afflicted by Dupuytren's disease. There are also Icelandic sagas, thought to originate in the 12th and 13th centuries, telling of "miracle cures" of contracted hands by priests in Iceland + Orkney. Additionally, the "Curse of the MacCrimmons" is a Scottish legend of a family of bagpipers in the 15th to 18th centuries that was apparently "cursed" by the development of finger contractures in their later years that prohibited them from continuing to play the bagpipes.[1-5]

The first written description of anything resembling what is now called Dupuytren's Disease is credited to Felix Plater in 1614 when he described a mason whose "tendons" of the ring and little fingers "ceased to function." In 1777, Henry Cline (1750-1827) performed the first known dissection of an affected hand, thereafter proposing palmar fasciotomy as a cure for the affliction. One of Cline's students, Astley Cooper (1768-1841), who himself became one of the great surgical teachers in Europe, actually theorized in 1822, years before Dupuytren, that chronic inflammation of the palmar fascia could lead to contractures, and that the aponeurosis "may with advantage be divided by a pointed bistory." Despite Cooper's contributions, it was a lecture by Guillaume Dupuytren (1777-1835) that later gave the condition its eponym.

Dupuytren was an incredibly hard working individual who truly went from poverty to nobility, being made a Baron by King Louis XVIII. He held many positions at the famous Hôtel-Dieu in Paris, France and made numerous contributions to Medicine; at least 20 eponyms carry his name.[7] While respected for his work, he was not universally liked; his contemporaries considered him "The greatest of surgeons and the least of men" and "The Brigand (not Baron) of Hôtel-Dieu." Dupuytren hated to write; his teachings were given in lectures and written down by his students. It was a now famous lecture given in 1833 that really changed the future. In his "Clinical Lectures on Surgery," Dupuytren attributed the contracture to the palmar aponeurosis and stressed the normality of the joints involved. In addition to describing the anatomy, he described the clinical presentation, natural history, and surgical treatment of the condition (fasciotomy), as well as the post-operative course. Given this and his academic stature, the condition became known as "Dupuytren's Disease." [7]

Epidemiology

The distribution of Dupuytren's Disease is often attributed to the expansion of the Vikings. Upwards of 70% of people of Northern European decent have Dupuytren's Disease though the penetrance is variable. The prevalence remains the highest in Scandinavians and Scottish and it is very rare in Hispanics, Black Africans, and Native Americans.[3] There is a ~3-6% prevalence among whites world-wide. The male:female ratio is about 9:1 and the prevalence increases

with age; the peak incidence in males is 40-59 years and the peak in females is 50-69 years.

Many conditions (e.g. alcoholism, cigarette smoking, diabetes mellitus (type II + type I), hyperlipidemia (cholesterol and triglycerides), HIV, pulmonary TB, epilepsy, RSD/CPRS/Sudeck's Atrophy) have been associated with Dupuytren's Disease though a cause-and-effect relationship remains undetermined.[9] Since originally described by Cooper and Dupuytren, manual work and injury have been thought to be related to the development of Dupuytren's Disease, however recent studies have failed to show any significant correlation with any particular occupation. Because Dupuytren's Disease is more common with age, other conditions that also increase with age and have been thought to be associated with Dupuytren's Disease are likely more coincidental than causative. There is however a clear hereditary component as ~70% of patients have a family history of Dupuytren's Disease. While autosomal dominant and autosomal recessive patterns have been considered, a non-Mendelian inheritance, much like cardiovascular disease, is most likely. As genetic predisposition appears more important for the occurrence of Dupuytren's Disease than other medical or social comorbidities, it is rarely seen at the University of New Mexico.

Clearly, certain individuals are more prone to developing Dupuytren's disease than others. In 1963, Hueston presented criteria or "diathesis factors" for Dupuytren's disease, believing that the presence of these factors correlated with the predisposition to develop Dupuytren's Disease. His criteria included: early onset (<40 years old); bilateral involvement; positive family history; and the presence of ectopic lesions (i.e not of the palmar fascia). If a patient had none of these criteria, there was only a 17% chance of disease recurrence or extension, while if all 4 criteria were present, there was a 78% chance of recurrence or extension.[4] These original criteria were later modified such that early onset was considered <50 years old, 'ectopic lesions' were restricted to only Garrod's nodes (nodules on the dorsum of the finger proximal interphalangeal joints), and male gender was added. Many of these "diathesis factors" have been linked to genetic markers (e.g SNPs) correlated with Dupuytren's Disease.[10]

Clinical Presentation

Patients typically present in their adult years with finger joint contractures. The first manifestations of the disease are actually skin changes such as skin pitting and nodule formation though patients rarely present at this early stage. Cord formation is also classic for Dupuytren's disease. Typically, cords are present most commonly in line with the ring finger, followed by the small finger, long finger, index finger, and thumb (in decreasing prevalence). In diabetics, long finger and ring finger cords are more common than small finger cords; females may also have a more radial presentation and may have isolated web-space or PIP involvement.[8] As cords contracts, joint contractures occur. Metacarpophalangeal (MCP) joint and proximal interphalangeal (PIP) joint contractures are most common, though distal interphalangeal joint contractures also occur. The Hueston table top test is used to evaluate for contractures; a positive test it one in which an individual cannot place his/her hand flat on a flat surface (table top) due to joint contractures. Patients may complain of difficulties placing their hands in their pockets or shaking hands because of the contractures. They may also note the presence of lesions or contractures elsewhere, such as the feet or genitals.[6]

The differential diagnosis of Dupuytren's disease is extensive; anything that can cause a digital contracture should be considered. The differential includes, but is not limited to: Trigger finger (stenosing tenosynovitis); Flexor tendon adhesions; callus; camptodactyly; neoplasm (e.g fibrosarcoma, epitheliod sarcoma, ganglion, soft-tissue giant cell tumor); burn contracture; boutonniere deformity (e.g from central slip injury or rheumatoid arthritis); post-traumatic deformity (e.g. fracture malunion, osteoarthritis, stiffness); and ulnar or median neuropathy.[5] There is also an entity known as "Non-Dupuytren's" contracture. Non-Dupuytren's contracture is a non-progressive palmar fascial proliferation associated with trauma, previous surgery, or edema. Unlike in Dupuytren's Disease, Non-Dupuytren's contractures affect an ethnically diverse population, are typically unilateral without ectopic manifestations, and may actually regress.[11]

Pathophysiology

While much has been learned about the pathophysiology of Dupuytren's Disease, much remains to be elucidated; the exact pathogenesis remains elusive. The myofibroblast has been shown to be the offending cell. This cell derives from the normal fibroblasts of the palmar fascia under influence of numerous cytokines (e.g. IL-1, TGF-β, et al.); their activity is controlled both by mechanical forces as well as autocrine/juxtracrine mechanisms. Known contraction agonists include lysophosphatidic acid (LPA), Prostaglandins (especially $PGF_{2\alpha}$), and TGF-β. γ-Interferon has antagonistic affect in vitro. There is also an apparent immunologic component as there are increased dermal dendrocytes and inflammatory cells found in Dupuytren's cords, and there is an association with HLA-DR3. Molecular analysis has also shown that there are increased androgen receptors and increased collagen type III in Dupuytren's

fascia. Perhaps one of these findings will lead to a future treatment and possible cure.

Anatomy

As Flatt wrote in 2001, "the development of Dupuytren's disease is always along anatomically identifiable connective tissue structures." [4] As such, knowledge of normal palmar fascia is crucial to an understanding of Dupuytren's disease. The palmar fascia is composed of three main aponeuroses: the radial aponeurosis, the ulnar aponeurosis, and the central aponeurosis. A majority of the pathology is seen in the central aponeurosis. This aponeurosis has three main types of fibers: longitudinal; transverse; and vertical. The longitudinal fibers are the pretendinous bands. The transverse fibers include the natatory ligament (also known as the superficial transverse metacarpal ligament) which is contiguous with the distal commissural ligament of the radial aponeurosis, and the transverse ligament of the palmar aponeurosis (also known as Skoog's ligament) which is contiguous with the proximal commissural ligament of the radial aponeurosis. The vertical fibers are the vertical bands of Grapow and the septae of Legueu and Juvara (SLJ). The SLJ divide the distal palm into seven compartments (four for the flexor tendons and three for the lumbricals and neurovascular bundles) and insert into soft tissue confluences at the MCP joints.

The fingers also have elaborate fascial structures with many, often variable, attachments. At the bases, there is a web-space coalescence consisting of the spiral band, the natatory ligament and the SLJ. The Gosset lateral digital sheath (GLDS) has contributions from the natatory ligament (superficial) and the spiral band (deep). There is also intermittent fascial encasement of the digital neurovascular bundles with Grayson's ligament palmar, Cleland's ligament dorsal, GLDS lateral, and Thomine retrovascular fascia medially.

Almost any of these normal fascial structures can become pathologic in Dupuytren's Disease. The vertical bands of Grapow are involved in skin pitting and nodule formation. The most common cords are: pretendinous cords; central cords; spiral cords; natatory cords; Abductor digiti minimi cords ("hypothenar cords"); lateral cords; retrovascular cords; commissural "Y" cords; and radial thumb cords. These cords can cause flexion contractions of the MCP joints and interphalangeal joints; occasionally there will be an extension contracture of the distal interphalangeal joint due to involvement of the oblique retinacular ligament. Also of note, Cleland's ligament and Skoog's ligament are typically spared in Dupuytren's Disease. The spiral cord, lateral cord, digital cord, and hypothenar cord may displace the neurovascular bundles.

Treatments

In 1977, Hueston wrote of a treatment philosophy that still holds true today: "Plan to do nothing for as long as possible, and then do the minimum necessary to restore maximum function." [1] As such, non-operative treatment plays an important role. Observation is the mainstay of non-operative management. Radiation, ultrasound, Vitamin E, and various medications have been tried though largely abandoned due to their ineffectiveness. Occupational therapy and splinting is still utilized. A variety of intra-lesional injections are also options. For early lesions, the goal has been to modulate the myofibroblasts. While many different injections have been tried (e.g calcium channel blockers, azathiorinem prostaglandins, DMSO, et al.), only γ-Interferon and corticosteroids injections have shown beneficial effect. For advanced lesions, the goal has been to dissolve the cord. Again, while many injections have been tried (e.g. fibrinolysin, pepsin, trypsin, hyaluronidase, et al.), Clostridial Collagenase (Xiaflex®) has risen to the contemporary mainstream, primarily for isolated pretendinous cords affecting only the MCP joint.

When non-operative treatment has failed, and the contractures are considerably affecting a patient's function or quality of life, surgery in considered. There are no universally agreed upon criteria for surgery, though >30° flexion contracture at the MCP and >15° flexion contracture at the PIP are frequently used indications. The goal of surgical treatment is to control the disease, not to cure it; a cure is likely only possible if the pathophysiology is addressed. From a surgical standpoint, there is an assortment of options spanning a range of aggressiveness. On the least aggressive end of the spectrum is percutaneous needle fasciotomy/aponeurotomy. Much like Dupuytren himself detailed in the early 1830s, a variety of fasciotomy techniques exist as well, including open and percutaneous, single and segmental. The most common surgical technique is a limited or regional fasciectomy. The most aggressive surgical options include radical fasciectomy (McIndoe procedure), dermatofasciectomy + skin grafting, fusions, and amputations. With any procedure, additional variables may be included such as the use of chemical adjuncts and/or the addition of a PIP capsuloligamentous release. The type of skin closure is also debated; primary closure with or without local tissue rearrangement is most common, though an open-palm technique and the use of free tissue grafting also have their proponents. Despite numerous studies, no technique has established itself as the most effective, safest, or most reproducible.

No discussion of treatments is complete without discussing complications. The primary complications of non-operative treatment relate to the natural history of the

disease and the predisposition of the patient. With injections, skin necrosis, fat necrosis, and flexor tendon ruptures are possible. With surgery, rate and types of complications vary substantially. Complications include: hematoma; skin necrosis; skin tears; tendon rupture; digital nerve or artery injury; infection; stiffness; and complex regional pain syndrome (especially with concomitant carpal tunnel release). And naturally, disease recurrence or extension is common, ranging from a 20-80% risk for all interventions.

Conclusion

Dupuytren's Disease is a benign, inherited, fibroproliferative disease of the palmar and digital fascias of the hand. In Dupuytren's disease, as normal becomes abnormal, a deep understanding of anatomy is critical. Progression and extension of the disease is related to individual predisposition. There is a plethora of treatment options, ranging in aggressiveness, though no treatment has proven superior. Perhaps, in the future, with a greater understanding of the disease pathophysiology, a non-operative treatment will offer a cure. Currently, the goal of treatment is not to cure but to restore as much function as possible while avoiding complications.

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Orthopedics as It Relates to Pregnancy and the Parturient

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Introduction

Pregnancy has diverse effects on the musculoskeletal system, and the effects of orthopedic surgery or trauma on pregnancy merit consideration as well. This article will summarize a variety of conditions in which orthopedics and pregnancy collide.

Conditions

Low Back Pain (LBP)

This occurs in 72% of pregnant women, and is defined as pain in the lumbar region of the spine, above the sacrum. The enlarging uterus causes an anterior shift in the center of gravity, which means the fulcrum of the pelvis is further away from the spine, causing strain on the lumbar spine. LBP is treated with acetaminophen and exercise, especially aquatic exercise.

Pregnancy Related Posterior Pelvic Pain (PRPPP)

This occurs in 20% of pregnant women, and is defined as pain in the sacroiliac joints of the pelvis and in the buttocks with or without radiation down the posterior thigh to the knee. Pain occurs with weight bearing, and can also be elicited with the posterior pelvic pain provocation test (PPPPT). To perform the PPPT, the pregnant patient lies supine with one lower extremity extended and the other flexed to 90 degrees at the hip and knee. The examiner exerts a force from anterior to posterior along the femur of the flexed lower extremity, which should elicit pain in the sacroiliac joints similar to what the patient experiences with weight bearing. PRPPP results more from asymmetry of SI joint laxity, not simply the degree of laxity. Serum levels of relaxin were thought to be associated with joint laxity, but this has become more controversial lately as more recent evidence implies that levels of relaxin are not related to joint laxity. Relaxin seems to have more hemodynamic effects such as increased cardiac output and renal blood flow, as well as increased arterial compliance. Occurrence of PRPPP in one pregnancy is predictive of future postpartum posterior pelvic pain. It is treated with a nonelastic sacroiliac or pelvic belt, which is applied properly if it covers the greater trochanters.

Lumbar Disk Herniation

Herniation of a lumbar disk occurs in 1/10,000 pregnant women. Risk increases with increasing maternal age, not necessarily the state of being pregnant. Average age of the mother was 33 years in a case series of 6 patients reported in 1995. There has been one case report of cauda equina syndrome from a disk herniation in a pregnant woman. Symptoms include acute onset of radicular pain and numbness in the lower extremity, positive straight leg raise test, leg pain greater than back pain, and hypoactive reflexes. Treatment is conservative if neurologic symptoms remain constant. If muscle relaxers are required, cyclobenzaprine is category B for pregnant women. If neurologic deficits are progressive or severe, an MRI is indicated to plan for surgery. In Spine in 2001, a case report of 3 pregnant patients with herniated disks who underwent surgery was reported. The patients positioned themselves on the operating table (such as an OSI table) in order to ensure that their abdomens were hanging free and that there was no pressure on the fetus. Two of the patients had L5-S1 disk herniations with lower extremity radiculopathy and had a neurologic exam that was back to baseline at 1 year postoperatively. The other patient had cauda equina syndrome and still had diminished sacral sensation at 1 year postoperatively. In Archives of Physical Medicine and Rehabilitation, 5 patients with disk herniations were treated nonoperatively until they delivered, and then they were treated with laminectomy and diskectomy. Two of the five patients had a permanent residual foot drop. The article didn't specify the trimester of disk herniation onset in relation to the patients who had a permanent neurologic deficit.

Scoliosis

Idiopathic scoliosis is present in 2% of the population. Incidence is 3% for curves measuring 10-20 degrees, and 0.3% for curves greater than 30 degrees in magnitude. Scoliosis involves a lateral curve of the spine in the coronal plane, as well as a rotational abnormality in the axial plane. 30% of people with scoliosis will have a family history positive for scoliosis.

An article in JBJS in 1987 discusses scoliosis as it relates to pregnancy. Group A consisted of 175 patients who became pregnant one or more times, and Group B consisted of 180 patients who never became pregnant. Both Group A and Group B patients were treated nonoperatively, either with observation or bracing. Both groups sustained an average 2.2 degree progression in their curves, and 2/3 of patients in both groups had curves that did not progress over time. The braced Group B patients had a decreased risk of >10 degree progression (2%) than braced Group A patients (11%). There was no difference in curve progression between Groups A and B with regards to curve pattern. The highest risk of having >10 degree progression of a curve occurred in mothers (Group A) who had their first pregnancy after age 24 years. There was no difference in the amount of curve progression with one pregnancy versus three pregnancies in the Group A patients. More severe curves are at greater risk of progression. For the group of 165 patients who had undergone posterior spinal fusion, there were 63 patients who became pregnant (Group A) and 42 patients who did not become pregnant (Group B). In these nonoperative Group A patients, there was no progression of the curve at any pseudoarthroses and no coronal imbalance after pregnancy. 67% of fused Group A patients developed back pain during pregnancy compared with 77% of the nonoperative Group A patients. Two of the 159 deliveries in the Group A patients (fused and nonoperative) had unsuccessful spinal anesthesia, one in the fused group and one in the nonoperative group. Two of the 79 deliveries for the fused Group A patients were by caesarean section, compared with 10/159 deliveries for the nonoperative Group A patients. None of the caesarean sections were due to scoliosis; rather, they were for common delivery issues such as fetal distress and cephalopelvic disproportion. The rate of caesarean section in this study was 7.4%, which as less than half the national average at the time of 16%.

Scoliosis also has bearing on the effectiveness of neuraxial anesthetic, or epidural analgesia. Because of the rotational component of scoliosis, the spinous process projects towards the concavity of the curve while the epidural space deviates to the convexity of the curve. Consequently, when starting below the spinous process, anesthesia providers must angle the needle approximately 35 degrees towards the convexity of the curve in order to enter the epidural space. The interlaminar space is wider on the convexity of the curve as well. 80% of nonoperatively treated scoliosis patients in a 2009 review article had successful spinal anesthetic; failure was due to failed placement, multiple attempts, patchy pain relief, asymmetric pain relief, and unilateral blockade. In patients who had undergone posterior spinal fusion, 69% had a successful spinal anesthetic. Reasons for failure were similar for the nonoperative patients, except there was a 4% incidence of dural puncture in the operative group. The lower success rate in the fused patients was attributed to scar tissue and bone graft hindering entrance of the needle, as well as postoperative adhesions and obliteration of the epidural space. However, the article noted that anesthesia providers incorrectly identify the lumbar interspaces by palpation 71% of the time. Some strategies to overcome unilateral blockade include positioning the patient in the lateral decubitus position with the less affected side dependent, or using a high volume low concentration solution. As an alternative to standard spinal anesthetic placement in the lumbar region, a caudal block could be used.

Carpal Tunnel Syndrome

CTS is a compression or entrapment mononeuropathy of the median nerve at the wrist. Its true incidence in pregnancy is unknown. It is a clinical diagnosis in 31-62% of pregnant patients, and an electrodiagnostic diagnosis in 7-43%. In nonpregnant women, the incidence ranges 0.7-9.2%. It is second only to low back pain as a musculoskeletal complaint in pregnancy. It can be related to the generalized edema of pregnancy, as pregnant women tend to have fluid retention, increased blood volume by 30-50%, and progesterone-induced hyperemia. It can also be associated with altered glucose metabolism, as it is in diabetes, because of the increased metabolic needs of the mother and fetus. There is a higher risk of CTS in patients with gestational hypertension and preeclampsia, and in patients with enough hand swelling to prevent wearing of rings. It usually occurs starting in the third trimester, but earlier onset can have a more rapid course. Compared to age-matched female controls, pregnant women have a shorter duration of symptoms, are more likely to have bilateral symptoms, exhibit lower severity of nerve compression on electrodiagnostic studies, and have 3-4 times higher change of improvement. Diagnosis is by physical exam, and electrodiagnostic studies are obtained if surgery is being considered. Night splints provide relief in 82%. Corticosteroid injections may be tried, though they've not been studied in pregnant patients, as steroids aid in surfactant production in premature babies. Resolution of CTS symptoms is variable in the literature, but about 85% of patients experience resolution of symptoms within 2-4

weeks of delivery. Up to 50% of the remaining 15% have residual symptoms 3 years postpartum.

Femoral Head Osteonecrosis of Pregnancy

This was first described in 1957. It is rare in pregnancy without coexistent risk factors such as corticosteroids, trauma/dislocation, or alcohol. There are only about 40 case reports of femoral head osteonecrosis in pregnancy. The femoral head can be thought of as an "end-organ system" with regards to perfusion, and is in a confined space. It then sustains a temporary or permanent loss of blood supply, resulting in necrosis. Multiple factors in pregnancy have been proposed: higher levels of estrogen and progesterone can lead to fat embolism, there is an increasing amount of unbound plasma cortisol in the third trimester, pregnancy is a hypercoagulable state, there is some venous congestion in pregnancy, and there is mechanical stress from the weight gain during pregnancy. Osteonecrosis of the femoral head in pregnancy occurs in the late second trimester or third trimester. Groin or buttock pain is worse with weight bearing and walking, though not completely relieved by rest. Patients will have an antalgic or Trendelenburg gait, and some limited internal rotation at the hip. Radiographs are not helpful in the early stages of the disease, but MRI has 99% sensitivity and specificity. MRI can also differentiate femoral head osteonecrosis from transient osteoporosis of the femoral head. Treatment is surgical. In a metaanalysis of 819 nonpregnant patients with early stage osteonecrosis of the femoral head, observation with limited weight bearing led to treatment failure with femoral head collapse by 3 years in 80% of those patients. There was a case report in 1988 of 2 pregnant patients who developed osteonecrosis of the femoral head 4 weeks before delivery, treated with hip joint aspiration and limited weight bearing, with resolution of symptoms in 2 months and normal radiographs after several months. This would contribute to the theory of increased pressure causing osteonecrosis. Bisphosphonates have been proposed to prevent collapse of the femoral head after osteonecrosis, but are not FDA approved for necrosis of the femoral head in pregnancy and they are category C for pregnant patients. Surgical options are the same as for nonpregnant patients, and are typically delayed until after delivery.

Transient Osteoporosis of the Hip in Pregnancy

TOH of pregnancy was first reported in 1959. It is more common than femoral head osteonecrosis of pregnancy, with 500 case reports. TOH also affects men aged 40-60 years. Etiology is uncertain. It is a localized phenomenon, so metabolic, hematologic, and systemic causes are unlikely. It is possible that the fetus impinges on local nerves or blood vessels, as suggested by a case report from Japan, where the condition resolved within 3 weeks of terminating a pregnancy in one patient. Parathyroid hormone does mobilize calcium from bone, and was previously thought to be high in pregnant women, but the radioimmunoassays used in those studies measured multiple fragments of PTH, many of which are inactive. Parathyroid hormone levels are actually low to normal in all trimesters. TOH presents in third trimester, and the fetus acquires 80% of its calcium during that time. TOH is usually unilateral. Patients have pain with weight bearing, walking, and extremes in range of motion. In the early stages, radiographs are normal, and MRI is recommended. Ultrasound would only show hip effusion, a bone density scan involves radiation, and labs such as Vitamin D and alkaline phosphatase are not helpful. Labs could be used to rule out infection. MRI will show diminished signal on T1 sequences over a diffuse area (as opposed to a focal lesion for osteonecrosis) and high intensity signal on T2 sequences (as opposed to moderately increased signal only in the subchondral region for osteonecrosis). Bisphosphonates may be used for treatment postpartum, but TOH tends to resolve within 2-4 months postpartum anyway. Protected weight bearing is advised, and surgery may become necessary if osteoporotic fracture occurs. Multiple case reviews of TOH in pregnancy describe subcapital femoral neck fractures.

Pregnancy Outcomes after Pelvic Ring Injury

An article out of Journal of Orthopaedic Trauma in 2012 described delivery outcomes for 31 women who became pregnant one or more times after pelvic ring injury. 55% were treated surgically for their injuries. 16 patients had spontaneous vaginal deliveries, 3 of which had retained transsymphyseal plating. 13 patients underwent caesarean section, 46% of which had retained implants. 2 of the 13 patients had a pre-injury caesarean section, 4 patients experienced preeclampsia, breech, or arrest of labor, 3 patients elected caesarean section, and 4 were advised by their obstetric physician to have a caesarean section. In total, the rate of caesarean section was 44% post-injury, and over half of these were due to patient or physician preference. 1 of the 4 patients advised to have a caesarean section by her OB had 1.8cm of narrowing of the pelvic ring due to a lateral compression injury, but 3 of the patients who had an SVD had pelvic ring narrowing of 1.2-2.2cm.

Pregnancy Outcomes after Orthopedic Trauma: In The Journal of Trauma: Injury, Infection, and Critical Care in 2010, a retrospective review of pregnant patients presenting to a Level 1 trauma center over 12 years was analyzed. They compared patients with orthopedic injuries (65 patients) to patients with nonorthopedic injuries (990 patients). Motor vehicle collisions and falls were 80% of the mechanisms

of injury in both groups. Orthopedic injuries included fractures, complex hand injuries such as tendon lacerations, and soft tissue injuries extending down to bone. Patients with orthopedic injuries were more likely to have an injury severity score of greater than or equal to 17 (12%) compared to patients with nonorthopedic injuries (0%). 34% of patients with orthopedic injuries delivered at the time of trauma admission, compared to 13% of patients with nonorthopedic injuries. 31% of patients with orthopedic injuries delivered at less than 37 weeks gestation, compared to 3% of patients with nonorthopedic injuries. Multiple orthopedic injuries resulted in 50% of patients having a preterm delivery, whereas a single orthopedic injury resulted in 25% of patients having a preterm delivery. Adverse pregnancy outcomes were similar for patients with operative and nonoperative orthopedic injuries. The number of surgical procedures for orthopedic injuries did not affect pregnancy outcomes. Pelvic fractures were associated with fetal death in 30%, and placental abruption in 30%. In summary, if a patient sustains trauma with enough energy to impart an orthopedic injury, she is at much higher risk of having adverse outcomes for her pregnancy compared to a patient with nonorthopedic injuries.

Consequently, pregnant women require much closer attention after injury. Pregnant women have a dilutional anemia at baseline, with an increase in plasma volume by 50% and a lesser increase in amount of red blood cells. With 30% blood volume loss, the mother's mean arterial pressure can remain unchanged, but the blood flow to the placenta is already decreased 10-20%. Fetal monitoring is required at more than 20 weeks gestation as fetal distress may be the first indicator of maternal hemodynamic compromise. If the mother is stable, ultrasound can be used to evaluate fetal motion, fetal heart rate, and placental integrity. Avoid placing the mother supine, as this can cause hypotension due to compression of the great vessels; 15 degrees of left lateral decubitus is enough. If radiographs are required, the maximum radiation dose allowed is 5 rads. For example, an AP pelvis is 0.040 rads but a CT of the abdomen is 2.6 rads. The fetal central nervous system is relatively radioresistant after 25 weeks. If surgery is required for orthopedic injuries, open plating techniques are recommended versus more percutaneous techniques that utilize more fluoroscopy. Local anesthetics are not teratogenic, but general anesthetics have the potential to increase the risks of spontaneous abortion, low birth weight, and premature delivery. Additionally, pregnant women are more hypercoagulable than nonpregnant patients, so lovenox is recommended if they are immobilized.

Pubic Symphysis Diastasis

This occurs in 1/2,000 to 1/30,000 pregnant patients during delivery. As opposed to high energy trauma, the force (baby's head) is applied from posterior to the symphysis. 40% of pelvic stability comes from the symphysis, where a tensile force is applied with weight bearing. Diastasis can occur due to multiparity, fetal macrosomia, precipitous labor, cephalopelvic disproportion, and hyperabduction of the hips during delivery. When it occurs, there is often a palpable or audible crack; subsequently, the patient has pain with weight bearing and lifting, and sometimes bladder dysfunction. Diastasis >2.5cm implies that the anterior sacroiliac ligaments have been damaged. Diastasis <4cm can be treated with a binder and bedrest. Surgery is required with diastasis more than 4cm, typically an external fixator acutely with possible internal fixation later.

Pelvic Dislocation

The incidence of pelvic dislocation is limited to case reports. It is defined by pubic symphysis diastasis >6cm combined with sacroiliac joint disruption. Pelvic dislocation can result in sacral fractures, lumbosacral plexus injury, and even death. In the Journal of Trauma in 1997, a case series of 4 patients was reported. Pelvic dislocation was diagnosed in the peripartum period in 3 patients and at 25 months postpartum in the 4th patient. All patients were in the lithotomy position with epidural analgesia. The average weight of the babies was 8.8 pounds. ¾ had hyperabduction and flexion of the hips during delivery. For ¾, it was the first attempt at a vaginal delivery. The average pubic symphysis diastasis recorded was 6.4cm. One patient required exploratory laparotomy and transfusion of 10 units of blood. All patients were treated nonoperatively with closed reduction, a binder, and lying in the lateral decubitus position until they were able to walk. One patient had pressure necrosis over her hips from the binder, the patient diagnosed at 25 months had a permanent lumbar neuropraxia, and the patient who underwent exploratory laparotomy had a unilateral femoral neuropraxia. All patients had permanent residual sacroiliac joint discomfort with sclerosis on radiographs, plus a residual pubic symphysis diastasis of 1.7cm. Again, surgery is typically indicated for diastasis >4cm.

Coccyx Fracture

There are case reports of coccyx fracture sustained during delivery. It most often occurs with delivery on a hard surface, which limits the normal 2.5cm posterior excursion of the coccyx that occurs with delivery in order to increase the anterior to posterior diameter of the birth canal. The patient

will note pain and crepitus with sitting, pain with bowel movements, pain with hip extension, and tension myalgias of the pelvic floor. Diagnosis is typically by palpation, as lateral radiographs of the sacrum can be difficult to interpret and an MRI would not change the treatment plan. Treatment is with analgesics and having the patient sit on a doughnut-shaped cushion. It is important to distinguish a coccyx fracture from sacroiliac joint injury, as SI joint injury can cause pain to be referred to the pelvic floor.

Sacral Stress Fracture

There are 11 case reports of postpartum sacral stress fracture. It is unclear whether it is a stress fracture due to fatigue, where normal bone fractures under abnormal stress, or whether the stress fracture is due to osteoporosis, which can be associated with pregnancy. Risk factors include excessive load caused by the weight gain and lumbar hyperlordosis, jogging before or soon after delivery, vaginal delivery of a large infant, and precipitous delivery. Patients can experience radicular pain with these sacral stress fractures. The FABER (hip flexion, abduction, external rotation) test can be positive, and patients will have a negative straight leg raise test with no neurologic deficits, hopefully differentiating the radicular pain from a herniated disk. Radiographs are difficult to interpret due to overlying bowel, so a CT scan performed postpartum is advised for diagnosis. MRI is an alternative to CT scan, the gold standard. Treatment is with protected weight bearing until symptoms resolve.

Compartment Syndrome of the Leg

Reports are rare in the obstetric literature, and most instances of this are actually described in the urology literature. Incidence is 1/3,500 for procedures in the lithotomy position. Multiple factors relating to the lithotomy position can predispose to developing compartment syndrome of the leg: there is decreased hydrostatic perfusion pressure of the leg, there is a reduced arteriovenous gradient, hip and knee flexion impedes arterial flow and venous return, the weight of the limb in the stirrups, and forced dorsiflexion of the foot. Additionally, patients can become hypotensive, are sometimes administered vasoconstricting drugs, and can sustain a reperfusion injury after release from the lithotomy position. Compartment syndrome is a clinical diagnosis established by the patient's pain: pain out of proportion, pain not responsive to pain medications, and pain with passive stretch. Additionally, the examiner can often palpate tense, swollen compartments. If the patient is obtunded, measure the pressures in the compartments. Treatment is fasciotomies of all compartments of the leg. There was a case report in Orthopedics in 2007 regarding a patient who developed anterior compartment syndrome after "difficult labor" in the lithotomy position for only 45 minutes.

Pregnancy and Childbirth after Total Hip Arthroplasty

More than 5000 total hip arthroplasties are performed in women less than age 45 years every year. Reasons for this include developmental hip dysplasia, osteonecrosis of the femoral head such as Legg Calve Perthes, juvenile inflammatory arthritis, and trauma such as hip dislocation. In an article in JBJS in 2005, the Mayo clinic analyzed 47 women ages 18-45 years old who underwent total hip arthroplasty prior to pregnancy and delivery. During pregnancy, 60% of the patients had pain in the replaced hip, but 57% of those patients actually had pain in both hips. 36% of the patients had a caesarean section: 2 patients because of OB preference, 1 patient because of the Orthopedist's preference, 1 patient due to fetal breech positioning, 3 patients due to hypertension or preeclampsia, 7 patients due to delay or arrest of labor, and 3 patients for unknown reasons. 64% of the 47 patients had spontaneous vaginal deliveries. There was no difference in rate of SVD versus caesarean between patients with unilateral or bilateral hip arthroplasties. There were no instances of prosthesis dislocation, loosening, or fracture during SVD. With persistent groin pain after delivery, the orthopedist should evaluate for acetabular loosening. 5 of 7 patients with persistent groin pain postpartum were revised 5 years later; 3 patients had a loose acetabular component, 1 patient had only fibrous ingrowth onto the acetabular cup, and 1 patient had a loose acetabular component with catastrophic polyethylene wear and osteolysis. Age at the time of total hip arthroplasty, not the occurrence of childbirth, is the most important risk factor for requiring revision of the arthroplasty. However, there was a 1.7 times higher risk for requiring arthroplasty revision after childbirth.

Pelvic Osteotomy and Childbirth

10/1,000 children are born with hip dysplasia; 1/1,000 have a dislocated hip. Hip dysplasia is more common in females (80% of babies with developmental hip dysplasia). In some instances, this disorder requires corrective pelvic osteotomy. Pelvic osteotomy can alter the dimensions of the bony pelvis. The most important pelvic diameter is the "midpelvis" measurement; on the lateral, this is measured from the inferior aspect of the pubic symphysis to the sacrum. On an AP view of the pelvis, the midpelvis dimension is measured from ischial spine to ischial spine. Ideally, the patient has a minimum midpelvis measurement of 9.5cm, as the average biparietal diameter of the fetus is 9.3cm. The mothers will have lower midpelvis dimensions if they were older at the time of pelvic osteotomy, due to the

decreased time for remodeling. Patients should be offered a trial of labor with spontaneous vaginal delivery, but they need to discuss their history of pelvic osteotomy with their obstetrician.

Hip Arthrodesis

There is one article in the orthopedic literature regarding hip fusion and its effect on conception and childbirth. 5 patients had previous hip arthrodesis; they all described difficulty with abducting the hips during intercourse. 2 of the 5 patients conceived, and both of these patients had 2 spontaneous vaginal deliveries each without complication.

Achilles Tendinopathy

The Achilles reflex is typically delayed in the same patients when they are pregnant compared to when they are nonpregnant; this may be related to altered thyroid activity during pregnancy. There is a case report of Achilles tendinopathy improving during pregnancy in one patient, likely due to immune or hormonal factors. The higher levels of cortisol in pregnancy are immunosuppressive. Estrogen and progesterone can shift the immune system towards production of anti-inflammatory cytokines such as interleukins 4 and 10. Human chorionic gonadotropin is also anti-inflammatory and immunosuppressive.

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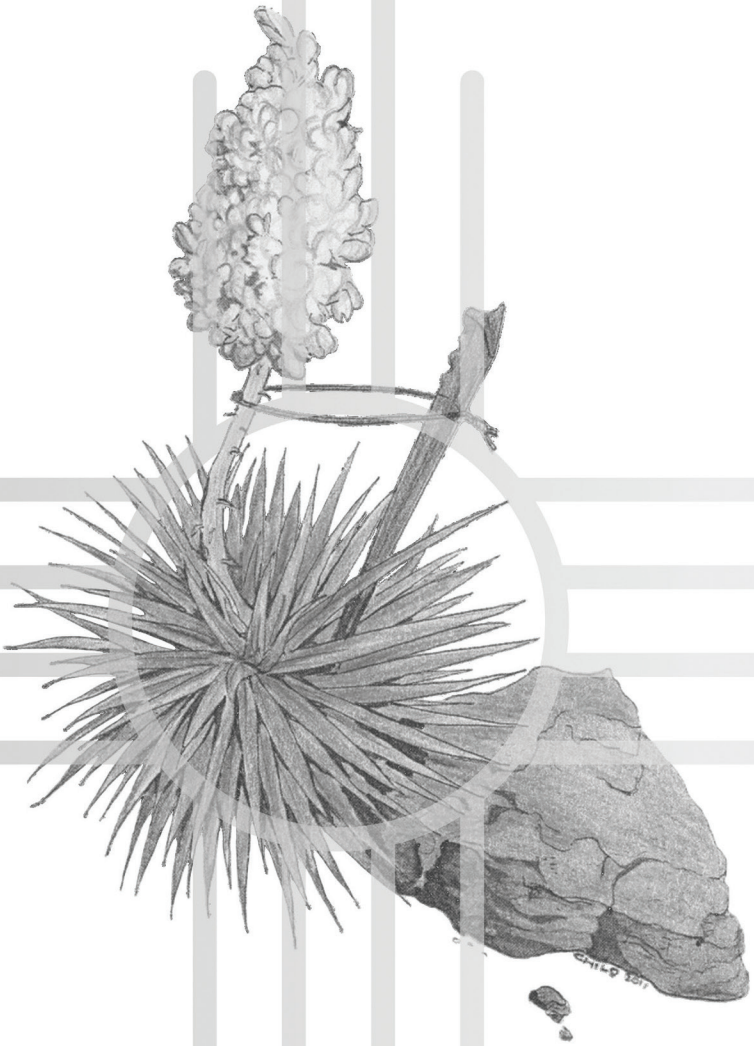

Even Incomplete Bisphosphonate-Induced Femoral Shaft Fractures Are Best Treated with Nailing

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Review of: *Egol KA, Park JH, Prensky C, Rosenberg Z, Peck V, and Tejwani NC. Surgical treatment improves clinical and functional outcomes for patients who sustain incomplete bisphosphonate-related femur fractures.* J Orthop Trauma. *2013;27(6): 331-335.*

Summary

Bisphosphonate therapy has risen as a standard in treatment and prevention of osteoporosis. Through potent inhibition of bone resorption, specifically impedance of osteoclast function and recruitment, bisphosphonates have clinically demonstrated their effectiveness in increasing bone mineral density and reducing the risk of fractures at critical load-bearing regions. Despite their widespread success in osteoporosis management, a new condition of bisphosphonate-related femur shaft fractures has recently emerged, in which initially presenting stress fractures may progress to complete fractures. It is generally recognized that complete atypical fractures are best treated with medullary nailing. However, treatment of incomplete atypical femoral shaft fractures associated with chronic bisphosphonate use is controversial. We are reviewing an important article recently published in the Journal of Orthopedic Trauma regarding the most effective treatment of bisphosphonate induced incomplete femoral stress fractures.

This study by Egol et. al. retrospectively examined the clinical course and outcomes of 31 women who sustained an incomplete femur fracture (43 fractures, 12 bilateral), following bisphosphonate therapy for a mean duration of 9.1 years (range, 5-20). Of this cohort, 13 patients had sustained a complete fracture of the contralateral femur. Eighteen patients (22 fractures) initially underwent non-operative treatment, with 16 individuals ultimately requiring surgery due to refractory pain and progressive radiographic lucency. Overall, 19 patients (21/43 fractures, 49%) were managed surgically, by intramedullary nailing. Clinically, pain resolution was observed in 81% (17/21) of surgically treated fractures compared to 64% (14/22) of non-operatively treated fractures. Radiographically, 100% of fractures (21/21) in the surgical group demonstrated healing at an average of 7.1 months (range, 1.5-12), while only 18% of fractures (4/22) in the nonsurgical group demonstrated union at an average of 11 months (range, 6-24). Additionally, function (Short Musculoskeletal Function Assessment) post intervention was significantly superior in the surgical group in comparison to the nonsurgical group (p=0.0017). The authors recommended intramedullary nailing for incomplete bisphosphonate-related femur fractures as superior to non-operative treatment in reducing pain, healing the stress fracture and optimizing functional outcome.

Discussion

This study offers a timely contribution to the dialogue confronting the optimal treatment approaches to incomplete bisphosphonate-induced atypical femoral fractures. While surgical intervention involving intramedullary nailing has been the preferred clinical route for complete bisphosphonate-related femur fractures, the protocols for incomplete fractures have been less defined and treatment guidelines are needed for this group. Recognizing that prolonged bisphophonate treatment (>5 years) potentially induces compromised bony microarchitecture and recognizing the substantial risk of fracture completion, it is important that orthopaedic surgeons identify and address incomplete femur fractures based on characteristic clinical and radiographic profiles. Most revealing of impending fracture in this series was sharp, localized, prodromal thigh pain aggravated by weight-bearing, consistent with radiographic focal, lateral cortical thickening followed by the development of a linear radiolucency.

Non-operative modalities of this study included discontinuation of bisphosphonates, limited weight-bearing, and individual-based prescription of external bone stimulators and Teriparatide, similar to previously published studies and clinical regimens.[1,2] These modalities have a long history of success in the more common stress fracture attributable to abnormal cyclical load or defined

metabolic bone disease, but the non-operative treatment of bisphosphonate related incomplete stress fractures was not nearly as successful. Intramedullary nailing gave superior results with few new complications. However, not all factors were evaluated in this study including cost. Despite the fact that the patients nailed in this series did well, the literature reports a variety of complications and cautionary tales. In this series, some of the non-operative cases did do well and there was no attempt to determine the factors that predicted successful non-operative treatment. Medullary nailing is not innocuous[3] and not always completely successful as reported in this series (4/21 with residual pain) and the literature.[4] Therefore, it remains prudent practice to assess the risk-to-benefit ratio on an individualized basis when counseling prophylactic surgical treatment of incomplete bisphosphonate-related femur fractures, as surgical care is not necessarily always needed or superior to non-operative treatment. However, we do agree with the authors' recommendation that most incomplete bisphosphonate-related femur shaft fractures are best treated with intramedullary nailing within a few weeks of diagnosis.

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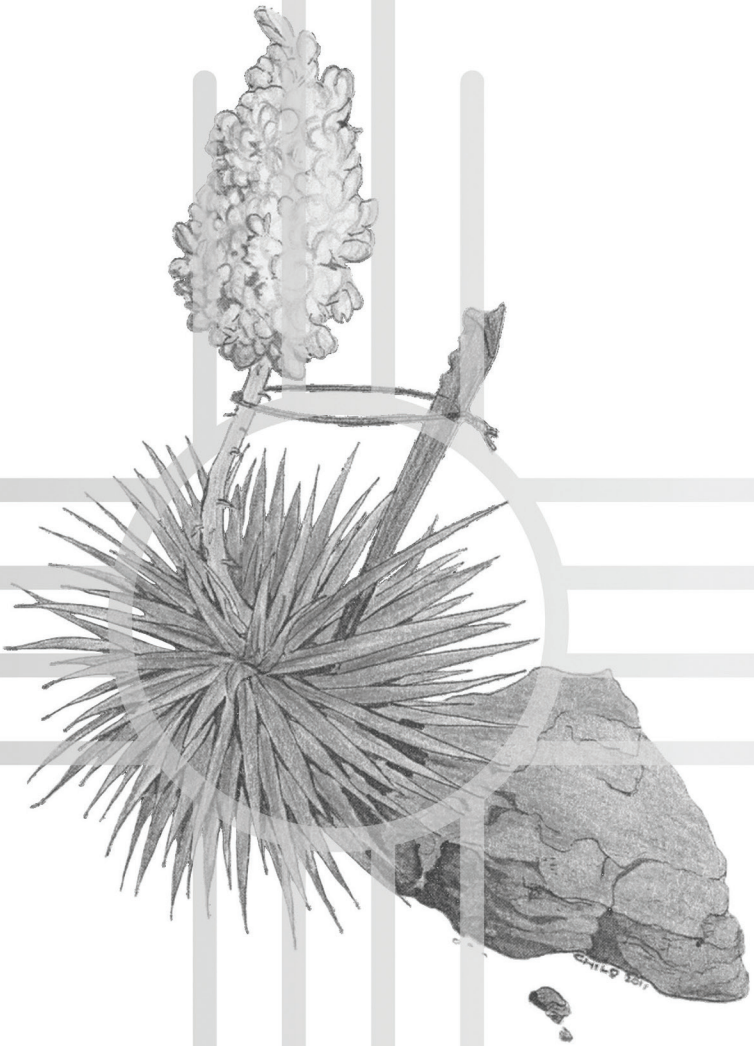

The Postero-anterior X-ray View of the Thumb to Illustrate the Basal Joint Articulations

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Introduction

When evaluating the thumb carpometacarpal (CMC) joint, x-rays of the hand or wrist give limited and often inadequate information about this articulation. The main reasons are 1) the rotation of the thumb in relation to the hand and 2) the bony overlap. We present a new view that allows the x-ray beam to profile the CMC joint in a true postero-anterior orientation. This x-ray angle allows visualization of the first metacarpal base deformity, and the trapezial articulation with both the first metacarpal and trapezoid clearly visualized. A case study is presented.

Case Study

A 55 years old woman presented to our office with pain at the base of the left thumb and limitation of activities of daily living. The pain was exacerbated with tasks such as sweeping, needle work, lifting, buttoning and washing dishes. She tried anti-inflammatory medication and splinting with minimal relief.

Examination demonstrated swelling at the base of the left thumb with local tenderness, positive shoulder sign (subluxation of the base of the first metacarpal) and positive grind test. There was no triggering of the thumb. The grip and pinch were diminished in comparison to the right hand.

Three x-ray views of the left hand (Figure 1) showed degenerative changes of the carpometacarpal joint of the thumb. The diagnosis of osteoarthritis was made. However there was much bony overlap in the lateral view of the hand, not allowing clear evaluation of the trapezial articulation.

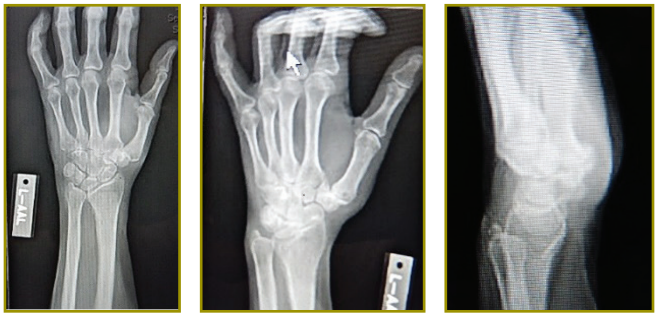

Figure 1: Three views of the hand showing degenerative changes of the thumb carpometacarpal joint. Note the bony overlap in the lateral view obscuring joint details.

An additional view, the postero-anterior view of the thumb (Figures 2 and 3) clearly demonstrated the extent of the deformity of both the base of the first metacarpal, the trapezium and the scaphotrapezial joint.

Figure 2: The hand is positioned in a lateral projection with the wrist in ulnar deviation. A 50 degrees sponge, allowing the trajectory of x-ray beam to produce a true PA view of the CMC joint, is used. The hand is resting on the side of the sponge while the thumb is on the crest.
Figure 3: Shows a true PA view of the thumb further illustrating the extensive joint arthritic changes at the CMC joint with no such changes at the STT joint.

The patient subsequently underwent partial trapeziectomy with capsular interposition. X-rays of the hand 2 weeks following surgery clearly outlined the post-surgical changes and the superiority of our described view (Figure 4).

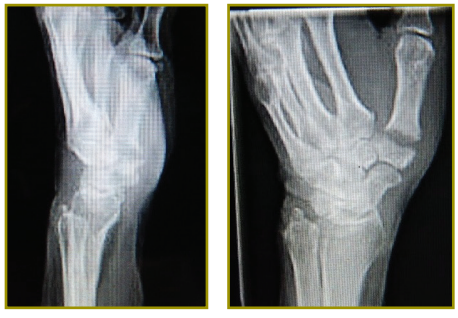

Figure 4: X-ray 2 weeks postoperatively clearly demonstrating the superiority of the thumb PA view (F4 B) in illustrating the post- surgical resection.

Discussion

There are many views described in the literature to demonstrate the arthritic changes at the carpometacarpal joint. Stress views[1] and Robert's view[2] will help in evaluating the joint, but both require effort by the patient to either push on the thumb or place the extremity in an uncomfortable position.

The described view allows the trajectory of the x-ray beam to take into account the rotation of the first metacarpal allowing better visualization of the joints of interest. This novel technique is reproducible and does not require the patient to uncomfortably rotate the shoulder or forearm, or require the x-ray technician to reposition the x-ray beam.

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Efficacy of a Novel Examination Maneuver in Diagnosing Meniscal Pathology

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Abstract

In this retrospective study we examine the effectiveness of the here named "Twist test" in diagnosing meniscal pathology. In preparation for this study, a literature review was conducted to look at commonly used "gold standard" exam maneuvers utilized in the diagnosis of meniscal lesions. The data from these studies was used as comparisons against the twist test. Medical records of patients who underwent knee arthroscopy from the 2013 calendar year were pulled and assessed for positive or negative Twist test results. These results were then correlated with Magnetic Resonance Imaging (MRI), and more definitively, arthroscopic findings. With this data, we calculated the sensitivity, specificity, and positive predictive value (PV+) of the exam maneuver. Our results suggest that this maneuver may have clinical relevance in diagnosing meniscal lesions.

Introduction

Meniscal lesions are a common source of knee complaints today having an incidence rate of 60-70/100,000.[1] The male to female ratio is between 2.5:1 and 4:1,[2] and according to Fazalare et al,[3] the most typical age range for a traumatic tear in the periphery of the meniscus is in patients under 30; conversely, complex and degenerative tears are often seen in patients older than 30 years. Given how frequently meniscal pathology is at least in part associated with knee complaints, a quick, efficient, and accurate clinical test would be helpful. Over the years, a variety of clinical tests have evolved to aid the clinician in his/her diagnostic quest to ferret out the relevant pathology. Among them, McMurray's test, Apley's grind test, and Joint Line Tenderness have risen to the top in frequency of use, though several other exam maneuvers are additionally used. In McMurray's, the clinician has the patient lay in a supine position. He/she then externally rotates the tibia to check for medial meniscal tears and cycles the patient's knee through passive flexion and extension. Alternatively, the knee is internally rotated and cycled when looking for a lateral meniscus tear. A positive test is identified by noticeable clicks with or without pain at the joint line.[3] Apley's grind test is similar in nature: With the patient in a prone position, the knee is axially loaded while the clinician internally and externally rotates the leg. Again, if pain or clicking ensue, the test is considered positive.[2] Joint Line Tenderness is simply palpating the medial and lateral joint lines between the tibia and femur for pain or tenderness. Another lesser known diagnostic maneuver is Thessaly's test. In Thessaly's test, the patient stands on a flat foot with the other lifted off the ground and flexes the involved knee to 5 degrees and rotates externally and internally, 3 times in each direction. The test is repeated with knee flexion of 20 degrees. This is done while the patient uses the doctor for balance support and if the patient's presenting symptoms are reproduced, the test is positive.[2,3] Initial reviews of Thessaly's test indicate a positive correlation between the test and meniscal pathology, though it does not appear to be often utilized and has not undergone many reviews.[2,4-6] Thessaly's is a similar exam to the Twist test, though some features of Thessaly's compromise what we believe to be a strong aspect of the Twist test — the ability to stand in a comfortable position. The Twist test is an easy maneuver to perform that allows the patient, often already uncomfortable, to feel in control of the maneuver. The test requires that the patient stand up in a comfortable setting and shift their weight to each leg in sequence. While the weight is shifted, the patient is asked to twist at the hips, placing rotational strain on the knee. A positive result is defined as the patient claiming a sensation of pain, clicking, discomfort, or any combination thereof. The twist test evolved as the result of our observation that frequently patients who turned out to have meniscal tears told us that their knee symptoms were increased when the knee was exposed to rotational stress. Theoretically, having the patient stand in extension will close the joint space and force the lesion across the articular surface. In addition to its accuracy, the value of the Twist test also resides in its ease of use. Save for providing an arm to balance on in case of need, little is asked of the clinician in performing this test. Further, our experience has shown that the majority of patients find comfort in knowing that they are in control of the test and that the clinician's hands are not there to

expose them to an unexpected and painful maneuver. In this study, we look to compare the effectiveness of the Twist test with that of its more traditional counterparts.

Materials and Methods

In order to collect our data, we isolated a group of patients who had undergone knee arthroscopy within the 2013 calendar year. It was then verified that these patients underwent a Twist test prior to their arthroscopy. Three key pieces of information were required for inclusion in this study: a positive or negative twist test recorded in the clinical exam, an MR scan (report and imaging reviewed by the clinician), and arthroscopic documentation of meniscal pathology or lack thereof. Once we confirmed that the patients' records included a twist test, we assessed their MRI results and ultimately looked at their post-operative diagnosis. With this information we calculated the sensitivity (defined as those who test positive and have the disease divided by the total population with the disease), specificity (defined as those who test negative and do not have the disease divided by the total population without the disease), and positive predictive value (PV+, defined as those who test positive and have the disease divided by the total number of positive tests.) These tests then told us the probability a patient will test positive given they have the disease, the probability a patient will test negative given they do not have the disease, and the probability that a positive test indicates one has the pathology. This information was then compared to similar parameters calculated for the more traditional tests to determine effectiveness.

Results

The n for our population was 137 individuals. The mean age for this group was 55.16 years, with the range spanning from 10 years to 87. Of the group, 59, or 43.07%, were male and 78, or 56.93%, were female. Regarding the side, 55.47% (61) of complaints were on the left knee and 44.53% (76) were on the right knee. The results from this population show that the sensitivity for lateral meniscal tears is 89.66% and 91.49% for medial meniscal tears. The sensitivity for a lesion in either meniscus is 90.52%. The specificity for the test with regards to the lateral meniscus is 11.39%, compared to 16.28% in the medial meniscus; the collective specificity is 19.05%. The positive predictive value (PV+) for the lateral meniscus is 42.62%, but jumps to 70.49% for the medial meniscus. More importantly, the PV+ for any meniscal tear is 86.07%, indicating that a positive Twist test has an 86.1% accuracy rate in diagnosing meniscal pathology within this group. A large portion of our population did indeed have the condition in question, with 116 of the 137 patients definitively having some form of meniscal pathology. Of the 21 remaining, one had a fold in her medial meniscus, though it did not turn out to be torn in any way and 13 suffered from a synovial plica. The other 7 individuals had a range of issues from patellofemoral tracking instability to synovitis to loose bodies in the knee.

Discussion

According to Hegedus et al,[4] which was a meta-analysis of various studies looking at the efficacy of McMurray's Test, Joint Line Tenderness (JLT), Apley's Test, and other miscellaneous tests, a wide range of values for sensitivity and specificity exist. Looking at McMurray's Test, 14 different studies were analyzed. Of these, sensitivity ranged anywhere from 29% to 65% on the medial meniscus (average 48%) and specificity ranged from 71% to 94% (average 88%); the lateral meniscus had sensitivities ranging from 15%-68% (average 45%), and specificities ranging from 86%-97% (average 91%); tears in either menisci had sensitivities ranging from 28%-74% (average 47%) and specificities ranging from 11%-96% (62%). Again, 14 studies looked at JLT. For this maneuver, medial meniscus sensitivity ranged from 58%-86% (average 72%), and specificity ranged from 45%-87% (66%); the lateral meniscus ranges were 22%-93% (average 56%) for sensitivity and 70%-98% (average 88%) for specificity; tears in either menisci had sensitivity ranging from 27%-95% (average 70%) and specificity ranging from 5%-96% (average 42%). Apley's Test was examined by seven studies: The medial meniscus range was 41%-47% (average 44%) for sensitivity and 82%-93% (average 88%) for specificity; the lateral meniscus ranged from 23%-41% (average 32%) for sensitivity and 86%-99% (average 93%) for specificity; tears in both menisci ranged from 13%-70% (35%) for sensitivity and 33%-100% (average 75%) for specificity. Finally, the reviews of five unique tests showed sensitivity ranging from 27%-92% and specificity ranging 81%-97%. A review of Akseki et al showed their test had a sensitivity of 67% for the medial meniscus and 64% for the lateral meniscus; the specificity was 81% for the medial and 90% for the lateral meniscus. Merke's sign showed a sensitivity of 71% and a specificity of 83% for either meniscus. The Steinmann I sign had a sensitivity of 27% and a specificity of 96% for either meniscus. The dynamic test had a sensitivity of 85% and a specificity of 90% when it came to the lateral meniscus; no other review was done on this test. Finally, the Thessaly test had a sensitivity of 89% for the medial meniscus and 92% for the lateral meniscus; the specificity was 97% and 96%, respectively.

Galli et al,[7] another meta-analysis that focused on Joint Line Tenderness and McMurray's test, painted a similar picture. Joint Line Tenderness was found to have a sensitivity of 63% and a specificity of 50%; and McMurray's was found to have a sensitivity of 34% and a specificity of 86%.

Harrison et al[5] looked solely at the effectiveness of the Thessaly test. In their study they found the maneuver had a sensitivity of 90% and a specificity of 98%; their positive predictive value was 98.5%. These numbers indicate considerable effectiveness with this maneuver, though the study, itself, claims that the results cannot be applied to the general population due to their small sample population and the study being conducted at a referral center.

Rinonapoli et al[8] examined McMurray's and Apley's tests. They found McMurray's to have a sensitivity of 80% and a specificity of 78.5%. They found Apley's to have a sensitivity of 84% and a specificity of 71%.

Though the Twist test still needs to undergo a more critical vetting process, our initial findings indicate that it may be a viable diagnostic maneuver in a clinician's tool bag to be used before a patient is sent for an MRI scan when one is suspicious of meniscal pathology. The sensitivity of the Twist test is as high, if not more so, than McMurray's, Apley's, Joint Line Tenderness, and other commonly performed maneuvers. Further, though some of the other studies did not calculate PV+, we have confidence that our value of 86.07% would be fairly competitive. This indicates that the Twist test, if positive, has a high likelihood of diagnosing meniscal pathology in a patient. Given the ease and comfort with which this test can be performed, we consider the PV+ indicative of the usefulness of the Twist test. Additionally, it requires little experience on the part of the examiner, and thus would be a sound maneuver for students to perform. Furthermore, the test also puts the patient in a position to quickly perform Helfet's test (full extension of the knee while seated or, in this case, standing to test for meniscal pathology) so that the practitioner can rapidly checkoff multiple maneuvers without having to place the patient in additional positions. Despite the promising numbers in sensitivity and PV+, the Twist test does have fairly poor specificity from these findings. We believe these findings can be explained, however, by the post-operative population we chose to sample from; this will be discussed further in the limitations.

Limitations

The limitations we have identified in this study are based primarily on the number and nature of our sample population. We decided to confine our population to the 2013 calendar year of knee arthroscopy patients. This led to an n of 137, which is enough to draw conclusions, but really should be expanded upon to truly substantiate the accuracy of our data. Further, the nature of our patients is confined to those who underwent knee arthroscopy. The lack of non-surgical patients, or even patients without knee trouble, led to what is believed to be an artificially low number of true negative tests (within this study, we had four true negatives, but 21 of our subjects were without the disease). This data could potentially be interpreted as showing that even a healthy individual could have a positive twist test, irrespective or meniscal pathology, though we believe that further study on non-operative and healthy knee patients would disprove this claim. We must include, however, that this data would be somewhat difficult to acquire as we would have to rely on MRI data to confirm the diagnosis; MRIs are generally quite accurate but even within our population we found 17 false positives and 15 false negatives. Additionally, we found it quite interesting that 13 of our false positives were found to have a synovial plica. This was an unanticipated finding that ultimately harmed the effectiveness of the Twist test in diagnosing meniscal tears; the fact that these patients did indeed have pathology in some form in their knee helps offset the missed diagnosis, though.

Initial position

Left twist

Right twist

Future research

Building on the aforementioned openings for research, we believe this investigation would benefit from expanding the size of the patient population. Given we have been performing this test for nearly 10 years, the data does exist for us to continue this retrospective study and make the sample size larger. We believe, however, that prospective analysis of patients who do not have knee problems, or who are not believed to have a torn meniscus, would help substantiate our claims regarding the poor specificity of the test.

Conclusion

Our results indicate that the Twist test may be a more effective means of diagnosing meniscal lesions than other more commonly used maneuvers. If this is the case, we believe it can become a mainstay in a physician's clinical checklist for diagnosing meniscal tears. From this data, the Twist test outperforms McMurray's test, Apley's test, and Joint Line Tenderness in sensitivity and the specificity comparison can be explained with our aforementioned logic. The Twist test appears to be rather comparable to the Thessaly test (not surprising given their similar methodology) but we believe it surpasses it in ease of administration. The Twist test allows the patient to control the maneuver and requires no experience on the part of the physician or student; it additionally lines the doctor up for performing other exam maneuvers that require the patient to be standing. We must admit, however, that there is some room for error in this maneuver as it relies on the patient to accurately perform it and convey subjective results. Despite this shortcoming, we still believe this novel test for diagnosing meniscal pathology can be a valuable tool in any clinician's tool bag.

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Congenital Scoliosis: A Retrospective Chart Review

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Abstract

Background: The etiology, severity and prognosis of congenital scoliosis depend on multiple factors, with limited data in the literature. There is also limited data on surgical correction based on the underlying vertebral anomaly. Given the progressive nature of the disease and eventual need for surgical intervention, the study was designed to obtain more data, assess disease presentation and progression in relation to environmental and physical characteristics, and evaluate surgical predictors to elucidate the disease and understand its prognosis in relation to various factors.

Methods: Using a retrospective chart review, we created a database for patients with congenital scoliosis seen at the Carrie Tingley Hospital in Albuquerque, NM from 2002 to 2011. This includes information on patient age, ethnicity, geographical location, degree of spinal curvature(s) using the Cobb method, vertebral anomaly(ies), and surgical intervention(s) and outcomes. Data was analyzed using ANOVA, and simple and logistic regressions.

Results: Of the 125 patients recorded, mean age at presentation was 4 years and 9 months and mean length of follow-up was 5 years. We found a statistically significant relationship between age at presentation and scoliosis severity and found that the most common underlying vertebral anomaly was hemivertebrae, which was associated with a better prognosis and a negative predictor for surgery. Thoracic anomalies were associated with worse prognosis.

Conclusion: Many factors influence the severity and progression of congenital scoliosis. With future studies elucidating effective interventions, it will be necessary to screen at a younger age given the direct correlation between age and disease severity. Certain anatomical traits can predict a better or worse prognosis, and thus can aid in management and provide a better quality of life.

Introduction

Natural History

Congenital scoliosis is a lateral curvature of the spine due to developmental abnormalities of the vertebral bodies, with a recorded incidence of 0.5-1/1,000 births. There has been no mention in the literature of any significant geographical or ethnic correlations with incidence or severity of the scoliosis, however, the female to male ratio has been noted to be 1.4-2.5 to 1.[1] This disease not only is associated with multiple comorbidities and a decreased quality of life, but it can also be progressive and lead to detrimental consequences including cardiopulmonary compromise and thus increased morbidity and mortality. As expected, there is also an economic burden associated with this condition.[2]

According to the Scoliosis Research Society, congenital spinal deformities and the severity of the deformity can be identified and classified by the type of vertebral anomaly seen in the patient. Studies focusing on the bony abnormalities in congenital scoliosis note that it can result from a multitude of structural defects, including hemivertebrae, block vertebrae, butterfly vertebrae, wedged vertebrae, and unsegmented bars.[2] Such vertebral anomalies are the products of a defect in or the failure of a specific developmental process to take place. The two normal developmental processes in which defects can result in vertebral defects and spinal deformity are formation and segmentation, or a mix of both.[3] Such vertebral abnormalities place a pressure on the growing spine to form in an asymmetric fashion, giving rise to kyphosis, lordosis, or scoliosis.[1]

Hemivertebrae and wedged vertebrae are the result of complete or partial failure of formation. When two hemivertebrae are present, both exhibiting failure of growth on the same side, a severe unbalanced congenital curvature will result. Conversely when two hemivertebrae are present, exhibiting failure of growth on opposite sides, balanced congenital scoliosis will result.[3]

Prognosis

In addition to aiding physicians in better understanding the etiology of scoliosis in their patients, the type of vertebral abnormality can help understand and predict the severity and prognosis of patient's condition. Studies show that the anomaly resulting in the most severe congenital scoliosis is a unilateral unsegmented bar with a contralateral hemivertebra at the same level, usually manifesting with a curvature of at least 50 degrees by age 3. The next most severe congenital scoliosis occurs in the presence of a unilateral unsegmented bar alone. After this, the next most severe is in the presence of 2 fully segmented hemivertebrae; following this presentation in the scale of severity is scoliosis in the presence of 1 fully segmented hemivertebra and a wedge vertebra. The presence of hemivertebra usually results in a curvature of at least 40 degrees by the age of 10. The least severe form of congenital scoliosis is one involving a block vertebra. It is evident, however, that patients can present with a mixture of abnormalities which are not classifiable using this system, which makes it difficult for clinicians to predict the severity and prognosis of their condition. Studies have shown, however, that the poorest prognosis is attached to the presence of a unilateral unsegmented bar, with or without other abnormalities, and should be treated immediately.[3]

Other prognostic factors in congenital scoliosis include the site of the anomaly, age of the patient at the time of diagnosis, and balance and pattern of the spinal curve. Curves in the thoracic and thoracolumbar regions of the spine tend to be more severe and carry a worse prognosis than curves in the cervicothoracic region and the lumbar region. Age is another prognostic factor in congenital scoliosis; in children, scoliosis usually has its most rapid progression after the age of 10, during the preadolescent growth spurt. Thus, children who present with a clinically apparent spinal curve early in life, specifically before the age of 10, have a marked growth imbalance and usually have yet to undergo a rapid progression of the curve, leading ultimately to a severe scoliosis.[3]

Common Comorbidities

According to studies, congenital scoliosis is often seen associated with various genetic syndromes such a Jarcho-Levin Syndrome, spondylocostal dysostosis, and Alagille Syndrome. As congenital scoliosis is associated with developmental abnormalities, it is reasonable to wonder whether there are other abnormalities present in different organ systems.[2] One study showed that 82% of patients suffering from congenital scoliosis also had malformations in 4 different organ systems.[4] These can include esophageal atresia, tracheoesophageal fistula, anal atresia, facial asymmetry, and bladder and cloacal exstrophy. Klippel-Feil Syndrome, Goldenhar's Syndrome, and incontinentia pigmenti have also been noted in many patients. Many of these have the VACTERL association: Vertebral malformations, Anal atresia, Cardiac malformations, Tracheoesophageal fistula, Renal and Radial anomalies, and Limb defects.[2] Three independent studies showed that 20-40% of patients with congenital scoliosis had a spinal dysraphism, such as diastematomyelia, tethered spinal cord, fibrous dural band, syringomyelia, or intradural lipoma, which can lead to the neurologic deficiencies seen in some patients with congenital scoliosis.[5] Lung function can also be severely compromised in children with congenital scoliosis and restrictive lung disease is an indication for immediate surgical intervention. One study showed that asymmetric ventilation and perfusion between the two lungs is seen in over half of the children presenting with congenital scoliosis; the severity of the lung disease, however, did not correlate with the Cobb angle measurements (measurement of the degree of curvature in scoliosis).[6]

Clinical Evaluation and Management

When congenital scoliosis is suspected clinically, x-rays and evaluation by a pediatric orthopedic surgeon are indicated. Standard PA and lateral views are used initially, followed by supine views, which can help better visualize the vertebral anomaly and pattern of anomalies. Additionally, bending films can reveal the level of flexibility and rigidity of the spine. Surgical correction is usually indicated in about 50% of patients with congenital scoliosis, due to curve progression and complications associated with the curvature, including compromised pulmonary function. Patients with thoracic curvatures approaching 90 degrees usually experience restrictive lung function and must have surgery as soon as possible. The goal of corrective surgery is to prevent the development of a severe deformity before it occurs in a patient suspected to have progressive congenital scoliosis, thus also secondarily preventing complications that may occur as a result of the curve progression. In patients with marked growth imbalance, even surgical intervention may not yield perfect results, and an optimum outcome would be a relatively straight spine. In determining which patients would best benefit from surgical intervention, it is again useful to consider the prognostic factors in a different light. If the patient is diagnosed early, while the curve is still small, they may benefit from prophylactic surgery. Consideration of the severity and degree that the curve will reach depends on many factors, including whether or not the patient has passed his/her growth spurt and their current standing, as well as the type of anomaly and balance of the curve. These factors are used to determine whether the patient

will benefit significantly from surgery and whether surgery will prevent future degeneration. Patients who are being considered for surgical correction of the their spinal curvature may need several CT and/or MRI studies to better visualize the vertebral anomaly, as well as identify and manage any cardiac or renal abnormalities, due to the frequency of anomalies with these systems in patients with congenital scoliosis. Additionally CT or MRI will show the presence of any spinal dysraphism, such as tethered cord, which must be released prior to surgery.[5]

Conversely, some patients with non-progressive or slowly progressing scoliosis, usually those with hemivertebrae or mixed anomalies are managed non-surgically. Typically these patients are followed under close observation, with regular radiographs taken every 6 months to monitor for any changes in the curvature. These measurements are done using the same technique every time and comparing films with prior ones in determining the current status of the scoliosis. The regular patient visits are made more frequent during the periods of maximum growth, which are in the first four years of life and during adolescence.[3] When bracing is used, it is generally used in patients with flexible spines and has been proven effective in such patients with high thoracic curves with the Milwaukee brace.[7] One study noted that braces are ineffective in congenital scoliosis if the curvature exceeds 40 degrees or if less than 50% flexibility is established using imaging.[8]

Surgical treatment is the most effective way of correcting congenital scoliosis. There are various different surgical procedures, and which one is used is dependent on factors including patient age, size of the curve, type(s) of vertebral anomalies, and associated conditions. One type of surgical procedure is convex growth arrest (anterior and posterior hemiepiphysiodesis), posterior fusion, combined anterior and posterior fusion, and hemivertebra excision.[8] Convex growth of the spine has a poor prognosis in congenital scoliosis. Thus, the goal of convex growth arrest is to stop the convex growth and allow for concave growth which will ultimately correct the deformity. It is usually performed on patients younger than 5 years of age, with healthy growth plates, capable of growth potential on the concavity, and a short curve of no greater than 60 degrees. It is a safe procedure but has very slow correction of the curve and therefore it is difficult to assess how effective it has been on a patient.[10] Posterior fusion is another surgical procedure to stabilize the curve and prevent further progression. This procedure is usually performed on an older child with a relatively flexible and moderately severe curve. The entire curve needs to be covered by the fusion as well as extend to the central gravity line to be effective. Since the 1990s, combined anterior and posterior fusion has been performed more often than posterior fusion alone and is usually performed for thoracic, thoracolumbar, and lumbar curvatures of poor prognosis, thus high convex growth potential. Finally, hemivertebra excision is a procedure that has been performed since the 1920s, and is an attractive surgical procedure as it removes the source of the curvature. It is usually performed in patients younger than 5 years of age with the development of a secondary curve with fixed decompensation which cannot be adequately approached using other procedures.[11]

Other surgical procedures include growing rods. Growing rods are used because the other surgical procedures work by stopping growth, which can generally have unfavorable effects on the growth of the trunk, thorax, and lung development. The growing rod operation, done through the back of the patient is designed to allow for continued growth of the spine. This is usually done on an outpatient basis through a small incision, and when the child has grown and is ready to have another procedure, such as posterior spinal fusion, then the growing rod is removed and surgery performed. VEPTR (vertical expandable prosthetic titanium rib) is also another surgical procedure which can be performed on children with congenital scoliosis if they have thoracic insufficiency, a relatively common ailment in patients with scoliosis. This procedure however is not widely offered in all institutions.[12]

Outcomes

Few studies have been reported with data on surgical outcomes for congenital scoliosis based on the vertebral anomaly. One study concluded that when the deformity was due to an unsegmented bar, with or without hemivertebrae, after surgery the rate of change of Cobb angle had slowed but was not reversed. The study stated that in patients with mixed spinal anomalies, following surgery the rate of progression of the deformity had been reduced, but the Cobb angle still increased. Most patients with hemivertebrae had a reversed or slowed rate of progression after surgery, with a decrease in the Cobb angle. The study also concluded that surgical outcomes were more clinically significant in patients with a younger age at surgery, and outcomes were better in patients with lumbar and thoracic anomalies.[13] Another study focused on surgical outcomes using anterior and posterior fusion in patients with congenital scoliosis due to hemivertebrae. They concluded that in comparison with preoperative values, the Cobb angle rate of change had been reversed in 23 patients, slowed or arrested in 5 patients, and remained unchanged or actually progressed in two patients. Again, better outcomes were noted in patients at a younger age during surgery and with lumbar anomalies.[14]

An extensive study was performed in order to assess the rate of complications associated with surgical correction

of congenital scoliosis. The study concluded that surgery for scoliosis had a varying, but high rate of complications. Long term risks for this surgery have not yet been reported. Interestingly it was stated that two thirds of the time, early surgical intervention for congenital scoliosis is all that is required, while about 33% of the time there will be a need for another operation.[14]

It is evident that congenital scoliosis is a complex condition, with a relatively unknown and possibly multifaceted etiology, unknown incidence and unclear genetic, geographic, and ethnic associations, as well as a multitude of co-morbid conditions and the possibility of severe disability and deformity, sometimes requiring one or more surgical interventions to improve the quality of life for patients. It is therefore imperative to study this condition in more detail to fill the knowledge gaps and perhaps intervene earlier to improve the prognosis and quality of life for these patients. The purpose of this study was to find a better understanding of the epidemiology of congenital scoliosis in New Mexico as well as factors affecting its severity and progression. Specifically we wanted to determine whether or not there is a link between the disease severity and factors including age, ethnicity, number of associated syndromes, and type, number, and region of vertebral anomalies; we also wanted to determine if there were any factors predisposing patients to surgical intervention.

We hypothesized that there would be statistically significant associations between disease severity and age, ethnicity, number of associated syndromes, and the presence of hemivertebrae in any location. We also hypothesized that a higher age, being Hispanic, and multiple associated syndromes would be predictive of surgical intervention.

Methods

For this study, a database was created for patients with congenital scoliosis, who were seen at the Carrie Tingley Hospital in Albuquerque, NM from the years 2002 to 2011 (Figure 1). The database was compiled using a retrospective chart review, by obtaining and recording historical and clinical information on each of the patients from PowerChart, the electronic patient record system used. Given the small but unlikely risk of a breach in confidentiality, the database was created on a Microsoft Excel 2007 (Microsoft Corporation, Redmond, WA) spreadsheet on password-protected computers on the University of New Mexico campus only, with no mobile devices used under any circumstances and no transport of information. A unique study number was assigned to each patient and there was a separate linker file kept in a locked file cabinet, with the intention of it being destroyed once all data was been obtained and analysis completed. HRRC approval was obtained prior to the start of data collection. The established inclusion criteria were children with congenital scoliosis, seen at Carrie Tingley Hospital between the years of 2002 and 2011, aged 0-17. Those who did not meet these criteria, and those without adequate data or follow up of at least 2 years were excluded from the study. Specifically, information on each patient's age was obtained at the time they first presented to Carrie Tingley Hospital, at the time of their last follow-up visit, as well as their current age. Their length of follow-up was obtained, according to how long they were followed by a clinician at Carrie Tingley Hospital for their scoliosis. Their gender, ethnicity, NM county, weight, height, and BMI at first presentation was also obtained and recorded. Data was obtained on the magnitude (in degrees) of their spinal curve at presentation and last follow-up; these curvatures were measured from radiographs of each patient using the Cobb method. We also obtained information on their type(s) of vertebral malformation as recorded in their medical chart, whether or not patients had surgery done per the chart and if so what type, and whether or not an MRI was performed. Data on other comorbid conditions was gathered per the medical chart. Finally we obtained information on whether or not the patient required additional revision surgery, and any notes on their status at last follow-up, which was merely whether or not the patient was stable and being followed for their congenital scoliosis, lost to follow-up, or awaiting an intervention. Prior to the start of data collection, power calculations were done.

In order to measure the spinal curvature of each patient with congenital scoliosis, radiographs of each patient were evaluated, before and after surgery (if applicable), and the degree of curvature(s) was measured using the standard Cobb method. Notably, one single author measured the curves using the standard Cobb method in order to ascertain the accuracy and reliability of the measurements.

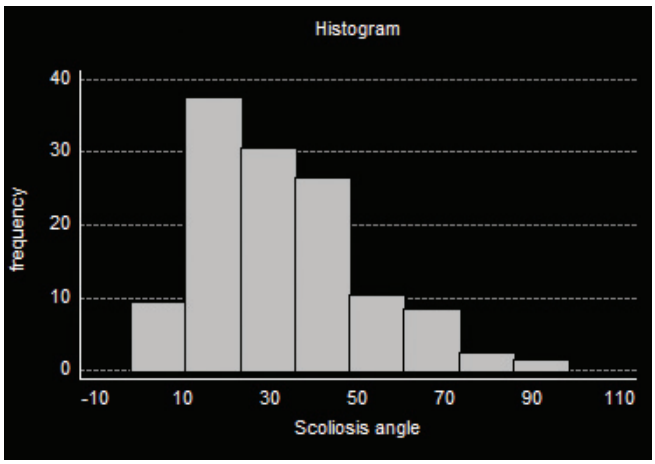

Figure 1: Percentiles for scoliosis angle

The degree of scoliosis was measured and recorded using the degree units.

During the data collection and analysis, special attention was given to the clinical course of patients with hemivertebrae, which have been noted to be the most common and have the best prognosis, with or without surgery. Comorbid conditions or associated syndromes of interest in this study included Klippel-Feil Syndrome, syringomylia, and kyphoscoliosis with pulmonary compromise, as these are fairly common and associated with poorer outcomes.

The expertise of a biostatistician was utilized in order to analyze the data and determine whether or not it was statistically significant. The statistical tests used to test our hypothesis included the chi-squared test to compare the observed data with the data we would expect to find according to our hypotheses. In addition, univariate analyses involving observation and analysis of one variable at a time were carried out. R-squared statistics, Kruskal-Wallis tests, Mann-Whitney tests, F-tests, one-way analysis of variance tests, simple and logistic regressions, and odds ratios were also utilized during the statistical analysis. Two-tailed tests and a Type I error rate of 0.05 were employed throughout. The primary variables that we focused on were gender, ethnicity, number of hemivertebral malformations, region of hemivertebral malformations, and the presence of one or more associated syndromes. Associations that we focused on were the associations of each one of these variables with the degree of spinal curvature at presentation and the association of certain variables with the probability of surgical intervention, as well as the relationship between the number of hemivertebrae and associated syndromes. The above mentioned statistical tests were utilized to determine possible associations. All statistical calculations were made with Statgraphics Centurion XV version 15.2.06 (StatPoint, Inc., Herndon, VA).

Results

The retrospective chart review yielded information on the epidemiologic characteristics of 125 children with congenital scoliosis seen at Carrie Tingley Hospital between the years 2002 and 2011, as well as information on the nature of their scoliosis and its progression. The data obtained has been compiled into a database (Figure 2). The mean (SD) age at presentation was 4 years and 9 months (4 years and 10 months) with a range of 1 month to 17 years. The mean length of follow-up was 5 years, with a range of 2 to 12 years. 69 patients were female and 56 patients were male. There was a wide range of scoliotic curve magnitudes at presentation, ranging from 3 degrees to 93 degrees, with some patients having a single curve and others exhibiting compensatory curves. A one-variable analysis showed that the curve magnitude at presentation followed a normal distribution, with the mean (SD) value at 32.5 degrees (17.6).

A simple regression and analysis of variance evaluating the relationship between age at presentation and curve magnitude showed a statistically significant relationship (P-Value = 0.006). The ethnic distribution of the study population was as follows: 70 Hispanic, 36 Caucasian, 13 Native American, 1 African American, and 5 "Other." Ethnicity was based on self-report by patients as found in their medical charts. Because of the presence of only 1 African American in the study population, and 5 "Other," we did not consider these two categories in the statistical analysis of curve magnitude in relation to ethnicity. One-way analysis of variance was done to evaluate the relationship between ethnicity and curve magnitude, and based on the F-ratio and F-test, there was not a statistically significant relationship between ethnicity and curve magnitude (P-Value = 0.45).

Regarding the nature of their scoliosis, approximately 49% of patients had one or more hemivertebrae accounting for their abnormality, while approximately 36% of patients had mixed vertebral abnormalities (including hemivertebrae, butterfly vertebrae, bars, fusion and segmentation abnormalities). Approximately 15% of the patients had non-hemivertebral isolated abnormalities accounting for their spinal curvature. The relationship between the curve magnitude and number of hemivertebrae was explored using a one-factor analysis of variance. It is unexpected that the mean scoliosis angle was highest in subjects with no hemivertebrae (Figure 3). However, this difference was not statistically significant (Kruskal-Wallis test, P-Value = 0.68). Of the patients who had hemivertebrae, 49% were located in the thoracic region, 21% in the lumbar region, 26% in the thoracolumbar region, and 4% in the cervicothoracic region. The relationship between region of hemivertebrae and curve magnitude was explored using the Mann-Whitney

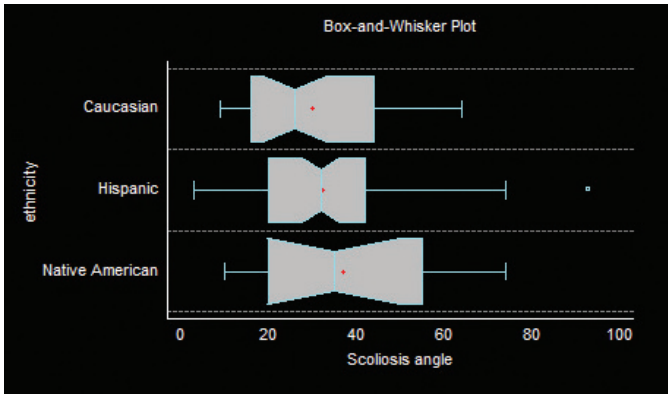

Figure 2: Simple Regression - Scoliosis angle vs. Months
Progression of curve over time
Scoliosis angle = 28.3432 + 0.073 Months

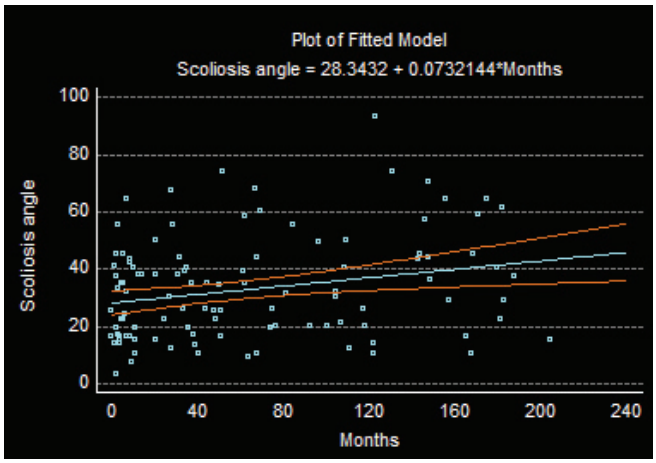

Figure 3: Multiple Range Tests for Scoliosis angle by ethnicity

test for a difference in medians. The median angle was not significantly different among subjects with involvement of the cervical, thoracic, or lumbar regions (P-Values = 0.75, 0.09, and 0.68 respectively).

Approximately 55% of all patients had one or more associated syndromes. The relationship between the number of associated syndromes and the number of hemivertebrae was explored using a one-factor analysis of variance. It is interesting that the mean number of hemivertebrae was 2.25 in subjects with 4 associated conditions, while the mean number of hemivertebrae was less than 1.6 in all other groups. However, this difference was not statistically significant (Kruskal-Wallis test, P-Value = 0.46).

Regarding surgical intervention, about 37% of the patients studied required surgical intervention at some point during their clinical course, and of these patients, 24% of them required revision surgery at least once. Focusing on the most common vertebral anomaly implicated in the disease, we evaluated those with hemivertebrae for probability of surgery. Approximately 44% (8) of patients with 0 hemivertebrae underwent surgery; 36% (23) of those with 1 hemivertebra had surgery; 33% (6) of those with 2 hemivertebrae had surgery; 30% (8) of those with 3 hemivertebrae had surgery. The relationship between the number of hemivertebrae and the probability of surgery was explored using a univariate logistic regression model. Interestingly, subjects with no hemivertebrae were more likely to undergo surgical intervention than those with 1 or more hemivertebrae. However, this difference was not statistically significant (P-Value= 0.82). Proceeding to determine whether or not there was a relationship between region of hemivertebrae and the probability of surgery, we found that of the patients with thoracic involvement, 37% had surgery; of those with lumbar involvement, 17% had surgery; of those with thoracolumbar involvement, 41% had surgery; of those with cervicothoracic involvement, 20% had surgery (there were only 5 patients meeting this category). To further analyze this relationship for statistical significance, a univariate logistic regression model was used. Only the presence of thoracic vertebral hemivertebrae was associated with a higher likelihood of requiring surgical therapy (Odds Ratio = 0.32, deviants explained=3%, P-Value=0.04).

Discussion

Congenital scoliosis is a complex disease with a multifactorial etiology which has not been studied extensively nor clearly delineated. The incidence and potential genetic factors are unclear, however, it is known that congenital scoliosis is associated with multiple severe comorbidities which serve to worsen the prognosis and quality of life for these patients. Depending on the severity of their disease and the progression of their spinal curvature, surgical intervention may take place which may or may not improve quality of life and prognosis. This study serves as the largest retrospective chart review for children with congenital scoliosis to date, and attempted to fill the knowledge gaps about what epidemiologic and anatomical factors play a role in the pathogenesis and natural progression of the disease. Additionally the study aimed to determine predictors of surgical intervention in patients with congenital scoliosis.

In our study, one of the many important findings was that there is a statistically significant direct relationship between age at presentation and degree of spinal curvature in patients with congenital scoliosis. This means that children with congenital scoliosis who present for the first time at an older age will have a larger spinal curvature as compared to those presenting at a younger age, who will have a much less pronounced spinal curvature. This implies that if it is determined that there is an effective surgical or non-surgical intervention that would improve the quality of life and prognosis for these patients, a form of screening should be initiated to detect and closely follow scoliosis at an earlier age. Other surprising findings were that approximately 56% of the patients in the study were Hispanic, a percentage that exceeds the recorded distribution of the Hispanic ethnicity in New Mexico, and the higher prevalence of congenital scoliosis in a few geographical regions in New Mexico, including Bernalillo, Santa Fe and San Juan counties. Additionally, 55% of the patients had associated co-morbid conditions, which closely matches data from other studies looking at co-morbid conditions in congenital scoliosis.[2]

In regards to the type and location of vertebral anomaly, the findings of our study confirmed hemivertebrae to be the most common form of vertebral anomaly leading to spinal curvature in congenital scoliosis.[2] Additionally, the scientific literature stating that thoracic/thoracolumbar involvement

indicate a worse prognosis was indeed addressed by the results of our study: we found that hemivertebrae located in the thoracic and thoracolumbar regions were more predictive of surgical intervention than those located in other regions. These results were statistically significant (P-Value = 0.04). Yet our results also showed no statistically significant relationship between region of hemivertebrae and curve magnitude. This is interesting because it implies that although there is no difference in the severity of scoliosis at presentation based on the location of the abnormality, those with thoracic/thoracolumbar abnormalities are more likely to have surgery; this is statistically and clinically significant and implies that perhaps patients with thoracic/thoracolumbar involvement have a more progressive disease course than do others.[4] Further research on the nature of curve progression depending on the location of the abnormality may shed more light on this finding.

Another interesting finding from our study was that our results confirmed that the presence of hemivertebrae is associated with a better prognosis and that patients with multiple hemivertebrae tend to have non-surgical interventions. In our study, patients with zero hemivertebrae had the highest degree of spinal curvature as compared to those with multiple hemivertebrae. Furthermore, patients with zero hemivertebrae were more likely to have surgical intervention than those with one hemivertebrae, while those with one hemivertebrae were more likely to have surgical intervention than those with two hemivertebra , and those with 3 or more hemivertebrae were the least likely to have surgical intervention. Although these differences were not found to be statistically significant, they were interesting and in support of the idea purported by other studies that the presence of multiple hemivertebrae is not only a relatively common manifestation, but is also associated with a better prognosis and a decreased need for surgical intervention.[2-4]

In contrast to what is stated in other studies, specifically that approximately 50% of patients with congenital scoliosis undergo surgical intervention, in our study only 37% of patients underwent surgical intervention. This, however, may be secondary to the fact that this was a retrospective chart review, looking at some patients who are still early on in the course of their childhood and are still being followed, and will perhaps have some form of surgical intervention in the future.[6]

It is notable that the results imply that there are certain anatomic characteristics, such as the presence of specific anomalies like hemivertebrae and number and location of such anomalies, which can predict better or worse outcomes. This information, along with the results indicating a correlation between age and curve severity at presentation, illustrates the importance of screening and/or close follow-up of such patients with imaging studies in order to detect specific anatomical characteristics and use that information to predict the disease course and prognosis, and thus better and more efficient management. Further studies in the future should focus on the effectiveness of various surgical and non-surgical interventions in order to find ways to improve the quality of life for patients with curve severity and characteristics predictive of a poor prognosis.

In regards to limitations of the study, although great care and attention was been taken to ensure the precision of the methods in gathering information, compiling it into a table/graph and analyzing and interpreting results, the possibility for unreliability always exists; this was been minimized as much as possible with multiple authors checking the data for accuracy and precision. Primarily, there are certain limitations to performing a retrospective chart review. These include incomplete or missing documentation and poorly recorded or absent information. In the case of our study, when this issue was confronted, the patients with absent or poorly documented information were excluded from the study, per the established exclusion criteria, to avoid an incomplete database. Another limitation to such a study was ensuring reliable Cobb angle measurement. In order to address this, great precision was used in measuring the Cobb angles on the x-ray films of each patient at presentation and at last follow-up. In order to avoid mistakes while calculating the measurements, a single measurement technique was be used, specifically the Cobb method which is widely used in measuring spinal deformities and following the progression of spinal curvatures; this method was used consistently throughout the study by one author for measuring the angles for every single patient, and comparing that angle with those possibly recorded in the patient's electronic or paper charts for accuracy. Finally, another limitation to the study is that the data obtained may not be applicable to the patient population in other states in the United States, as this study focuses on the population of patients with congenital scoliosis in New Mexico. It also may not be fully applicable to the patient population in countries outside of the United States.

Acknowledgements

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Regional Anesthesia at University of New Mexico: A Diffusion of Innovation

Research Primer and Feasibility Assessment

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Background

Improvement in health care outcomes has long been a meaningful focus of medical research, and the discipline of Anesthesiology shows no exception. When different anesthetic modalities are compared, many studies show that ambulatory surgery patients who receive peripheral nerve block have a shorter length of stay than those who undergo general anesthesia, and that peripheral nerve blocks less frequently result in pain, nausea, vomiting, and sore throat postoperatively.[1-2] With these benefits in mind, more outpatient surgery centers are transitioning to the routine use of peripheral nerve block anesthesia in those patients for whom it is an acceptable alternative to a general anesthetic.

Upper and lower extremity procedures, commonly performed by orthopaedic surgeons, lend themselves well to regional nerve block anesthetic techniques. Within the United States, the sole use of regional anesthetic techniques for procedures that previously utilized general anesthesia has increased substantially and we have seen similar growth at our institution, the University of New Mexico Hospital. Over the last 20 years, there has been a significant shift in the type of anesthesia performed for orthopaedic extremity procedures at our institution, and largely, there has been substantial increase in the proportion of cases performed via peripheral nerve block alone as opposed to general anesthesia.

Our Institution

The story of the increase in utilization of regional anesthesia at our institution has followed an interesting path. One of our study authors, anesthesiologist Dr. Randy Rosett, joined a private practice in 1984, where he met and practiced with another anesthesiologist, Dr. Firoz Vagh, for over 17 years. Throughout this time, their shared interest in regional anesthesia grew and they worked hard to implement it as the modality of choice when possible (mostly axillary and interscalene blocks for upper extremity surgery during this time). This desire was borne out of a strongly held belief that these techniques would revolutionize patient care. However, both Dr. Rosett and Dr. Vagh left the private practice hospital in 2001 when the facility closed its doors. Subsequently, Dr. Rosett was recruited to assist in the development of an ambulatory surgical center for the University of New Mexico Hospital. Dr. Rosett accepted and was able to convince Dr. Vagh to do the same and join him in 2003. This new center, "OSIS" (Outpatient Surgery and Imaging Services), was successfully founded in 2003.

With both Dr. Rosett and Dr. Vagh on board, they aimed to continue their practice of high utilization of regional anesthesia. However, this process would not be as easy as they had anticipated. Many surgeons initially were very resistant to the implementation of regional anesthetic techniques as a replacement for general anesthesia. Largely, they were hesitant because of previous experiences of high regional anesthesia failure rate, delays in surgery start times due to regional block administration and nerve injuries resulting from the regional anesthesia procedure.

Undeterred, Dr. Rosett and Dr. Vagh continued to advocate for the use of peripheral nerve block techniques and slowly developed momentum. Patient satisfaction surveys were conducted which showed excellent results, consistently in the 95th percentile range. Over time, the use of regional anesthesia increased and now peripheral nerve blocks are performed for the large majority of upper and lower extremity surgery, as well as chest wall and inguinal procedures. Many of the surgeons who initially resisted the change now strongly support the use of regional anesthesia, including the previous Chair of Orthopaedics, Dr. Moheb Moneim, who Dr. Rosett now characterizes as a strong advocate for the implementation of the change in practice.

The high level of success of regional anesthesia seen at OSIS has also assisted in the broad implementation of these practices at the other surgery centers within our institution. Furthermore, the techniques employed for the implementation of regional anesthesia at our institution have expanded and today nearly all of the peripheral nerve blocks are performed under ultrasound guidance. Our anesthesia residency now includes training in this field, and a fellowship in regional anesthesia is now offered and receives many competitive applicants yearly.

Diffusion of Innovations

We hypothesize that the change at our institution has likely followed a pattern commonly seen in diffusion of innovation theory, as described by Everett Rogers in his authoritative text "Diffusion of Innovations". Rogers defines diffusion as the process by which an innovation is communicated through certain channels over time among members of a social system. Important to this process are both the traits of the innovation and the traits of those who may come to adopt the innovation. Innovations that are perceived by individuals as having greater relative advantage, compatibility with their values and needs, trialability (the chance to test the innovation on a limited basis before widespread implementation), and observability (the opportunity to watch others adopt the innovation) will be adopted more rapidly than other innovations.[3-4] Furthermore, innovations with greater complexity may be adopted less rapidly.

Those who adopt an innovation are stratified into five groups based upon how quickly they adopt the idea or technology (Figure 1). "Innovators" actively seek new ideas. They are at least two standard deviations ahead of the mean with regards to how quickly they adopt a new innovation and represent 2.5% of individuals. "Early adopters" are greater than one standard deviation ahead of the mean with regards to how quickly they adopt an innovation and represent 13.5% of individuals. These individuals often communicate closely with innovators, and though they may not actively seek new ideas, they do have the resources and the risk tolerance to trial an innovation they learn about before others do. The "Early Majority" is within one standard deviation ahead of the mean time of adoption (34% of individuals), and the "Late Majority" adopts the innovation within one standard deviation after the mean time of adoption (34% of individuals). Each of these two groups is less likely to assume risk than the previously mentioned groups, but rely on the other groups to learn about their experiences with the innovation in question. Finally, "Laggards" are those who are greater than one standard deviation behind the mean with regards to how quickly they adopt an innovation, comprising 16% of individuals. For these individuals, a system's norms are often a barrier to change, and in some cases they will never adopt the innovation available to them.[3-4]

When the number of individuals who have adopted an innovation (y-axis) is plotted against time (x-axis), most innovations demonstrate an 'S' shaped pattern of adoption (Figure 2). That is, the cumulative number of individuals who has adopted an innovation starts off at a low level when only the innovators and the early adopters are involved, eventually grows at a rapid rate as the early majority and then the late majority adopt the innovation, and finally reaches a plateau (asymptote) at which point nearly no new individuals will adopt the innovation.

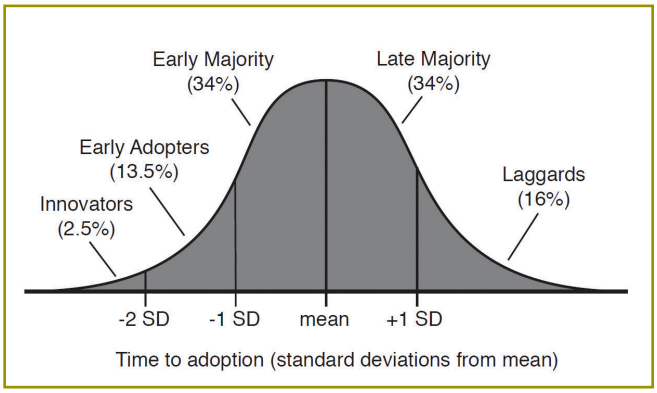

Figure 1

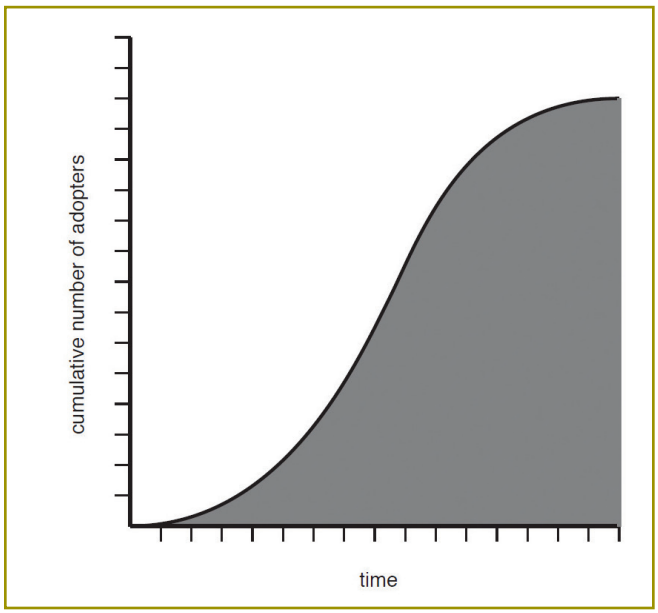

Figure 2

Research Plans

Given the relative advantages of regional anesthesia and the changes at our institution, we plan to execute a dual armed study that investigates both the measurable quantitative

change in the frequency of this anesthetic modality, as well as the qualitative factors that affected this change.

For the quantitative arm, we aim to prove that the growth of regional anesthesia for use as the primary anesthetic modality in orthopaedic surgery at our institution has followed a diffusion of innovations pattern. This will be accomplished thorough a retrospective chart review, for which we plan to select specific pertinent CPT codes and then review all patient charts for which these CPT code procedures were performed over our duration of interest. Our hope is to use this data to illustrate the diffusion of innovations 'S' curve.

For the qualitative arm, we plan to explore the factors involved in the change process for pertinent personnel within our institution. This will be carried out through the use of standardized interviews of surgeons, anesthesiologists, administrators, and other pertinent individuals. These interviews generate transcripts that will undergo thematic analysis and qualitative evaluation.

Our hope is to not only fully characterize the changes that we have seen locally, but also evaluate the propelling elements and barriers to change that may be applicable to other institutions.

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Anatomy Primer of the Wrist Ligaments

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Introduction

The wrist ligaments are complex and not easily accessible. They are concealed volarly by the contents of the carpal tunnel and dorsally by the extensor tendons and the extensor retinaculum. Knowledge of the anatomy of the various ligaments is essential to understanding wrist instability patterns and treatment.

Types of Ligaments

Volar Ligaments

The volar ligaments are best seen during wrist arthroscopy. (Figure 1) The radio-scapho-capitate (RSC) ligament extends from the radial styloid to the capitate. It extends over the scaphoid waist but does not attach to it. It functions as a scaphoid stabilizer. The long radio-lunate (LRL) ligament extends from the radial styloid to the lunate. The short radio-lunate (SRL) ligament extends from the distal radius to the lunate. The ulno-carpal (UC) ligament extends from the volar ulnar capsule to the carpus and contains the space of Poirier. (Figure 2a: black dot) The volar radial ligaments are responsible for stabilizing the hand and wrist to the forearm. (Figure 2b)

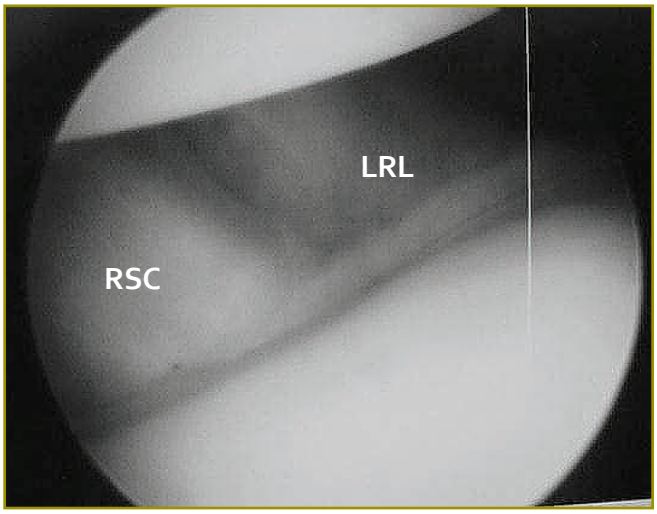

Figure 1: Arthroscopic view of the volar wrist ligaments.
RSC: radioscaphocapitate
LRL: long radiolunate

Figure 2a (left): Anatomical cadaveric rendering of the volar wrist ligaments with the black dot representing the space of Poirier.

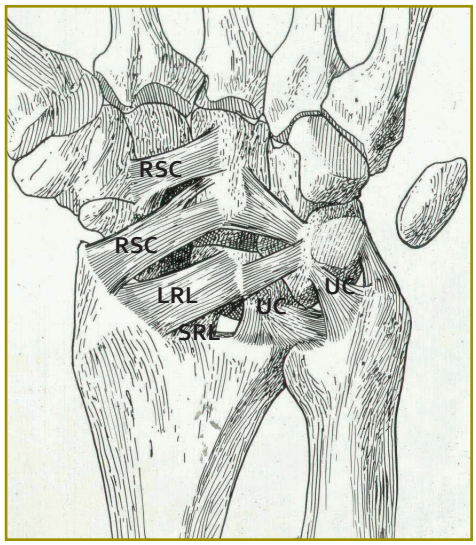

Figure 2b (right): Artist rendition of the volar ligaments.
RSC: radioscaphocapitate
LRL: long radiolunate
SRL: short radiolunate
UC: ulnocarpal

Dorsal Ligaments

The dorsal ligaments (Figures 3a, 3b) are less distinct due to the presence of the extensor retinaculum. The dorsal inter-carpal ligament extends across the carpus from the triquetrum radially to the scaphoid and radial styloid. The dorsal luno-triquetral ligament extends from the lunate to the triquetrum. A tear of the dorsal inter-carpal ligament and luno-triquetral ligament results in volar intercalated segmental instability (VISI) deformity.

Figure 3a: Anatomical cadaveric dissection of the dorsal wrist ligaments

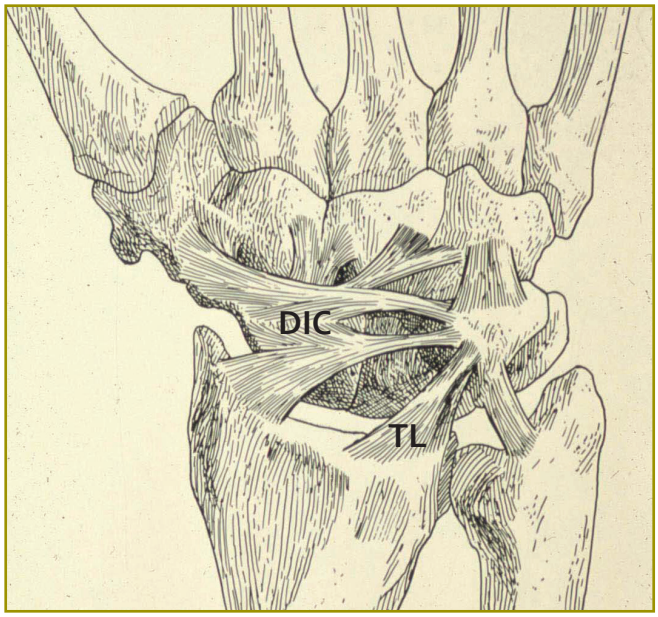

Figure 3b: Artist rendition of the dorsal ligaments.
DIC: dorsal intercarpal ligament
TL: triquetral ligament

Intercarpal Ligaments (Figures 4 & 5)

The scapholunate ligament is C-shaped with dorsal, proximal and volar portions. It is not a true interosseous ligament as it does not lie between the two bones. It functions to hold the scaphoid and the lungate together. A tear of the scapholunate ligament results in the most common pattern of wrist instability and leads to dorsal intercalated segmental instability (DISI).

The lunotriquetral ligament is also not a true interosseous ligament as it does not lie between the two bones.

The capito-hamate, capito-trapezoid, and trapezoid-trapezial ligaments are true interosseous ligaments as they lie between the corresponding bones. The capito-hamate ligament allows the capitate and the hamate to move together as a single unit.

Types of Injuries

There are two main types of wrist ligament injuries; greater arc and lesser arc (Figure 6). In greater arc injuries, there is a fracture through the scaphoid and in some cases there is a fracture through the capitate. Trans-scaphoid, perilunate dislocation is an example of a greater arc injury. In lesser arc injuries, the injury is purely ligamentous. Lunate and perilunate dislocations are examples of lesser arc injuries.

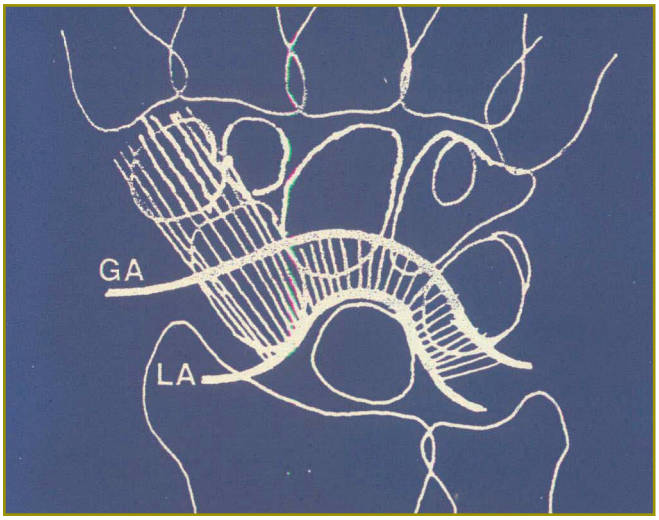

Figure 6: Wrist ligament injury patterns.
GA: greater arc
LA: lesser arc

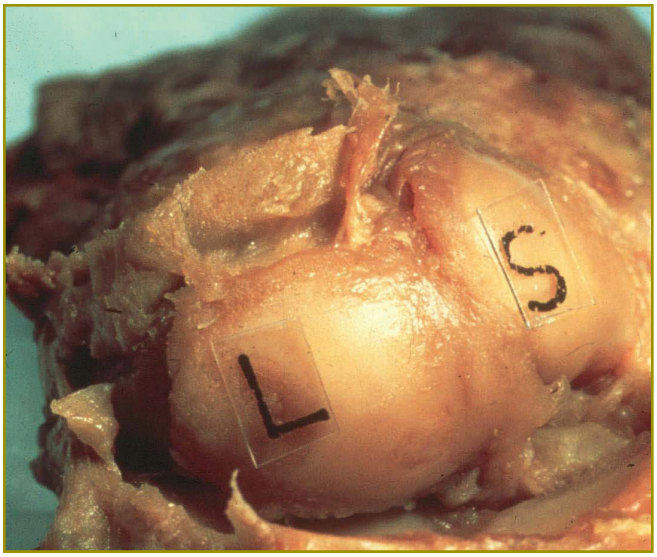

Figure 4: Cadaveric representation of the scaphoid (S), lunate (L), and scapholunate interval between the two carpal bones.

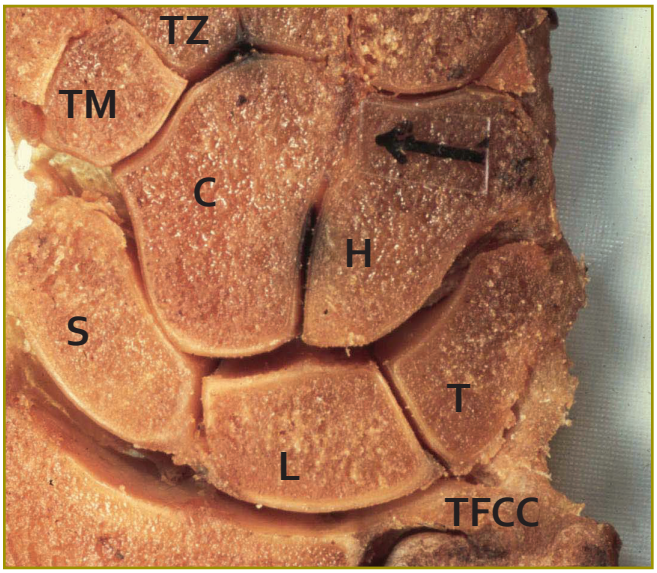

Figure 5: Cadaveric cross section of wrist carpal bones and ligaments.
TM: trapezium
S: scaphoid
TZ: trapezoid
C: capitate
L: lunate
H: hamate
T: triquetrum
TFCC: triangular fibrocartilage complex
Black arrow denotes the stout capitohamate ligament which allows the capitate and the hamate to move together as a single unit

Treatment of Hallux Valgus with a Chevron Osteotomy Combined with a Lateral Release

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Abstract

Purpose: Current literature recommends proximal first metatarsal osteotomy for large hallux valgus deformities. Combined distal osteotomy with lateral release can be done and may provide a similar degree of correction. The concern with this technique is disruption of the blood supply to the first metatarsal head. We hypothesized that a chevron osteotomy in conjunction with a lateral release is effective in correcting some larger hallux valgus deformities without causing disruption of the blood supply to the first metatarsal head.

Methods: We reviewed the imaging studies of forty-six cases that underwent a distal chevron osteotomy with lateral release for correction of larger hallux valgus deformities with incongruent joints. The AP radiographs of the operated foot were measured preoperatively and postoperatively. We documented the degree of correction of the first metatarsophalangeal (MTP) angle, degree of correction of the intermetatarsal (IM) angle, and improvement in joint congruity.

Results: The mean MTP angles were 30° preoperatively and 16° postoperatively. The mean IM angles were 15° preoperatively and 7° postoperatively. In all cases the first MTP joint was incongruent preoperatively and congruent postoperatively. In the short term follow-up, none of the radiographs showed evidence of avascular necrosis of the first metatarsal head.

Conclusion: A chevron osteotomy with lateral release can be used to effectively treat large hallux valgus deformities with minimal risk of first metatarsal head avascular necrosis.

Introduction

The surgical treatment for great toe hallux valgus depends on the severity of the deformity. Currently, most surgeons prefer soft tissue balancing for minor deformities, distal metatarsal osteotomy for mild to moderate deformities, and proximal metatarsal osteotomies for moderate to severe deformities. Proximal metatarsal osteotomies have higher rates of nonunion, malunion, and continued postoperative pain when compared to patients undergoing a chevron osteotomy.

The technique and results after a chevron osteotomy used for hallux valgus deformity has been well studied and routinely has good results. The current indications for a chevron osteotomy is for patients with an intermetatarsal angle of less than 15 degrees and a hallux valgus angle of less than 30 degrees without pronation of the toe. There are some surgeons who believe that adding a lateral capsular release to a chevron osteotomy will allow for more complete correction of hallux valgus deformity. Current literature is controversial on whether or not to perform a lateral release at the same time of a chevron osteotomy for the treatment of hallux valgus. Earlier clinical reports and textbooks have cautioned against surgeons performing any type of lateral release of the joint in conjunction with a chevron osteotomy. They have quoted such complications as nonunion, delayed union, and osteonecrosis of the metatarsal head secondary to disruption of the blood supply. However, more recent reports have shown that distal metatarsal osteotomies with soft-tissue releases can be performed safely. A study by Feiwell et al sought to answer this controversial question. They used cadavers to evaluate the anatomic blood supply to the metatarsal head. The perfusion was tested before and after performing a chevron osteotomy with or without a lateral release. Their first conclusion was that an extensive network of extraosseous vasculature existed proximal and distal to the metatarsal head. Their second conclusion was that the vascular networks supplying the metatarsal head were preserved when the osteotomy and lateral release were done properly.

It is the impression of the senior author that using a chevron osteotomy with a lateral release will not only allow for more complete correction of hallux valgus deformity, but that it can be used in cases with greater than 30 degrees of deformity without resultant avascular necrosis of the metatarsal head. The current study is a retrospective review of the senior author's patients with moderate to severe hallux valgus deformity upon whom he performed a chevron osteotomy with a lateral capsular release via second incision.

Materials and Methods

After obtaining human subjects approval by University of New Mexico HRRC, patients were identified by searching CPT codes. We identified 33 consecutive patients, 46 feet, who underwent a distal chevron osteotomy in conjunction with a lateral release. All surgeries were done by a single surgeon using the same technique. The charts were reviewed and radiographs were measured by the same investigator.

Data collected from the charts included basic demographic data, age at the time of surgery, length of follow-up, and any complications that arose. The plain radiographs from the preoperative appointment as well as the final follow-up appointment were reviewed. Measurement was obtained of the first intermetatarsal angle and the first metatarsophalangeal angle of the operated foot. A mark was placed at the center of the articular surface of the proximal and distal end of the first metatarsal. This was repeated for the first proximal phalanx and the second metatarsal. To obtain the hallux valgus angle a line was drawn through the marked center of the proximal phalanx and the first metatarsal. The angle of convergence of these two lines was measured using a goniometer. To obtain the intermetatarsal angle, a line was drawn through the marked center of the first and second metatarsal. The angle of convergence of these two lines was measured using a goniometer. Finally, the congruency of the first metatarsophalangeal joint was recorded as congruent or incongruent. The angles were re-measured and confirmed by a second orthopaedic surgeon.

Surgical Technique

Under tourniquet control, the lateral release was performed first with a longitudinal incision dorsally just proximal to the first web space. The lateral joint capsule, the adductor hallucis tendon, and the transverse metatarsal ligament were identified. The capsule and adductor hallucis tendon were released first. The amount of correction was checked and if further release was necessary, then the transverse metatarsal ligament was released. Release of the transverse metatarsal ligament was required approximately 50% of the time. A second incision was made over the medial eminence of the first metatarsal head. The dorsal medial cutaneous nerve to the great toe was identified and protected. After the first metatarsophalangeal joint capsule was completely exposed an L-shaped incision was made in the capsule which was elevated off of the medial metatarsal head. An osteotome was used to remove the medial prominence of the first metatarsal head. Using a microsagittal saw, the chevron osteotomy in the first metatarsal head was made with the apex pointing distal. The distal fragment was translated laterally and the overhanging bone from the metatarsal shaft was smoothed using a rongeur. The osteotomy was fixed with either a 0.45 pin or a bioabsorbable pin. Holding the great toe metatarsal phalangeal joint in a corrected position, the joint capsule was repaired after removing redundant capsular tissue. The skin was then closed with nylon suture.

Post Operative Care

Patients remained non-weight bearing on the operated extremity for 3 weeks. At three weeks patients were allow to begin weight bearing as toleratve in a post-op sandle. Through out the first 6 weeks post-op patients were kept in a soft bandage to keep the great toe in a corrected position. Patients were seen in the clinic weekly for dressing changes for the first six weeks.

Results

All 46 cases identified were included in the study, they had adequate information charted and the plain radiographs were available for review. The average age of the patients at the time of surgery was 47 with 29 female and 4 male. The average follow-up was 6 months (range 4 to 18 months).

The mean metatarsophalangeal angle preoperatively was 30 degrees (range 22-47) and postoperatively was 16 degrees (range 5-23). The mean intermetatarsal angle preoperatively was 15 degrees (range 10-20) and postoperatively was 7 degrees (range 2-12). In all the cases the first metatarsophalangeal joint was incongruent preoperatively and congruent postoperatively. See Figure 1 and 2 for some examples of the corrections obtained.

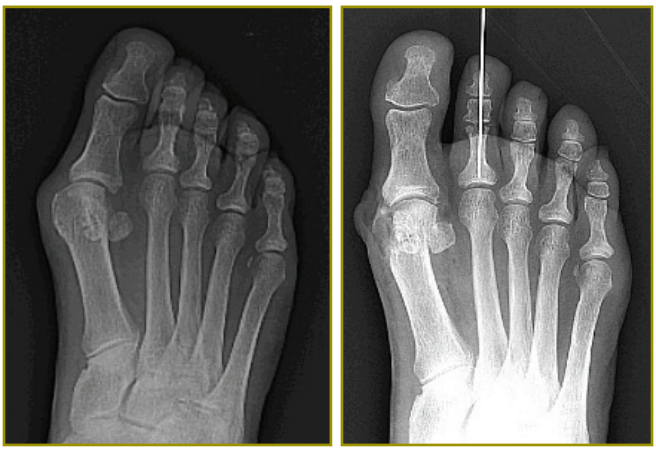

Figure 1: preoperative radiograph showing an incongruent first MTP joint with a MTP angle of 29 degrees and an IM angle of 13 degrees, A. postoperative radiographs showing a congruent joint with a MTP and IM angles of 8 and 5 degrees, respectively.

In this short-term follow-up, none of the radiographs showed evidence of avascular necrosis of the first metatarsal head, on plain radiographs. All patients went on to heal their osteotomy sites. There were three complications.

Figure 2: preoperative radiograph showing an incongruent first MTP joint with a MTP angle of 47 degrees and an IM angle of 13 degrees, A. postoperative radiographs showing a congruent joint with a MTP and IM angles of 20 and 8 degrees, respectively.

There was one case of reflex sympathetic dystrophy, which resolved with physical therapy at one year post-op. Another patient continued to have pain post-operatively despite good correction of hallux valgus deformity. The patient was found to have degeneration of the articulation between the metatarsal head and the medial sesamoid that was present on preoperative radiographs. Patient went on to have the medial sesamoid excised with complete resolution of her pain at nine months after the index procedure. A third complication, was a digital nerve injury which left impaired sensation on the medial aspect of the great toe, which was treated with observation. At last follow-up, 7 months, had occasional tingling on the medial aspect of the toe, but overall sensation had not improved.

Discussion

There are many procedures described for the treatment of hallux valgus deformity. For patients with moderate to severe deformity a proximal procedure is felt to be indicated.[1-4] It is our experience that chevron osteotomy with a lateral release is a reliable method to obtain good correction of the great toe deformity. In our series we did not have any patients develop avascular necrosis of the first metatarsal head with the addition of a lateral release. This allowed us to use a distal osteotomy for patients with larger deformities and incongruent joints. In this moderate sized case series we demonstrated good correction of moderate to severe hallux valgus deformity using a chevron osteotomy and lateral release with out evidence of avascular necrosis. We feel the key to this procedure is using performing a lateral capsular release under direct visualization through a second lateral incision.

The limitations of this study are that it is a retrospective review and relatively short follow up, average of 6 months. We do however feel that this shows an excellent correction can be obtained with distal chevron osteotomy and lateral release with low rates of complications.

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The Use of Human Amniotic Membrane for Cartilage Repair: A Sheep Study

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Introduction

The repair of cartilage defects in humans can be a difficult endeavor, and multiple options exist for the surgeon to approach this topic. The surgeon may choose to influence the defect with microfracture or abrasion techniques to stimulate a fibrocartilage patch in which to fill the defect. There are also options available that allow for the filling of the defect with chondrocytes of variable sources, both of autograft and allograft origin. The goal with all of these procedures is to replace cartilage defects with cartilage or cartilage-like material that is as close to normal hyaline cartilage as possible. An ideal choice for cartilage restoration and repair would be something that is readily available, easy to place in a defect, and minimal morbidity to the patient.

Multiple studies exist expounding on the potential uses of human amniotic cells in various platforms for tissue repair. It has been proven that amniotic cells are pleripotent in nature and can be influenced to produce various cell lines including chondrocytes.[1] Further, it has been shown in the lab that demineralized bone can influence pluripotent cells to produce chondrocyte and osteoblast type cells.[1] The potential for this knowledge to be used to repair cartilage defects has not been explored to the knowledge of the authors up to this point.

This study evaluates the use of human amniotic membrane mixed with demineralized bone to fill cartilage defects in a sheep model. It is hypothesized that this membrane would be able to fill these defects with chondrocyte-like cells, and that the defects would be filled with hyaline cartilage.

Method

Six adult sheep (less than three years old) where chosen for the study. Each of the sheep was evaluated by a licensed veterinarian and was determined to be healthy and without any limb deformity. Each sheep was anesthetized by a licensed veterinarian and one hind-quarter knee of each was sterilized and surgically exposed. Two cartilage defects were created using curettes, one on the weight-bearing surface of the femoral condyle and one in the trochlear grove (Figure 1). The defects did not violate the subchondral bone. Three sheep were used as control sheep and the defects were left unfilled. Three sheep were chosen to receive human amniotic membrane.

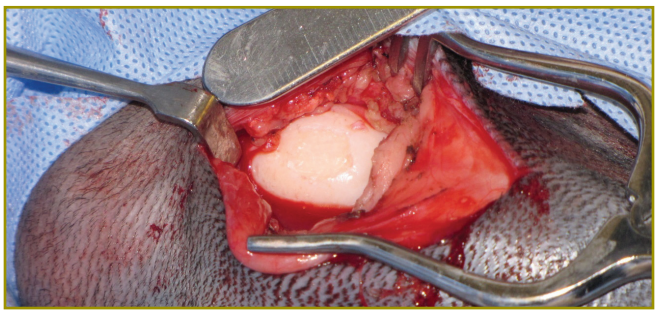

Figure 1: Cartilage Defect

The membrane was procured from a placenta and cut to fit the defect. The portion of the placenta utilized was from the outer membrane of the placenta that has been to shown to have pluripotent cells.[2] Care was taken to place the shiny epithelial layer away from the bone defect because this layer does not have pluripotent cells. The membrane was folded so that the pluripotent cellular layer faced the defect and the joint. Between the layers a small amount of sterilized demineralized human bone was placed in a sandwich-like manner (Figure 2). The membranes were fixed to the defects on the femoral chondyles using micro bone anchors and fibrin glue. The membrane was fixed to the trochlear defects using fibrin glue alone. The wounds were closed and the sheep were allowed to weight bear as tolerated immediately after surgery.

The wounds were evaluated at regular intervals to evaluate for infection and swelling. The sheep were clinically evaluated and a lameness rating was taken at set intervals. At six months post-procedure, the sheep were sacrificed and the distal femurs were harvested. Histological samples were taken of each of the operative sites, both those treated with amniotic membrane and without membrane. Normal cartilage samples were taken from each of the sheep for comparison. The histological samples were taken using mosaicplasty coring instruments to minimize cartilage damage.

The samples from each sheep were evaluated grossly and on a cellular level. Of the sheep that had amniotic membranes placed in their defects, 50% retained the membrane grossly. All of the retained samples were in

the trochlear groove defects. None of the samples on the femoral condyles retained the amniotic membrane. For this reason, analysis of the samples was only performed on those samples that retained the amniotic membrane.

The samples were stained with both H&E and Trichrome staining. Each of the samples (normal, control, and treated) was evaluated using a straight-forward scoring system that is a validated cartilage evaluation method. This evaluation method rates the sample on two levels. First the sample is rated 0-3 on overall appearance (0 = no cartilage present, 3 = mostly normal appearing cartilage) which was referred

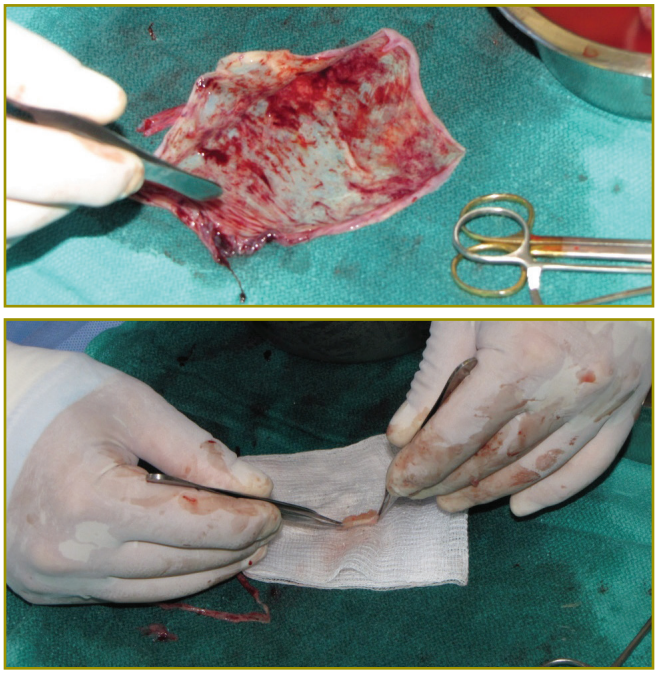

Figure 2: Placental Preparation

to as "simple score". Next, each sample was given a % value of cartilage-like tissue, these values were referred to as "% score". All samples were evaluated by both of the authors who were blinded to the results of the other observer.

Results

The lameness of each of the sheep was evaluated by the veterinarian at set intervals. All but one of the sheep (control) regained full range of motion (ROM) in the limb. All but the sheep that lost some ROM in the limb was rated at a lameness level of 0-1 at final evaluation. Table 1 details the lameness evaluation of each of the sheep.

Of the control sheep, none of the defects filled in with hyaline cartilage or fibrocartilage. In the sheep in which membranes were placed, 50% of the defects appeared to retain the membrane, which is consistent with other similar animal models. Samples of the membrane defects were examined histologically based on a simple, validated scoring system. These samples were compared to normal samples taken from the sheep. There was a strong statistical correlation showing very little difference between the test samples and the normal cartilage. The defects that retained their membranes had evidence of diffuse chondrocyte-like cell proliferation and showed a stromal matrix similar to hyaline cartilage.

Conclusion

Human amniotic membrane is a potential source of plueripotent cells that can be influenced to produce cartilage in defects in sheep model. The implications for application in a human model are promising and warrant further study.

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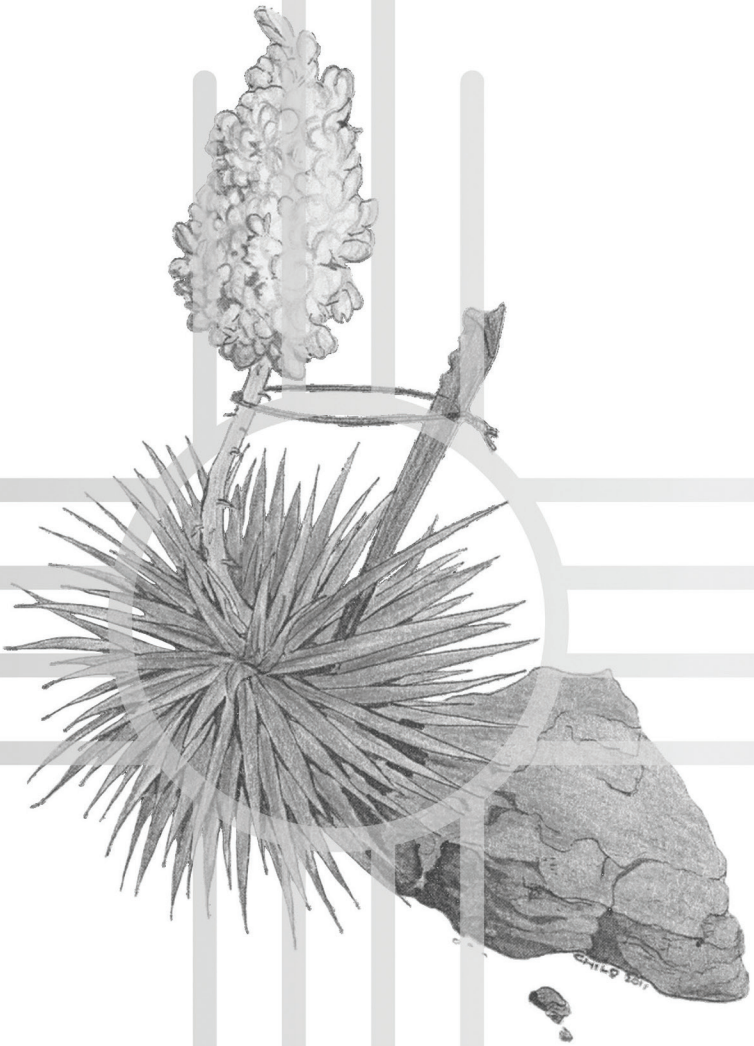
	Evaluation	Lameness (0-5)	Effusion	ROM
Sheep 1 (implant)	2 wks	2	3	
	6 wks	2	0	
	6 mo	0-1	0	full, nml
Sheep 2 (implant)	2 wks	3	2	
	6 wks	2	1	
	6 mo	0-1	0	full, nml
Sheep 3 (implant)	2 wks	2	2	
	6 wks	2	0	
	6 mo	0-1	0	full, nml
Sheep 4 (control)	2 wks	3	3	
	6 wks	1	0	
	6 mo	2	0	
Sheep 5 (control)	2 wks	2	3	reduced flex
	6 wks	2	0	
	6 mo	0-1	0	full, nml
Sheep 6 (control)	2 wks	1	2	
	6 wks	1	0	
	6 mo	0-1	1	full, nml

Table 1



Pediatric Proximal Ulna Plastic Deformation with Anterior Radial Head Dislocation — A Rural Monteggia Fracture Two Weeks out in a Tertiary Care Center: A Case Report

Luke Bulthuis MD† and Selina Silva MD†

†UNM Department of Orthopaedics and Rehabilitation

Abstract

The Monteggia fracture was originally described over two centuries ago. These fractures of the proximal one-third of the ulnar shaft with associated anterior dislocation of the radial head and its variants are well described and still an area of active debate. There is the additional challenge today of tertiary referral centers providing specialized care for this injury in the pediatric population, resulting in missed diagnosis and late referrals. This is a case report of one such patient, an eight-year old female referred to our center two weeks post injury with the diagnosis of an un-reducible radial head dislocation.

Case

An eight-year-old right-hand–dominant female had a fall from horse two weeks prior to presentation at our Pediatric Orthopaedic specialist clinic. Upon the fall, the patient had the left hand outstretched, and she experienced instant pain in her left elbow. She was seen at the Indian Health Services urgent care facility which was located near her home on a Native American Reservation home in eastern Arizona. As is typical in the situation of our patient, access is limited, and she was eventually referred locally and then regionally from her home to a care center in western New Mexico. Upon evaluation, the patient was found to have a dislocation of the radial head with no noted ulnar fracture. The patient was referred to the University of New Mexico Carrie Tingley Hospital, the only orthopaedic practice in the state subspecializing in Pediatric Orthopaedics. It was here that she received definitive orthopaedic management.

Upon evaluation in our clinic, the patient noted that her left elbow was still extremely painful. Her splint was removed and skin was found to be intact. She was found to be neurovascularly intact in the radial, ulnar, and median nerve distribution with palpable radial pulse. There was a prominence seen anteriorly over the antecubital fossa in the elbow, with ecchymosis anteriorly and medially, extending down the forearm. Range of motion of the elbow was limited from 40 degrees to 90 degrees of flexion with a neutrally oriented forearm. Pronation and supination examination were noted to be limited secondary to pain.

Plain radiographs revealed an anterior dislocation of the radial head can be seen (Figures 1a and 1b). Though there was no discrete fracture through the cortex of the ulna, there was an apex volar bowing of the ulna as seen on the lateral view. Closed reduction of the radial head could not be performed secondary to pain in the patient's elbow.

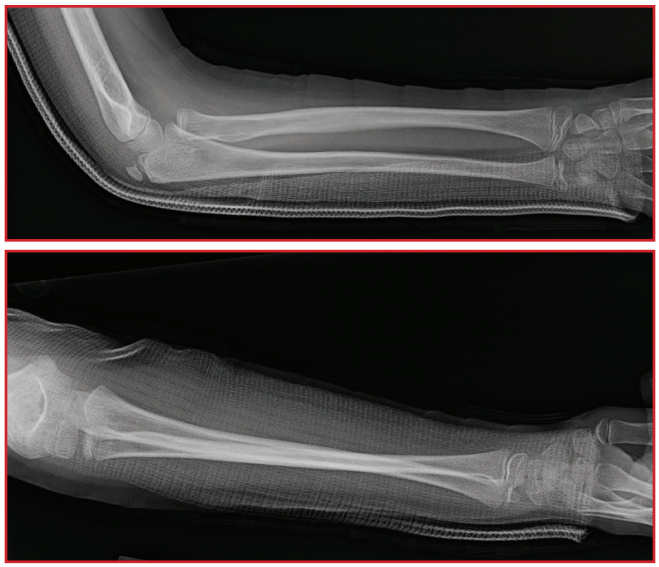


Figure 1:Initial outside x-rays showing radial head dislocation on lateral view.

A full and thorough conversation was undertaken with the patient and her parents. They were informed that the patient had an acute dislocation of the radial head and that she would require sedation for attempted reduction. They were furthermore informed that given the injury was two weeks remote and that inflammation and scar tissue and bowing of the ulna could possibly prevent closed reduction of the radial head. Thus after being informed of full risks and benefits to intervention the patient and parents

consented for anesthesia with closed reduction of radial head dislocation, ulnar osteotomy with internal fixation if necessary, and open reduction of radial head if necessary.

The following day, the patient was taken to the operating room where she underwent general anesthesia. Fifteen minutes of attempted closed reduction under c-arm fluoroscopy were undertaken, including manipulation of the ulnar bowing deformity (Figures 2a and 2b). Reduction of the radial head occurred only with maintained hyperflexion of the elbow.

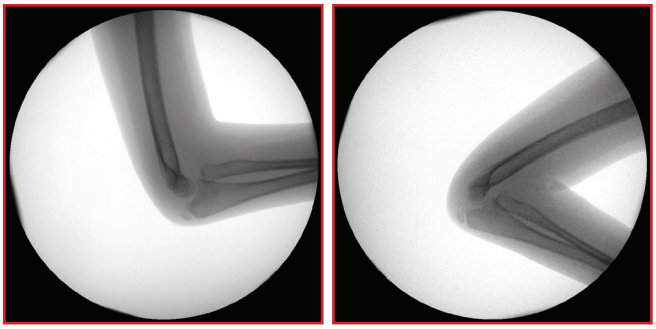


Figure 2: Intra-operative fluoroscan views showing radial head dislocation after unsuccessful attempt at closed reduction

The decision was made to perform the ulnar osteotomy. The patient was prepped and draped in the supine position with the right arm on the armboard. An incision was marked out along the proximal one-third of the ulna along and a direct approach between flexor carpi ulnaris and extensor carpi ulnaris.

Once the ulna had been subperiosteally exposed, the osteotomy was made in the middle of the proximal third of the ulna shaft in an oblique fashion. Fluoroscopy was then used to verify reduction of the radial head, which occurred easily. With the radial head concentrically reduced, a 3.5 LCDC plate was selected, and one screw distally and one proximally were inserted. The reduction of the radial head was found to be maintained throughout full range of motion, and the remainder of the plate was appropriately drilled and filled with non-locking screws totaling six cortices of fixation proximal and distal to the osteotomy.

Views of the radial head were then taken, anterior, oblique and lateral and reduction was found to be maintained (Figures 3a, 3b, and 3c). The patient was irrigated and closed in the standard fashion and placed into a long arm cast with forearm in supination. Intraoperative and postoperative imaging showed the radial head to maintain reduction throughout this procedure.

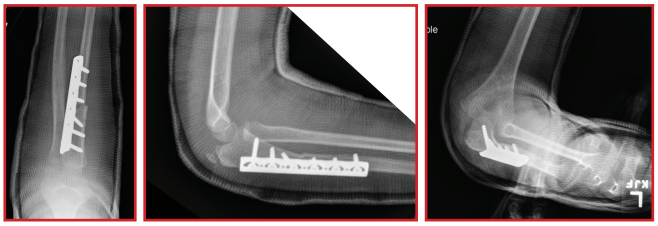


Figure 3: Immediate post operative x-rays after ulnar osteotomy and now concentric reduction of the radial head

Close patient follow up was undertaken to ensure maintained reduction of radial head and for elbow range of motion rehabilitation. At both one and four weeks postoperative, the patient was found to have a maintained reduction, though range of motion was limited at the latter visit, and casting was discontinued with the stipulation that range of motion be the only activity that patient undergo. At five weeks, reduction was maintained throughout range of motion. At the two month follow up, reduction was maintained, the osteotomy site was found to be healed, and the patient was pain-free and had attained full range of motion and thus was returned to activity as tolerated (Figures 4a and 4b). At ten months postoperative, the patient underwent removal of hardware with no adverse events.

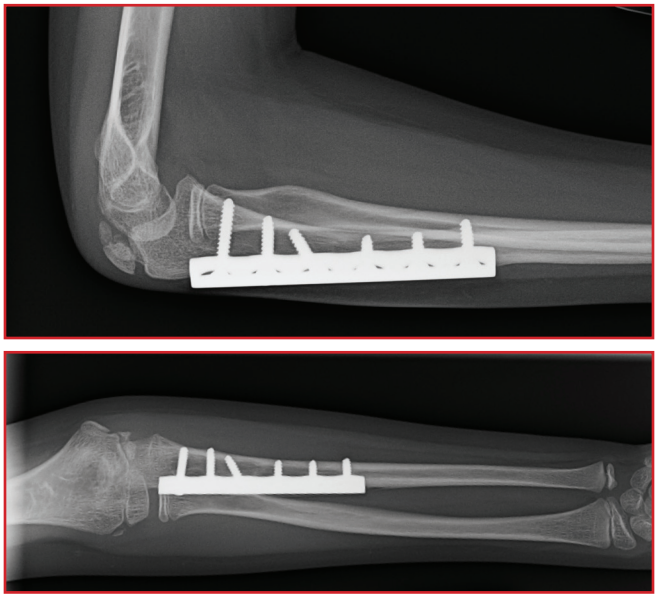


Figure 4: Ten month post-operative x-ray after ulnar osteotomy showing healed osteotomy and maintained concentric reduction of the radial head

Review of the Literature

Monteggia originally described an injury to the proximal one-third of the ulnar shaft associated with an anterior dislocation of the radial head, and though this injury was described in 1814, debate exists to this day about its proper classification and management.[1-4] This is due to the variability of the injury itself, the intricate anatomy in its vicinity of the injury, and the plethora of interventions that provide typically satisfactory yet frequently unreliable results. The forearm contains the radius and ulna and their proximal and distal articulations. When we are considering Monteggia injuries, the radiocapitellar articulation is paramount. The radius must glide along the capitellum in

elbow flexion and extension but must also rotate about the capitellum for the intricate act of forearm pronation and supination which affords uniquely human dexterity. This relationship is sensitive to small changes in the relationship. It was found that to maintain eighty percent of forearm rotation, the radial bow of an injured forearm would need to heal within five degrees of the contralateral side.[5]

Fractures of the proximal ulna associated with radial head dislocation were further categorized by Bado, who noted types 1, 2 and 3 for anterior, posterior, and lateral radial head dislocations, respectively. The observation was made by Ring that these could be considered equivalent to plastic or fracture deformities of the proximal ulna with apex in the same respective direction as radial head dislocation.[6] Rupture of the annular ligament, capsule, or other surrounding ligamentous structures then is obligatory if the radial head is to dislocate.[7] Thus, both ulnar and medial soft tissue deformities must be addressed for treatment of the injury. The injury is significant because it is often not diagnosed initially and the difficulty of reduction.[8] Consequences of a chronically dislocated radial head include pain, decreased range of motion, delayed posterior interosseous nerve palsy, osteoarthritis, and valgus instability,[2,7,9-11] and these problems may be progressive as ulnar growth discrepancy and soft tissue stretching increase with time. Intervention has been notorious for complication.[9-11] One recent case series of seven noted loss of fixation, non-union, radial nerve laceration, transient ulnar nerve palsy and compartment syndrome.[12] Thus, it is still a viable treatment option for irreducible radial head dislocations to be treated with and excision or replacement upon skeletal maturity should the patient have a clinically poor picture.[13]

Treatment options consist of closed reduction, open treatment of ulna, open treatment of radial head, or open treatment of both. Closed reduction can be used in some cases of ulnar deformity and rare cases of ulnar complete fracture. A series of 200 Monteggia lesions showed excellent results for maintained reduction with closed treatment though 10 of 14 Monteggia Bado type 1 closed reductions required reoperation in order to correct the radial head dislocation.[14] One study suggested surgical correction of ulnar deformity if greater than 5mm of deviation of ulnar bend remained from contralateral side[15] and most studies noted the importance of restoring natural ulnar border to be paramount to maintained reduction of the radial head, with splinting in flexion and supination to be the most stable.[6,14]

Most sources recommend initially treating failed closed reduction of the ulna with open correction of ulnar deformity. Surgical recommendation is for reduction of fracture deformity, or in cases of chronic or plastic deformities, osteotomy with fixation to correct deformity.[8, 15-17] There is no agreed upon method of fixation, though less invasive techniques such as wires with casting may be used in children when overall stability is provided.[4] It is suggested that intraoperative radiographic assessment of the radial head reduction be scrutinized by verification of concentricity of the radial head with the capitellum during both extension and flexion with pronation and supination.[6] Reduction of ulnar osteotomy should occur in the position where deformity is corrected but more importantly, where dynamic stability of the radiocapitellar joint occurs. Annular ligament reconstruction is recommended by some as a primary means of operative correction when the condition is chronic—lasting greater than eight weeks.[7,10,14]

Typical recommendation is for a combination of correction of ulnar deformity and repair or reconstruction of the soft tissue structures at the proximal radius when stability of the radial head is not conferred. If restoration of the flat ulnar border is undertaken and the radial head is not stable upon dynamic examination, the radial head must be stabilized.[8,18-19] A variety of techniques may be used, from reconstruction of the annular ligament using triceps fascia to open repair or reconstruction of the capsule while ignoring the annular ligament.[8,18] Other techniques include stabilization of soft tissue structures in the radiocapitellar joint by pinning of the joint until these structures heal.[20] If the radial head cannot be reduced after correction of the ulnar deformity, the joint must be opened to examine for blockage to reduction.[19]

Problems of chronic instability may not be correctable in the above manner by surgical intervention. These cases must be tempered by salvage operations. Children in whom the deformity is late or failed surgical treatment may have to deal with a deformity as continued treatment may lead to elbow stiffness. Eventual excision of the radial head may be a necessity, with or without arthroplasty While not ideal, results are typically better than the painfully chronically dislocated radial head.[4]

Summary

The Monteggia fracture and its variants have been the source of endless debate for greater than two centuries, prior to the roentogram. The principles of the injury are constant, though subtle variations to the injury make its treatment a challenge. Essential to successful treatment of lesions is the understanding that the forearm functions as one unit, and that both the integrity of the radiocapetellar joint and correction of ulnar deformity are necessary for treatment. Through examination of the literature, there is no one recommended treatment, though a clear treatment algorithm is suggested.

Initial workup of the patient should include a thorough history and physical and adequate radiographic examination of the patient. Prior to attempted closed reduction under sedation, the chronicity of the injury should be assessed. A congenital or chronic dislocation of the radial head will not likely reduce with closed manipulation, and an attempt would cause needless discomfort and incur the risks of sedation. An attempt under sedation should be attempted at acute presentation with splinting and close follow-up of patient regardless of success of reduction. A failed reduction should require formal attempt under operative sedation with the option of open treatment within two weeks of injury if possible. In the case of a late presentation, it is suggested that such an attempt can be undertaken anytime in the first year after injury.[8] It is important to evaluate the patient for additional injuries such as fracture of the radius, stability of distal radioulnar joint, and ulnar fracture, as these injuries will require different methods of treatment. If further intervention is required, additional imaging may be needed. When the ulnar deformity is not clear, plain radiographic imaging of the contralateral forearm with good lateral of the elbow should be undertaken for closed reduction and/or operative planning. In larger and more chronic deformities of the elbow, CT imaging should be considered, and 3D reconstruction can be useful for determination of failed forearm dynamics.[17]

As was the case with our patient, considerations must be given to the patient's access to health care. Furthermore, this consideration must be taken by care providers at every level of the patient's care. In our case, this meant arranging for general anesthesia with attempted closed treatment and operative intervention readied. Thus, the patient required anesthesia once for definitive treatment and once for implant removal following healing of osteotomy.

This well-described injury still poses challenges greater than two hundred years following its namesake's description. With knowledge of anatomy of fracture, treatment algorithm, and attention to the modern complexities of health care access, timely and successful management is possible.

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Chondroblastoma of the Humeral Epiphysis in a 15-Year-Old Female: A Case Report

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Introduction

Chondroblastoma, first described in 1927 by Kolodny and further detailed by Codman in 1931 and Lichtensterin and Jaffer more recently, is a benign ephiphyseal/apophyseal tumor primarily affecting the long bones.[1,2] It consists of 1-2% of all primary bone tumors and 5% of benign bone tumors.[3-5] The male to female ratio is 2:1.[3-8] The greater majority of patients are less than 20 years old.[9,10] The bones most affected are the femur and humerus.[5-10] While less common, chondroblastoma tumors can be found in the tibia, foot, flat bones, and vertebrae.[11,12]

One single, specific cytogenetic abnormality that can lead to chondroblastoma has yet to be described. However, research looking at cartilage signal molecules is proving promising. Studies have shown the tumor to be of mesenchymal cell origin, dedicated to chondrogenic life cycle via signals from active growth plate pathways, thus verifying the intricate relationship of chondroblastoma to the epiphysis.[14,15]

Grossly, chondroblastoma is a gray-white tumor with yellowish areas of calcification.[2] Microscopically, it has compact areas of chondroblasts with 1-2 nuclei, few mitotic figures, and the occasional multinucleated osteoclast like giant cells.[6] The textbook finding of dystrophic calcification "chicken wire" may also be present. Nearly one third of cases have secondary aneurysmal bone cysts.[6-8,10] Aggressive and metastatic tumors have been shown to have the same histology as indolent and solitary tumors.[16]

Chondroblastomas are classified according to the Enneking benign tumor classification.[23] Clinical presentation is usually insidious in nature with progression of pain from mild to significant both locally and in the adjacent joint.[3,4,6,8-10] Patients can present with a soft tissue mass or pathological fracture though this is uncommon with highest incidence of this in tumors of the foot. They usually have decreased range of motion and muscle wasting.[4,6,8-11]

Radiographically they are well-defined, eccentric oval or round lytic lesions of the epiphysis adjacent to an open growth plate.[3] Margins are generally sclerotic and sharp, sometimes having intralesional mottling with or without calcification. Most tumors are less than 4cm in size.[2,4,6,9] It is common to find surrounding soft tissue and marrow edema, but rare to find periosteal bone formation.[17] While some epiphyseal lesions will cross the physis and invade the metaphyseal bone, true metaphyseal and diaphyseal chondroblastomas are rare but have been described.[14,18] CT scan is ideal for identifying the tumors anatomic limits including distance from the growth plate.[11,12] Chondroblastoma is hypointense on T1 MRI and variable hypo-to hyperintense on T2. MRI is ideal for evaluating the status of surrounding soft tissue and the extent of marrow edema.[17]

The natural history of chondroblastoma has shown that it does not spontaneously resolve and has not been shown to respond to medical management.[5] The standard of care at this point is intralesional excision via curretage and bone graft with care to avoid the growth plate in skeletally immature individuals.[6-12] Excision augmented with high speed burr, electrocautery, phenol, argon beam, and cryotherapy are all described appropriate treatments.[19] Radiofrequency has been shown to have success with small tumors (<2 cm) that are away from the joint.[20] For aggressive tumors and recurrences, limb-sparing surgery and endoprosthetic reconstruction are now options.[4,10] Due to late recurrence and possibility of lung metastases, most recommend an annual follow up for at least 5 years with chest x-rays at each annual visit.[7]

The most common complication for chondroblastoma is recurrence, with studies reporting a 5-40% recurrence rate. However, the rate of recurrence is not related to one specific mode of management, tumor size, patient sex, or duration of follow-up.[6,8,9] The most common reason for recurrence is incomplete resection and biologic aggressiveness.[7] Less than 1% of chondroblastomas metastasize. There is no reported relationship of metastatic lesions to previous surgical or non-surgical treatment, tumor location, or patient age.[16,21,22] The average time to metastasis is 8 years.[16] Common locations are the lungs, other bones, soft tissue, skin, and liver.[16,21] Patients with metastatic chondroblastoma continue to have long survival rates and no benefit from chemotherapy.

Case

EG is a 15-year-old female, right hand dominant, who presented to the pediatric upper extremity clinic in August of 2013 with a chief complaint of eight months of left shoulder pain that was constant and exacerbated with use. Without a history of trauma, her pain was anterior, worse with overhead activity , decreased range of motion and significant muscle atrophy. She had mild relief with anti-inflammatory medication. She presented with a diagnosis of rotator cuff tear. Past medical, surgical, birth, and developmental history were all normal. There is no family history of cancer.

On physical exam, she was found to have pain with range of motion and tenderness to palpation at the left proximal humerus without a palpable mass. Pain significantly limited her range of motion with forward flexion and abduction at the left shoulder less than 90 degrees actively and passively. She had external rotation to neutral. She had noted atrophy of the left shoulder, arm, and forearm with decreased strength.

Radiographs of the left shoulder and humerus revealed a well-circumscribed lucent lesion within the proximal humeral epiphysis (Figure 1). There was no cortical disruption noted, but the lesion did extend very near the glenohumeral articular surface. A 3.0 Tesla MRI revealed a 3.5cm x 3.1cm, x 2.8cm heterogeneous, well-circumscribed lesion of the epiphysis that invaded the open physis and extended into the metaphyseal region. There was noteable marrow and soft tissue edema without axillary lymphadenopathy and a moderate joint effusion (Figures 2 & 3). CT of the chest was normal without metastatic lesions to the lungs. Full body bone scan was negative for multifocal disease.

One week after presentation, the patient had a CT-guided core needle biopsy performed by interventional radiology (IR). Pathology findings were consistent with chondroblastoma. Three weeks after her initial presentation, she underwent cryoablation. She experienced temporary partial relief of her pain from the cryoablation but her symptoms returned to baseline level in two months.

The patient subsequently underwent two cycles of radiofrequency ablation three months after her initial presentation. She again experienced minimal relief and was taking maximum doses of anti-inflammatory medications.

She was re-evaluated four months after the biopsy and repeat x-rays, CT, and MRI showed mildly increased marginal sclerosis as a result of the ablations but the tumor had increased in size now measuring 3.6cm x 3.5cm x 3.2cm and was very near the articular surface with more reactive soft tissue and marrow edema. There were also axillary reactive lymph nodes present.

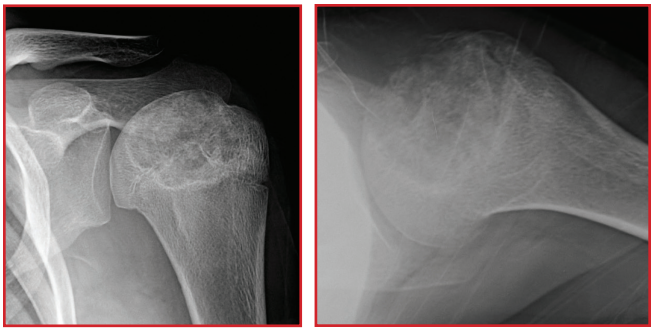

Figure 1: AP and Lateral radiographs of left shoulder showing a well-cicrumscribed lucent lesion with intralesional mottling and extension into the open physis and articular surface.

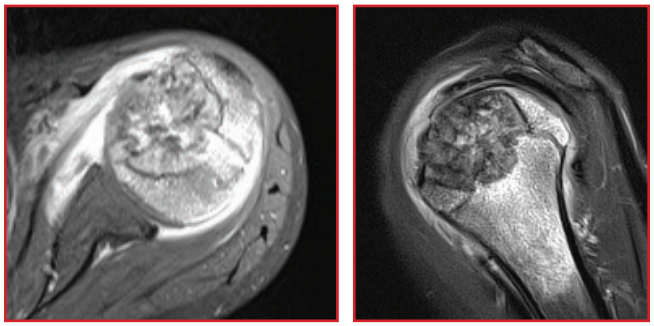

Figure 2 (left): Axial MRI T1 post-contrast showing lesion measuring 3.5cm x 3.1 cm. There is noteable associated soft tissue and marrow edema with a moderate joint effusion.

Figure 3 (right): Parasagittal coronal MRI T2 showing proximal marrow edema while also highlighting the intricate relationship of the lesion to the open physis.

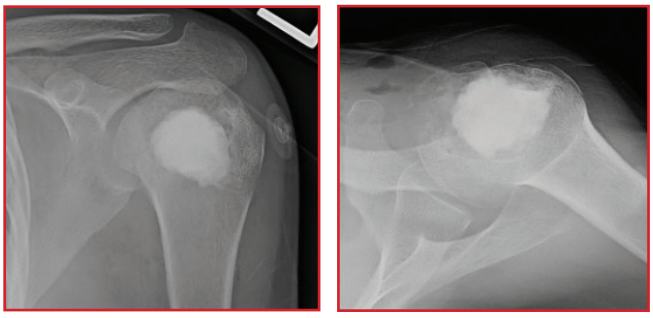

Figure 4: AP (A) and Lateral (B) radiographs of left shoulder after curettage and bone grafting. The white material on the x-ray is the bone graft.

On month 7 from presentation, she underwent intralesional curettage and grafting of the proximal humerus with bone graft substitute of calcium phosphate and calcium sulfate.[24] The deltopectoral approach was used and an anterior cortical window was created. Curettage was done using a high-speed burr with hydrogen peroxide for irrigation. Meticulous care was used to avoid the articular surface. (Figure 4)

Intraoperative pathology results show no cytogenetic abnormalties on genotyping with classic microscopic features of chondroblastoma (including molecular marker S-100 and DOG-1 +) in addition to hypocellular fibrosis

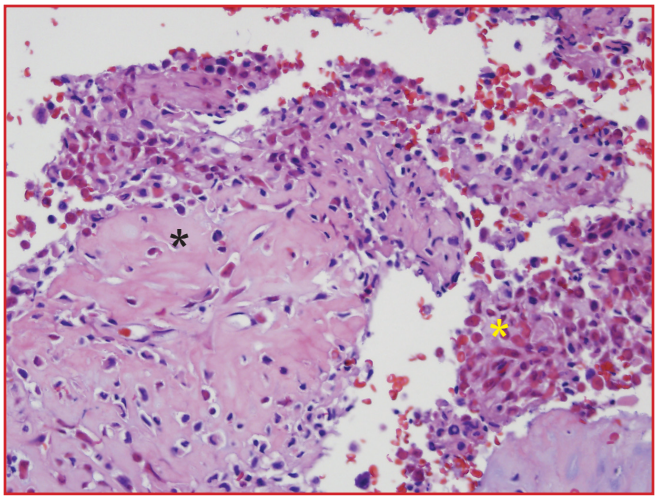

Figure 5: Slide micrograph image of chondroblastoma tissue biopsy showing area of necrosis after cryoablation (yellow star) and multinucleated pathological cell (black star).

and reactive and new-bone osteoid matrix. Her histology showed areas of necrosis from the cryoablation and pathological multinucleated cells. (Figure 5)

At her most recent follow-up two weeks post-operative, she had significant decrease from her baseline level of pain. She was showing increased strength with good effort. She had the same limited range of motion but minimal pain through the range.

Discussion

This patient represents a typical presentation of chondroblastoma. It was explained to the patient and her family at the time of presentation that intralesional curettage and bone graft would be the definitive treatment. A big concern for the patient was finishing out her school year before undergoing surgery and getting her pain controlled. Of concern to the surgeons was the proximity of the tumor to the articular surface of the humerus. Thus, in an effort to help sustain the articular surface, decrease the patient's pain, and to hopefully buy her some time until the school year was completed, cryoablation was done. Given the patient had some relief but her pain returned, radiofrequency ablation was attempted. Repeat imaging after both procedures were completed showed the tumor had increased in size. These interventions were not as successful as we had hoped, but the team was aware prior to the intervention that studies weren't reporting much success with tumors the size of the patient's in terms of decreasing size or symptom relief. The post-operative pathology showing hypocellular fibrosis indicates, however, that there were changes to the tumor as a result of the ablations.

In an effort to maintain the articular surface of the proximal humerus, the most superior aspect of the tumor was not entirely excised and this is evident on post-operative x-rays. This potentially does place the patient at increased risk for recurrence. The amount of symptom relief the patient experienced is promising. She will be followed closely in the post-operative period and then annually for at least 5 years. A follow-up case report is planned, particularly looking at recurrence, residual shoulder dysfunction, and maintenance of the glenohumeral joint surface.

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Arthroscopic Management of Extra-articular Hypertrophy of the Anterior Inferior Iliac Spine Apophysis Resulting in Hip Impingement: A Case Report

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Introduction

Femoroacetabular impingement (FAI) is described as a disorder at the femoral neck and acetabular rim junction.[1] While the majority of this pathology is the result of intra-articular abnormalities, extra-articular sources can also result in impingement type symptoms and dysfunction.[2-5] Hypertrophy of the anterior inferior iliac spine (AIIS) has been described as a potential source of extra-articular hip impingement.[6] Etiology of AIIS hypertrophy includes excessive congenital bone formation at the AIIS apophysis or the result of avulsion-type injuries of the direct head of the rectus femoris tendon.[7] Bone hypertrophy in this location can result in impingement type symptoms and lead to FAI related pathology including dysfunction of the hip joint including labral tears, acetabular cartilage damage and cystic bone changes in the femoral neck. As a result, surgical decompression can be indicated in the setting of AIIS hypertrophy and FAI related symptoms and pathology. Three types of AIIS morphology have been described including type 1 (distal AIIS ends proximal to acetabular rim), type 2 (distal AIIS extends to the acetabular rim), and type 3 (distal AIIS extends beyond the acetabular rim), where increasing subtypes are associated with worse clinical symptoms and related hip joint pathology.[8]

Both open and arthroscopic techniques have been described.[6,9,10] While open approaches have definite utility, arthroscopic techniques allow the surgeon to address the offending pathology while minimizing surgical morbidity.[11] In addition, arthroscopy enables the surgeon to address both extra and intra-articular pathology on both the femoral and acetabular side of the hip joint without significant difficulty and with little exposure or trauma to the joint and capsule.[11] In this case report, we describe a patient who underwent arthroscopic decompression and osteoplasty to manage hip impingement secondary to both intra- and extra-articular morphology.

Case Report

A 23-year-old male military cadet presented to our clinic complaining of 8 months of progressively worsening right hip pain. The patient noted sharp, sustained pain localized in the hip/groin region that appeared to be associated with long periods of walking/marching and running. Patient did not mentionany specific history of trauma or other injury to the hip region but did note that he had been active throughout his life. Physical exam noted pain with hip flexion, internal rotation, and abduction. Patient had limited hip flexion to 105°.

Plain x-rays including anterior-posterior view of the pelvis, and anterior-posterior and lateral views of the hip were performed (Figure 1). These demonstrated a large bony prominence at the level of the AIIS as well as a small femoral neck CAM deformity. In addition, cystic changes at the femoral head/neck junction were also identified. The joint space about the femoroacetabular articulation was well preserved and there were no other notablesurrounding osseous abnormalities. In addition to the hypertrophic bone changes at the level of the AIIS, an MRI also demonstrated evidence of anterosuperior labral tearing.

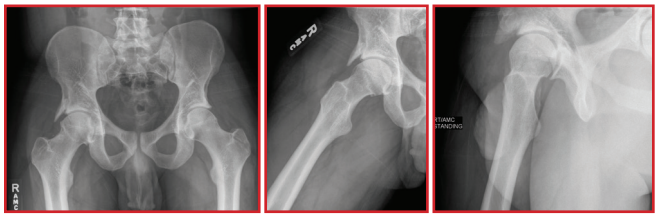

Figure 1: Plain x-rays of pelvis and right hip, pre-operative

Initially non-operative treatment was offered including activity modification, non-steroidal anti-inflammatory drug regimens, and intra-articular joint injections. Unfortunately these did not effectively relieve his symptoms particularly the intra-articular steroid injection, which

did not provide any noticeable pain relief or restoration of function.[11]

Due to continued limitations with activity and significant right hip pain, the patient elected to proceed with arthroscopic surgery. Using standard anterolateral and mid anterior arthroscopic portals the patient underwent resection of the AIIS prominence, femoral neck osteoplasty, anterior rim trimming and labral debridement. After a capsulotomy was performed, a large, non-mobile bone fragment was encountered that was found to overhang the joint by 2-3 centimeters, consistent with type 3 AIIS morphology.[8] Full exposure of the fragment was carried out and it was removed in a piecemeal fashion using and arthroscopic burr (Figure 2). Visual feedback and assessment of the amount of resection was aided by intraoperative fluoroscopy. Post-operative x-rays demonstrated interval removal of the AIIS hypertrophic bone spur as well as post-operative changes consistent with femoral neck osteoplasty (Figure 3).

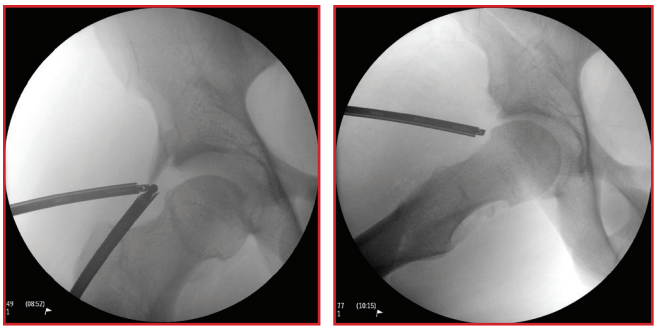

Figure 2: Intraoperative x-rays of right hip

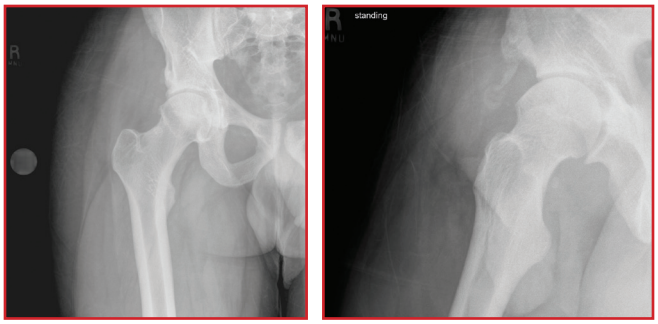

Figure 3: Plain x-rays of right hip, post-operative

Post-operatively, the patient underwent directed rehab including physical therapy and exercise biking. Patient's range of motion continued to progress post-operatively and hip pain substantially decreased compared to pre-operative levels. Follow-up and re-introduction of full range of activities is ongoing.

Discussion

FAI is a condition that is the most common mechanism behind early cartilage and labral damage in the non-dysplastic hip.[1] Early diagnosis and management is important in terms of hip preservation and limiting the amount of early degenerative changes that are often part of the spectrum of sequelae that characterize the clinical picture of FAI. Commonly, bony changes and congenital abnormalities at both the femoral and acetabular sides contribute to FAI pathology. 86% of patients presenting with FAI have a combination of cam and pincer type impingement.[12] More commonly, morphological changes contributing to FAI are intra-articular, however extra-articular abnormalities can also contribute to overall pathology including hypertrophy at the AIIS as described above. As illustrated in this case, it is important to assess those common intraarticular changes that contribute to FAI in the setting of obvious extra-articular abnormalities in order to manage all potential contributing factors to the overall clinical picture. As presented here, the patient had an obvious extra-articular bone spur resulting from a presumed rectus femoris avulsion injury, as well as a small cam deformity that may have also been a factor in the development of resulting joint damage including tearing of the labrum and grade 3 chondromalacia at the acetabular rim. Both potential factors were addressed arthroscopically, hopefully improving the likelihood of a good post-operative outcome and limiting continued degeneration of the hip joint.

Surgically, both arthroscopic and open approaches have been described to address extra-articular causes of hip impingement with good success.[13] Arthroscopy is particularly appealing in terms of limiting surgical morbidity including major complications.[14] Exposure and visualization are reasonable arguments for pursuing open approaches. As demonstrated in this case, however, we were able to address pathology on both the femoral and acetabular side of the joint relatively easily as well as being able to tackle both intra and extra-articular causes of FAI. This was accomplished relatively routinely with standard hip arthroscopy portals and patient positioning. This case, while certainly not unique in its presentation and resulting surgical intervention, does provide continued evidence of the utility of hip arthroscopy in trained hands to manage FAI pathology on both the femur and acetabulum whether or not the morphology is inside or outside of the joint.

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Stress Fractures in an Athlete with Primary Amenorrhea after Onset of Menarche at Age Twenty-Two: A Case Report

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Introduction

The female athlete triad consists of low energy availability, low bone mineral density, and menstrual irregularities. Low energy availability may be due to food restriction and/or excessive energy expenditure. Menstrual irregularities may consist of primary or secondary amenorrhea. In primary amenorrhea, the patient does not get her period by fifteen or sixteen years old. In secondary amenorrhea, the patient had menarche but missed three or more periods in a row. Low bone mineral density in premenopausal females can be defined as a Z-score between -1.0 and -2.0 but a Z-score of less than -1.0 in athletes is concerning because athletes usually have higher bone mineral densities than the general population1. The female athlete triad is difficult to treat due to multiple factors affecting the patient, such as pressure to succeed and to be thin, but the main goal of treatment is to have adequate caloric intake to improve bone mineral density and resolve menstrual irregularities. If not treated, the female athlete triad can lead to serious complications, such as osteoporosis, fractures, infertility, and cardiac arrhythmias[1]. On the other hand, with proper guidance and treatment, patients can resume regular menstrual cycles and possibly improve low bone mineral density.

Case Report

A twenty-two-year-old female cross country athlete presented to the training room clinic with primary amenorrhea. She was originally from Canada and had multiple work-ups for primary amenorrhea when she was fifteen, nineteen, and twenty-one years old but still did not reach menarche. Patient had always been slender, with her BMI around 16 kg/m^2, so she did not think much of her weight. Her mother and grandmother were also slender but they had menarche around fifteen years old. When the patient was in Canada, she had a pelvic exam and ultrasound, which showed cysts on the left ovary but otherwise normal. She was told that she may not have her period because she has polycystic ovaries. She had labs done that showed normal LH, FSH, anterior pituitary labs, TSH, and prolactin. She had low estradiol, progesterone, and serum testosterone.

After graduating high school, the patient attended a U.S. NCAA Division I University on a cross-country scholarship. At this University, she had another work-up that included labs, pelvic ultrasound, and DEXA scan, which showed osteopenia. After two years at this University, she transferred to another U.S. NCAA Division I University, where she again had a work-up for amenorrhea. In addition to these work-ups, the patient also did not have a withdrawal bleed with Provera. After the multiple work-ups, she was diagnosed with hypothalamic primary amenorrhea. She was encouraged to gain weight; however, the patient did not feel that she had been adequately instructed on how she should gain weight. She was offered oral contraceptive pills but the patient thought this was an "unnatural" way to get her periods so did not start the oral contraceptive pills.

The patient transferred to the University of New Mexico for her last year of eligibility as a graduate student. At this time, she did not have any stress fractures but did have stress reactions. Her history and presentation were not consistent with disordered eating but the patient was slender with a BMI around 17 kg/m^2. Her physical exam showed temperature of 97.6 degrees Fahrenheit and blood pressure of 97/61 mmHg. Her general exam showed a slender patient, in no acute distress. Her extremities showed mottling of both hands and feet with coolness. The rest of her physical exam was normal. At the University of New Mexico, she had repeat labs done and a DEXA scan. Her vitamin D 25-OH was 26, FSH was 9.5, and LH was 12.1. The DEXA scan results showed osteoporosis of the lumbar spine.

A meeting was held with the patient, one of the team physicians, her coach, and the sports nutritionist. They discussed that the results from the labs and her past work-ups suggest the diagnosis of hypothalamic primary amenorrhea due to the stress of running and low body weight. They came up with the goals to begin menarche naturally and attain better bone health by decreasing overall mileage and advancing diet. If she did not gain weight, exogenous estrogen was going to be considered. She was placed on Vitamin D3 1000 mg and Calcium 1200-1500 mg per day. Patient met with the nutritionist regularly and added about 800 calories to her daily intake. Since the nutritionist understood that the patient did not want to

feel heavy or weighed down because she is a runner, the nutritionist added a little protein, such as an egg to breakfast, and more calories, such as dried fruits and nuts, to her post-practice meals. The patient had gradual weight gain, about one to two pounds per week. After seeing the nutritionist for three and a half weeks, the patient had her first period. At the time of menarche, she was 47.4 kilograms, which placed her BMI at 18 kg/m^2.

The patient's first period lasted for four to five days. She also had associated cramping and acne. Patient became sexually active and requested to be started on oral contraceptive pills. During this time, the patient felt that she has improved stamina and workout recovery. She completed a 10 K run with a personal best. The patient had her second menses about twenty-six days after her first menses and at this time, she was 50.0 kilograms.

Unfortunately, approximately one month after she got her first period, the patient noticed right groin and buttock pain. The pain was sharp and worse with bearing weight on the right leg, bending over, internal rotation, and prolonged sitting. She did not have any injuries that started this pain. She was initially thought to have tight piriformis and hamstrings and was given Celebrex, as well as treatment with the athletic trainers. Her running volume was also decreased. The pain persisted with even limited running so after repeat evaluation, pelvic x-rays were ordered that showed a right ischial tuberosity stress fracture (Figure 1).

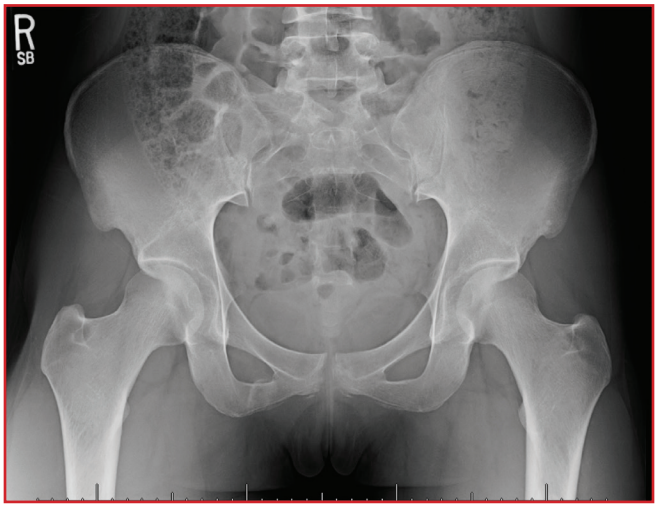

Figure 1: Right ischial tuberosity stress fracture. Incidental note of skeletal immaturity in this 23-year-old female (persistent apophyses along the bilateral iliac crests and ischial tuberosities).

Patient was instructed to rest completely from running, but was allowed pain free cross training. Three weeks later, a repeat x-ray showed healing right ischial fracture and she was progressed to zero gravity or underwater treadmill running as tolerates. Patient started running on dry land again without pain after about 6 weeks from her stress fracture diagnosis.

A little over a month after she returned to dry land running, the patient noticed pain in her right ischium and inguinal area, worse after her runs. An MRI of her pelvis was done and showed a new right superior pubic ramus and left inferior pubic ramus fracture, as well as incompletely healed (delayed healing) of the right inferior pubic ramus fracture (Figure 2). The MRI also showed an incidental finding of proximal left femoral bone lesion (Figure 3).

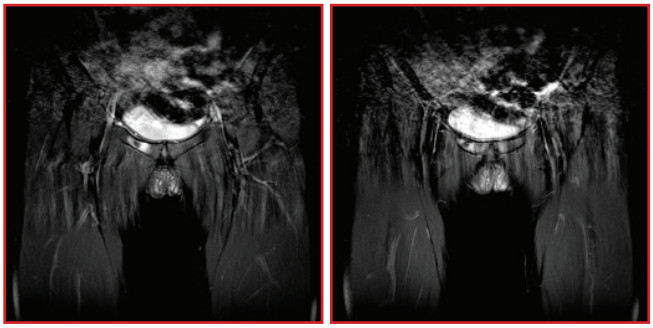

Figure 2: MRI showing new right superior pubic ramus and left inferior pubic ramus fractures. Incompletely healed (delayed healing given the intervening time) right inferior pubic ramus fracture.

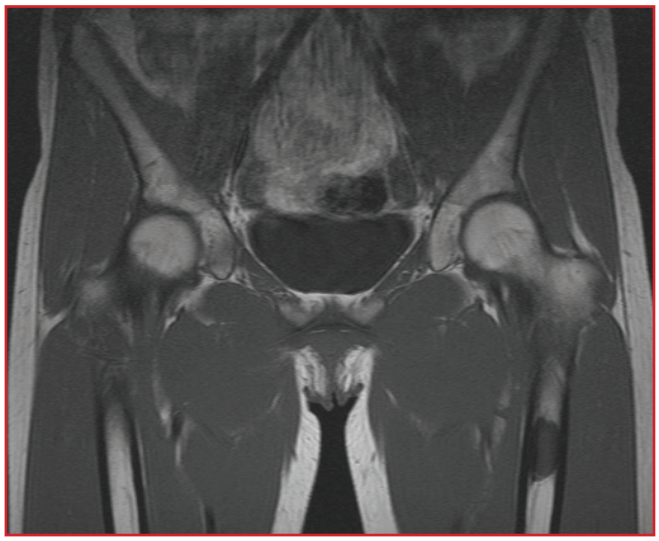

Figure 3: Incidental proximal left femoral bone lesion with very nonaggressive features.

The patient was seen by an Orthopedic Oncologist who felt the incidental femoral lesion was most likely due to fibrodysplasia and would monitor with another x-ray in 3 months. The patient was again instructed to rest and refrain from running. She was placed on crutches for a short period of time but then progressed to activity that did not cause any symptoms. She did not have pain with walking or using a stationary bike. Patient progressed her time on the stationary bike and started swimming more since this did not cause exacerbation of her pain. She was still not able to run due to pain. She had follow-up x-rays of her pelvis that showed bone healing but persistent fracture lines, indicating delayed bone healing (Figure 4). She currently is not able to run so is cross training with biking and swimming.

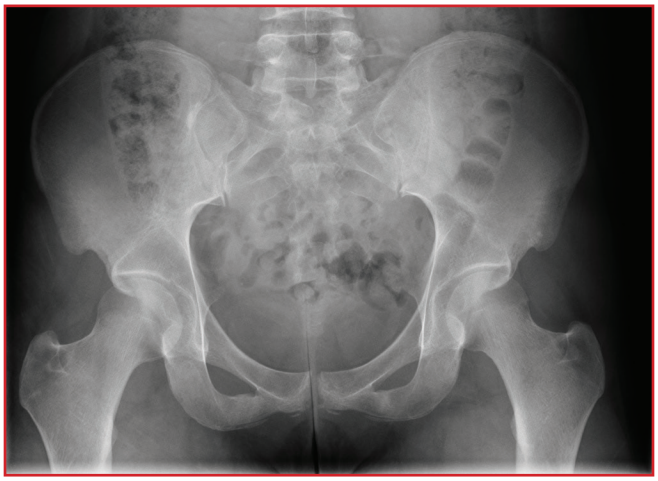

Figure 4: Follow up x-ray showing healing right obturator ring and left inferior pubic ramus fractures, unchanged in alignment

Discussion

The patient met criteria for the female athlete triad with low energy availability, low bone mineral density, and menstrual irregularities[1,2]; however, she was able to reach menarche in a little more than three weeks of having a positive caloric intake. Indeed, optimal treatment for the female athlete triad is to resolve low energy availability,[1,2] which this patient had accomplished. Multiple studies have shown that weight gain in anorexic patients can restore menses, which also leads to improvements in bone mineral density.[2,3] As with this patient, the treatment plans should consider the patient goals, unique diet and training, and any coexisting conditions. The primary goal should be to restore or normalize body weight; however, this may be more difficult if disordered eating is present, which was not the case in this patient. An increase in energy availability can affect metabolic hormones within days to weeks and menstrual function can resume in months,[2] but this may not be the same with restoring low bone mineral density.

Although normal menses may resume, restoring bone health can take longer. In this case, the patient increased her energy availability and started having normal menses but had three stress fractures after she reached menarche. Indeed, irregular menstrual cycles and low bone mineral density are associated with increased risk for stress fractures.[2] In a study done by Nattiv et al on NCAA track and field and cross-country athletes, female athletes with oligomenorrhea and amenorrhea had higher grade bone stress injuries and significantly lower bone mass4. The bone loss with the female athlete triad is likely due to energy deficient related factors and estrogen deficiency.[1,2] Lower estradiol levels can reduce calcium absorption, increase bone resorption, and suppress bone formation.[4] Therefore, both nutritional and hormonal recovery needs to be addressed to restore bone health.[1-3] The patient started her periods by increasing energy availability but her bone mineral density had already been affected and there is no clear timeline when or if her bone mineral density will improve.[1,3] Osteoporosis may be partially irreversible despite resumption of menses, oral contraceptives, and calcium.[5] One article suggested that osteoporosis may be irreparable after three years of amenorrhea.[6] Patients with amenorrhea may lose 2-3% of bone mass per year if not treated.[3]

After females regain their periods, improvements in bone mineral density can occur slowly, sometimes taking years, if possible.[2] Studies have shown that increases in bone mineral density of 2-3% per year have been seen with weight gain in patients who were anorexic1. Since patients may have low bone mineral density for a prolonged period of time, providers should also assess calcium and vitamin D states.[1,2] Patients should have at least 1,200 to 1,500 mg of Calcium per day and 400 to 800 IU of Vitamin D per day.[1,5,6] Weight bearing exercises may also help with bone strength; however, high impact activities in patients with low bone mineral densities may result in fractures.[2] Studies have shown that stress fractures occur more frequently in physically active women who have menstrual irregularities and low bone mineral density.[1] Pharmacological treatment may be considered if patients fail one year of non-pharmacologic treatment or if they have new fractures; however, there is no clear guidelines for pharmacological treatment in premenopausal women.[2] Bisphosphonates should not be used in premenopausal women with functional hypothalamic amenorrhea because of unproven efficacy in women of child-bearing age and bisphosphonates can reside in bone for years, potentially harming a fetus in the future1. Estrogen administration may be considered for those who are older than sixteen years old and have failed non-pharmacological treatment, but there is also mixed evidence for using oral contraceptives to increase bone mineral density.[1,2,5,6]

Prevention and early intervention is vital to treating the female athlete triad and reducing the risk of stress fractures. This patient may not have had stress fractures if she had reached menarche at a normal time. DEXA scans should be considered if patients have one or more high risk triad factors: history of diagnosed eating disorder; BMI 17.5 kg/m^2 or less, less than 85% estimated weight, or recent weight loss of 10% or more in one month; menarche at sixteen years old or later; current or history of less than six menses over twelve months; two prior stress fractures or stress reactions, one high risk stress fracture or stress reaction, or low energy non-traumatic fracture; and prior Z-score less than -2.0. DEXA scan should also be considered if patients have two or more moderate triad risk factors: current or history of disordered eating for six months or more; BMI between 17.5 and 18.5 kg/m^2, less than 90% estimated weight, or recent weight loss of 5-10% in one month; menarche between fifteen and sixteen years old; current

history of six to eight menses over twelve months; one prior stress fracture or stress reaction; prior Z-score between -1.0 and -2.0. Any athlete with a history of one or more non-peripheral or two or more peripheral long bone traumatic fractures should be considered for DEXA if they have one or more moderate or high risk triad factors. A consensus statement recommended follow up DEXA scanning should be obtained when there are expected changes in bone mineral density Z-scores. Studies have shown that increases in bone mineral density in anorexic women were associated with weight gain and resumption of menses but those who did not resume regular menses had continued declines in bone mineral densities.[2]

Initially, this patient was being evaluated for primary amenorrhea and her current bone mineral density was not known. She had reported a past DEXA that showed osteopenia. This patient was allowed to continue to train and compete; however, at that time, there were no clear recommendations as to when an athlete with the female athlete triad should be restricted from training. A recent consensus statement made recommendations for return to play after the first (San Francisco) and second (Indianapolis) International Consensus Meetings on the Female Athlete Triad took place (Figures 5 and 6). According to these recommendations, the patient would have had a high enough score that would have placed her at high risk and restricted her from training and competition.[2] Although there were no clear recommendations at the time the patient was initially evaluated, these recent recommendations can be used to screen for the female athlete triad, especially at pre-participation exams. Nevertheless, this case demonstrates that females are able to resume normal menstrual cycles by restoring their energy availability but the benefits on bone health may take longer.

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Risk Factors	Magnitude of risk		
	Low Risk = 0 points each	Moderate Risk = 1 point each	High Risk = 2 points each
Low EA with or without DE/ED	○ No dietary restrictions	○ Some dietary restriction; current/past history of DE	○ Meets DSM-V criteria for ED
Low BMI	○ BMI ≥ 18.5 or ≥ 90% EW or weight stable	○ BMI 17.5-18.5 or < 90% EW or 5-10% weight loss/month	○ BMI ≤ 17.5 or < 85% EW or ≥ 10% weight loss/month
Delayed Menarche	○ Menarche < 15 years	○ Menarche 15-16 years	○ Menarche ≥ 16 years
Oligomenorrhea/Amenorrhea	○ >9 menses in 12 months	○ 6-9 menses in 12 months	○ < 6 menses in 12 months
Low BMD	○ Z-score ≥ -1.0	○ Z-score -1.0 - -2.0	○ Z-score ≤ -2.0
Stress Reaction/Fracture	○ None	○ 1	○ ≥ 2; ≥ 1 high risk or of trabecular bone sites
Cumulative risk (total each column, then add for total score)	___ points +	___ points +	___ points = ___ Total Score

Figure 5: Cumulative risk assessment from the Female Athlete Triad Coalition Consensus statement

	Cumulative Risk Score	Low Risk	Moderate Risk	High Risk
Full Clearance	0-1 points	○		
Provisional/Limited clearance	2-5 points		○ Provisional Clearance ○ Limited Clearance	
Restricted from Training and Competition	≥ 6 points			○ Restricted from Training/competition—Provisional ○ Disqualified

Figure 6: Clearance and return to play guidelines from the Female Athlete Triad Coalition Consensus statement

Tuberculosis of the Ankle: A Case Report

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Introduction

Tuberculosis was one of the leading causes of death in the United States during the late 19th and early 20th centuries.[1] New Mexico has an interesting history with regard to tuberculosis since many people migrated to this region during that time period seeking treatment in the warm, dry climate.[2] Today, public health efforts and antibiotics have greatly decreased the incidence and mortality of tuberculosis in this country. In spite of these measures, TB has not been eradicated. In 2013, 50 active cases were diagnosed in New Mexico.[3] Immune-compromised state, poverty, and immigration contribute to its persistence.

We present the case of a 60 year old female who complained of chronic ankle pain which was ultimately diagnosed as Mycobacterium tuberculosis. Her risk factors included origin in the Philippines and immune-compromised state from medications she receives as a kidney transplant recipient. This is the first case of foot or ankle TB the senior author has ever encountered during 28 years as a physician at the University of New Mexico.

Case History

ET is a 60 year old Philippine female with end-stage renal disease secondary to polycystic kidney disease with post cadaveric renal transplant on 1/31/12. She immigrated to the United States as a child. Post-transplant, she was managed on tacrolimus and prednisone to prevent rejection. The patient presented to rheumatology on 10/17/12 with a several week history of left ankle pain. Plain radiographs demonstrated an effusion without osseous abnormality. (Figure 1) Laboratory workup at that time demonstrated WBC 10.5, ESR 85, and CRP 10.2. These values were consistent with her post-transplant laboratories. Aspiration of the left ankle was performed in the rheumatology clinic. Total nucleated cell count was 1200 with no crystals. Aerobic and anaerobic cultures were negative. Intra-articular corticosteroid injections were performed for pain relief on 10/24/12 and 12/5/12. These did provide some pain relief for the patient.

The patient initially presented to the orthopedic service after acute worsening of her symptoms. She sought care in the emergency department on 12/27/12 after four days of severe left ankle pain with inability to ambulate. Examination at that time demonstrated a joint effusion with tenderness to palpation around the ankle joint. She had limited range of motion secondary to pain and an intact neurovascular exam. WBC count was 6.6, ESR 84, and CRP 12.2. Radiographs were unchanged. A repeat aspiration was performed. Total nucleated cell count was 2400 with 96% neutrophils and no crystals. An MRI was obtained which demonstrated nonspecific talar body edema with synovitis and a small joint effusion (Figure 2). Initial cultures were negative, and the patient was discharged home with pain medications. Positive acid-fast bacillus cultures resulted 15 days later and demonstrated growth of multi-drug resistant Mycobacterium tuberculosis. She was taken to the operating room on 1/17/13 for arthroscopic irrigation and debridement of the left ankle and had significant

Figure 1: Lateral ankle radiograph of the patient on presentation demonstrating a small joint effusion.

intra-articular purulent material. The infectious disease specialists were consulted who started the patient on an appropriate antibiotic regimen with a 24-month duration of therapy. CT of the chest demonstrated no pulmonary lesions and AFB sputum sample was negative. The patient reported no fevers, night sweats, or weight loss. She had no history of immunization or treatment for tuberculosis. Repeat irrigation and debridement was performed 1/21/13 due to the significant purulence noted on her initial surgery. The patient was discharged from the hospital on 2/11/13. Her surgical incisions healed without complication. At her most recent follow up (7/19/13), the patient had some residual intermittent pain in her left ankle that was improving. She was able to ambulate with intermittent need of a walker, and was discharged from clinic on that date.

Discussion

Tuberculosis is caused by infection with the bacteria Mycobacterium tuberculosis. This is an aerobic bacillus which demonstrates acid fast properties on gram stain.[4] The majority of people who carry the bacteria are asymptomatic and noninfectious though they may convert to develop acute illness. When patients become ill with acute tuberculosis, the lungs are most commonly affected with symptoms of chronic cough, fever, night sweats, and weight loss. Extrapulmonary tuberculosis occurs in 15-20 % of active cases and is more common in immunosuppressed people.[5]

Extrapulmonary tuberculosis involving the ankle joint is rare and the diagnosis is often delayed.[6,7] As with this patient, symptoms, labs, joint fluid analysis, and radiographic evaluation can be nonspecific. The differential diagnosis includes other infectious, traumatic, neoplastic, and inflammatory conditions along with avascular necrosis of the talus.[8] Synovial fluid cultures require a long incubation period and are frequently negative.[9] Surgical biopsy may be required for diagnosis.[6] Antituberculosis medication is the main treatment for tuberculosis of the ankle. Surgical debridement may be required for significant synovitis or purulence, and arthrodesis is indicated for painful joint destruction.[9]

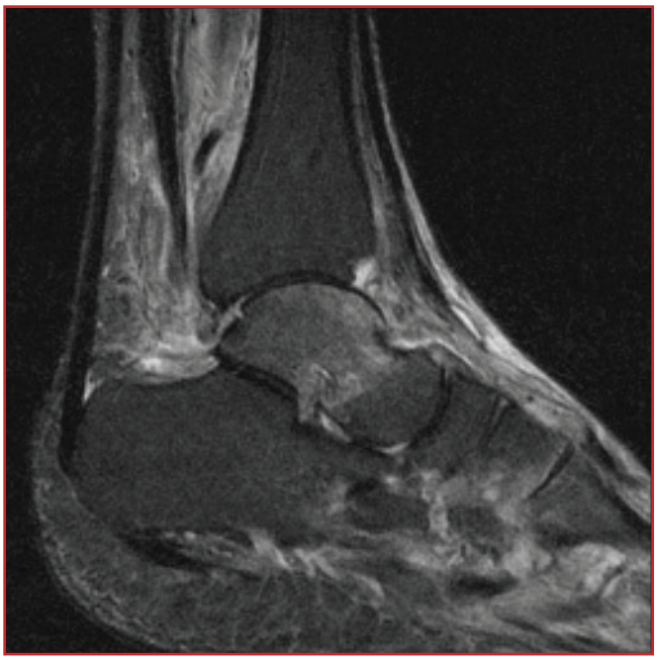

Figure 2: T2-weighted MRI image of the patient on presentation. Note edema of the talus and synovitis of the ankle joint and joint effusion.

The patient presented was originally from the Philippines where tuberculosis is common. The World Health Organization ranks the Philippines as one of the highest TB burdened countries in the world.[10] The Philippines is the second most frequent country of origin for non-US born TB patients in the United States.[11] Patients with renal transplants on immunosuppressive medication to prevent rejection are also at increased risk of developing tuberculosis.[12,13,14] This patient was on tacrolimus to help prevent rejection of a renal transplant she received approximately eleven months prior to being evaluated for ankle pain and swelling. She also had no pulmonary lesions which has previously been reported following infection with foot and ankle tuberculosis.[15,16]

In the United States, where the presentation of skeletal tuberculosis is exceedingly rare, considering it in the differential diagnosis of a patient with similar clinical features as the one presented here may result in an earlier diagnosis and treatment.

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Treatment of Severe Ankle Diabetic Neuroarthropathy (Charcot Ankle) with Retrograde Intramedullary Nailing: Report of Two Cases

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Introduction

Neuroarthropathy, commonly referred to as Charcot joint, results in fracture and progressive osseous destruction. The foot and ankle are the most frequently involved.[1] Patients in the acute process, progress through a variety of stages until consolidation or the reparative stage is reached.[2,3] Jean-Marie Charcot first described this condition in patients with tertiary syphilis in 1868. It was later attributed to patients with diabetes mellitus in 1936.[1] Today, in the United States, diabetes is the most common etiology of Charcot joint. This destruction of the normal foot and ankle anatomy leads to altered weight-bearing mechanics with decreased function and skin ulceration. Treatment of Charcot joint is usually non-operative with immobilization and limited weight-bearing until the healing phase is reached.[4] This may take months, or even up to a year.[5] It marks the beginning of lifetime treatment and surveillance to prevent future complications. These include ulceration, which often leads to infection including osteomyelitis, and eventually amputation.[4]

Though not fully understood, there have previously been two proposed mechanisms behind neuroarthropathy. Virchow and Volkman, postulated that changes leading to an insensate foot allowed repetitive trauma which in turn led to inflammatory and destructive phases. This accounts for the minimal or absent history of trauma in some diabetic patients who present with a Charcot joint.[6] The alternate theory proposed by the Frenchman Charcot stated that autonomic disregulation led to altered vasoregulation and vascular shunting followed by osteopenia and set the stage for bony destruction with microtrauma.[6] More recent research has pointed to inflammatory cytokines and molecular stimulation of osteoclast formation as being involved.[7]

The following cases demonstrate severe destruction of the ankle joint resulting in unbraceable deformity, instability, and inability to ambulate. Realignment and fusion with intramedullary nailing was performed in both cases.

Case Report

Two patients with a Charcot ankle were evaluated for consideration of alternative treatment to amputation.

The first patient is a 41-year-old female with diabetes and end stage renal disease being considered for renal transplant. She presented two years after sustaining a trauma to her left foot and ankle. At the time of presentation she has a severe deformity consisting of varus angulation of the ankle and apex plantar deformity of the sole. (Figure 1) She was barely able to ambulate in a cast boot with the deformity. Given the lack of passive correction this was not a braceable deformity. Though the skin was intact, the prominence of the distal fibula with overlying callus was felt to be at high risk of impending ulceration.

She underwent left ankle fusion with a hindfoot intramedullary nail, and was kept non-weight-bearing for two months. (Figure 2) This was followed by progression to partial, then full weight-bearing in a cast boot. At six months she was doing well with a healed fusion and improved ambulation. A slight plantar prominence remained, which was treated with custom plastizote insoles. At 8 months she was pain free, walking in shoes, and had returned to work.

The second patient is a 36 year-old male with no initial diagnosis of diabetes. He had a two year history of right ankle instability symptoms with minimal pain. He had no history of significant trauma, but did feel a "pop" while rolling his ankle several years before. He was initially able to ambulate in an air cast boot, though this became difficult given his worsening varus instability and progressive deformity. (Figure 3) He eventually had prominence of the distal fibula with abrasions but no frank skin breakdown. Due to concern for neuroarthropathy in this scenario, labs were performed which revealed a glucose of 354 and HgA1c of 12.1. The patient was referred for treatment of his newly diagnosed diabetes.

After controlling his diabetes, he underwent right ankle arthrodesis with a hindfoot nail. His post-operative course was similar to our first patient, with good pain relief and a functional foot at his 6 month follow-up. (Figure 4)

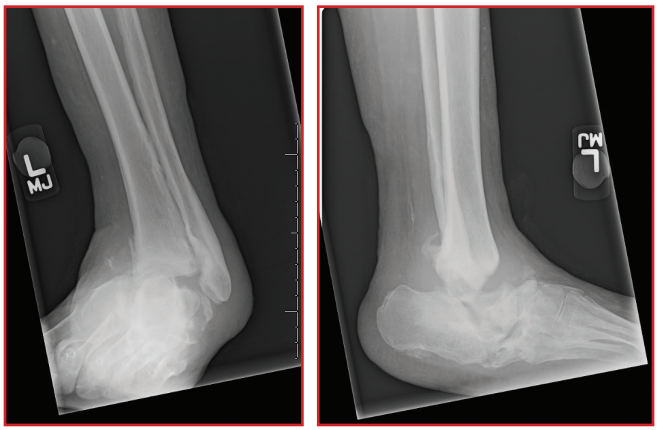

Figure 1: Preoperative AP and lateral x-rays demonstrating varus instability with weight-bearing, prominence of the fibula, and bone loss from talus.

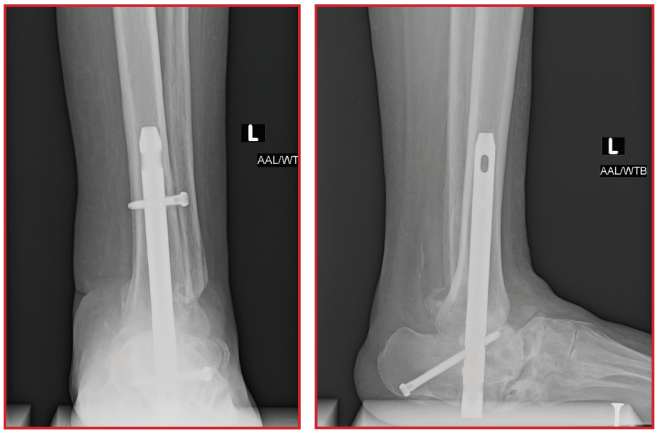

Figure 2: Postoperative AP and lateral x-rays with ankle realigned and nail in position resulting in stable plantigrade foot at 6 months.

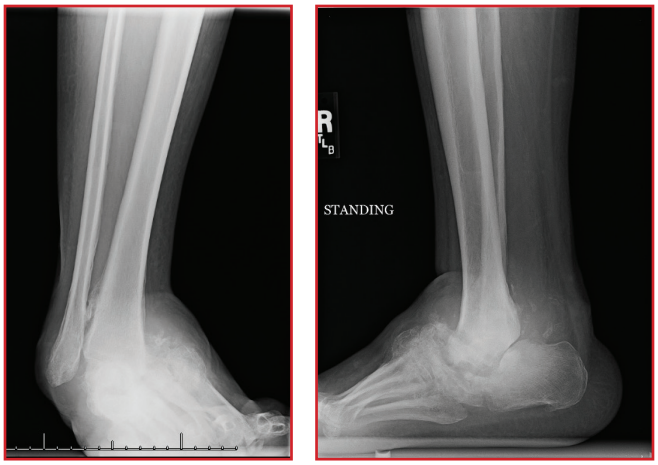

Figure 3: Weight-bearing AP and lateral x-rays of the ankle demonstrating prominent fibula from varus deformity and unstable ankle.

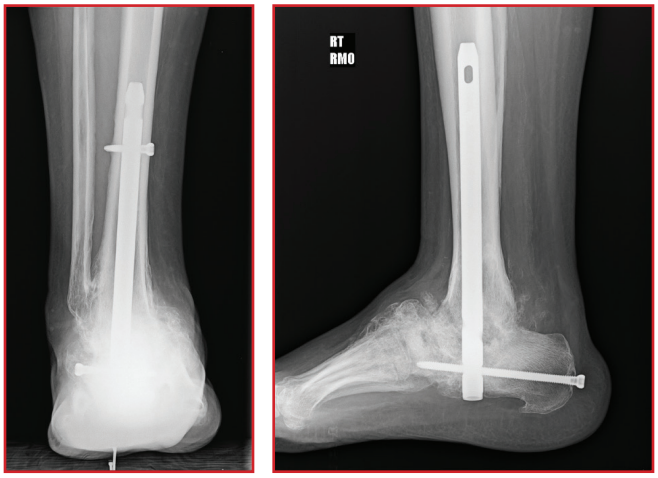

Figure 4: Weight-bearing AP and lateral x-rays of the ankle 6 month status post surgery demonstrating a stable well aligned foot

Discussion

The goal of treating Charcot neuroarthropathy is to obtain a plantigrade foot which is stable and able to be put in a shoe. This allows ambulation and improved functional use of the limb. Additionally it corrects excessive deformity which can lead to ulceration. Initially this is done with orthoses. While many times these goals are achieved, this was not attainable with these two patients. The bone destruction progressively lead to instability, deformity and bony prominence which prevented bracing and ambulation. By virtue of the concomitant diabetes, these two individuals were also predisposed to ulceration, infection, and the eventual threat of amputation. Surgical correction consisting of realigning and fusing the ankle is at times an alternative to amputation when Charcot destruction is severe. Such was the case for our two patients.

Candidates for this procedure should have sufficient vascular supply and potential for healing and ambulation. Though Charcot joint does not directly involve the blood supply to the foot and ankle, there is a high prevalence of peripheral artery disease in patients with diabetes. An ischemic Charcot joint would necessitate revascularization prior to surgical treatment.[8] Candidates should also be free of infection prior to surgical consideration and correction. Many of the signs and symptoms of Charcot joint are similar to infection, including swelling, erythema, elevated temperature and inflammatory laboratory markers. Additional studies may help differentiate osteomyelitis from Charcot joint.[9]

Given the odds of complications inherent with these procedures, patients must be compliant with the required postoperative care to obtain the best chance possible for a functional outcome. While these two patients have had a good short term outcome, it is important to consider that surgical complications are relatively high in this patient population. Even with a successful surgery, constant vigilance is required to prevent the underlying diabetes complications of associated wounds, infection and prolonged treatment.

Despite the high rate of complications in certain situations, arthrodesis might allow for limb salvage. The future may be more promising as salvage options for failed arthrodesis using a blade plate have recently been reported as well.[10] Research into the pathophysiology may lead to new targeted treatments for treatment and perhaps prevention.[7]

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Anterior Cruciate Ligament Revision — Posterolateral Bundle Augmentation of Vertical Graft: A Case Report

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Introduction

Anterior cruciate ligament (ACL) reconstruction is among the most commonly performed orthopaedic procedures in the United States, with more than 100,000 done each year.[1] Results are generally good; however, failures can occur at a rate of 10% to 20%.[2] The cause of failed ACL reconstruction varies, with technical error resulting in bone tunnel malposition being the most common cause.[3] Working through a tibial tunnel can make it more difficult to recognize the correct starting position on the femur, and the surgeon may be more likely to start the femoral tunnel in a central 12 o'clock position. The combination of subtle posterior placement of the tibial tunnel and central placement of the femoral tunnel results in a graft that is malpositioned in both the sagittal and coronal planes—a "vertical graft," [4] which can result in rotational instability on clinical exam. The number of potential ACL revisions in the United States is estimated at 3,000 to 10,000 per year.[5] In a revision case, typically the primary graft has ruptured and thus revision of the entire graft is necessary. However, as seen in a vertically placed reconstruction, the graft remains intact. In these particular cases, the option of selective single- or double-bundle augmentation of a primary vertical graft is available.

We report the case of a professional skier who presented with persistent rotational instability and an intact graft ten years after an ACL reconstruction performed at an outside hospital. The patient discussed in this report was informed that data concerning his case was to be submitted for publication, and he consented. The patient's confidentiality was protected in compliance with the Health Insurance Portability and Accountability Act.

Case Report

A thirty-four-year-old male who was a former professional skier presented to our clinic with right knee swelling and instability. He had undergone a right knee ACL reconstruction using bone-patellar tendon-bone (BTB) autograft, ten years prior, at an outside institution. His primary concerns were increasing episodes of "giving way", particularly during activities such as hiking or fly fishing. On physical examination of the right knee, there was a mild joint effusion noted. Range of motion was from 0-130 degrees. He had a 2A Lachman (increased laxity with a good endpoint) and a positive pivot shift. Posterior drawer was negative, and he was stable to varus and valgus stress at 0 and 30 degrees of flexion. In the prone position, the dial test was normal with no excess external rotation at 30 or 90 degrees of flexion. Radiographs (Figure 1) demonstrated vertical graft positioning that was more anterior on the femur and posterior on the tibia. MRI of the right knee (Figure 2) demonstrated an intact ACL graft.

We offered the patient the options of a complete ACL graft revision versus revision with posterolateral bundle augmentation. The patient requested to proceed with augmentation. Right knee arthroscopy confirmed an intact ACL graft that was vertical and allowed increased translation. A semitendinosus autograft was then harvested, leaving the gracilis intact. The graft was sized at 6mm. Drill holes were placed in the femur and tibia independent of one another. The hamstring graft was then passed posterior to the BTB graft and secured on the femoral side using an Endobutton®. The graft was then fixed in 15 degrees of flexion on the tibial side using a BioSure® screw.

The patient had an uneventful postoperative course. At subsequent visits he had regained full range of motion, strength, and denied any feelings of instability. He had resumed an active lifestyle including return to skiing. At his most recent visit, he was more than two years out from surgery. He had no knee effusion. At this time, he had a normal hop test compared to the contralateral side and Lachman symmetrical to the other side. There was no pivot shift and quadriceps strength and circumference was equal to the other side. Radiographs (Figure 3) and repeat MRI (Figure 4) are shown. MRI demonstrates an intact posterolateral bundle augmentation with some scar tissue formation.

Figure 1: AP and lateral radiographs of right knee demonstrating previous autograft bone-patellar tendon-bone (BTB) ACL reconstruction with vertical graft placement.

Figure 3: AP and lateral radiographs of right knee showing ACL revision with posterolateral bundle augmentation.

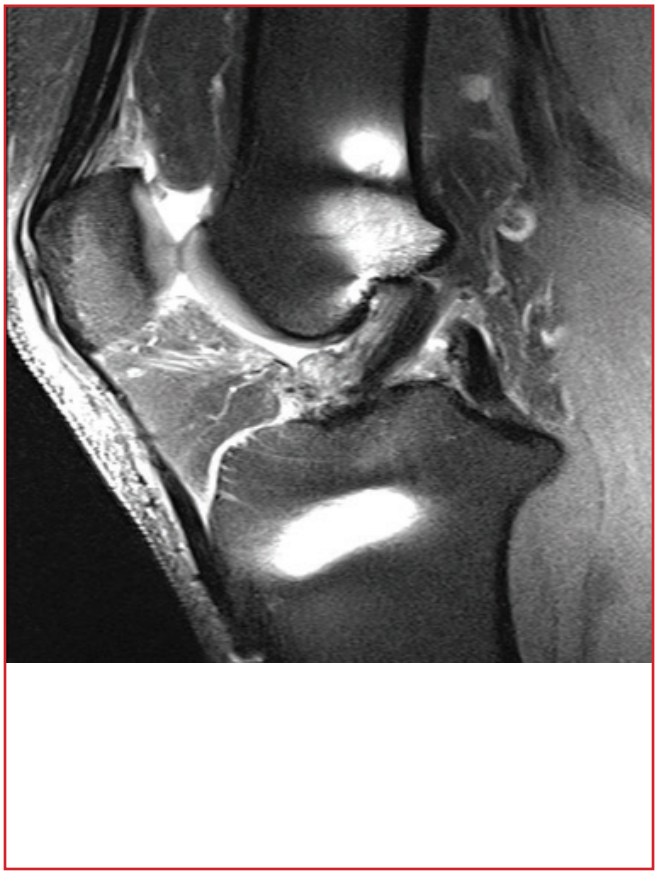

Figure 2.: Right knee MRI showing intact ACL BTB graft.

Figure 4: Right knee MRI showing intact PL bundle augmentation at 2 years postop.

Discussion

Traditional single-bundle anterior cruciate ligament reconstruction has been shown to achieve good to excellent results in about 60% of patients.[6] Fu, et al., have done extensive studies on the concept of anatomic double-bundle anterior cruciate ligament reconstruction.[7] The anteromedial bundle (AM) is the main contributor to anterior-posterior stability, while the posterolateral bundle (PL) mainly controls rotational stability, especially in deep knee flexion.

In rare instances, partial ligamentous disruption of one anterior cruciate ligament bundle in the native ligament may occur. Clinical exam may show a low grade pivot shift or glide but few other findings. A high index of suspicion

is necessary as oftentimes the diagnosis can only be made arthroscopically. MRI is accurate for differentiating the normal from the abnormal ACL. However, it is less reliable in diagnosing partial ACL tears.[8] Ochi, et al., describe a cohort of 45 patients over a ten-year period with partial ACL tears who were treated with either anteromedial or posterolateral bundle augmentation.[9] At a minimum 2-year follow-up, patients showed improved joint stability with a KT-1000 mean side-to-side difference of 0.5 ± 2.7 mm (preoperatively 3.3 ± 2.4 mm). The median Lysholm knee score significantly improved from 74 (range, 44 to 95) to 100 points (range, 81 to 100) after surgery. Abat, et al., reported on a series of 147 consecutive ACL reconstructions.[10] Twenty-eight patients (19%) had partial ACL tears. The minimum follow-up period was 30 months. Eighteen had anteromedial bundle augmentation and 10 had posterolateral bundle augmentation. Only 19% of their MRI's were categorized as partial ACL tears. The Lysholm score improved from 65.5 to 95.2 in the PL bundle augmentation group. The same or no more than one level lower Tegner score was restored. The pivot-shift, Lachman and anterior-drawer tests were negative in all cases.

More commonly, a patient will present after an ACL reconstruction with persistent instability, a Grade 1A or 2A Lachman, and a pivot glide or pivot shift. For this type of patient, a posterolateral bundle augmentation can be performed. Shen, et al., reported on nine posterolateral bundle augmentations performed for revision ACL surgery at their institution over a five-year period. Eight of the nine patients had normal results on both the Lachman and pivot shift tests. The mean KT-1000 side-to-side difference was 0.37 mm. Range-of-motion measurement showed an average side-to-side difference of 0° with the knee in extension and 0.75° with the knee in flexion. The mean score on the IKDC subjective knee form was 95.4.[11]

Our case illustrates a solution for one of the most common causes of failure of ACL reconstruction–malposition of bone tunnels. This technical error results in a vertical graft that can cause knee rotational instability due to failure to recreate the posterolateral bundle of the ACL. By performing a PL bundle augmentation of an intact vertical graft, our patient was able to return to competitive sports without instability and have excellent function of his knee. This concept can also be applied to partial tears of the native ACL ligament.

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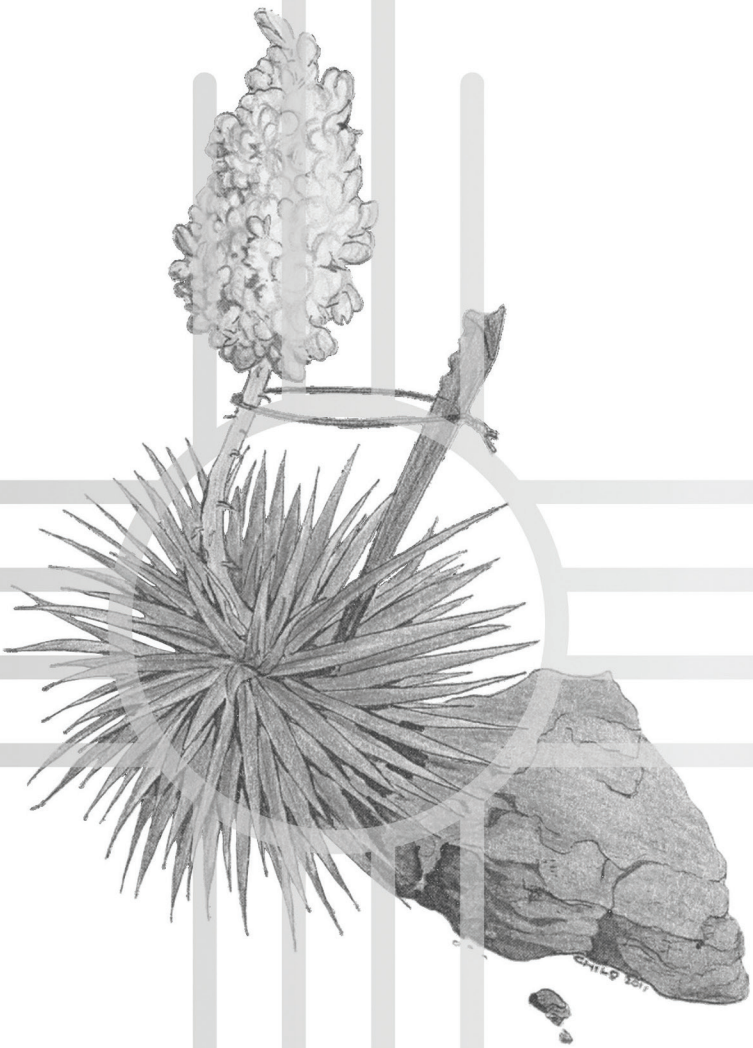

Report from the Division of Physical Therapy

Burke Gurney PT PhD OCS, Professor and Division Chief

It has been a busy year for the Division of Physical Therapy. In this, our 40th year, we just completed the selection of our 41st class of students, who will start in August. Since inception, our total student enrollment surpasses 750. When the new class arrives, they will see a Division that has recently experienced a lot of change. Burke Gurney was recently appointed as the new Division Chief. In addition, we had two long-time faculty retire, Beth Provost and Sue Queen. Beth taught our pediatric and health promotion content, and Sue taught the pharmacology and pathophysiology content. They will both be sorely missed. We recently hired two excellent new faculty — Marybeth Barkocy, who has taken her energy and expertise into the classroom to teach pediatrics and health promotion, and Tiffany Pelletier, who is quickly adapting to her role as Director of Clinical Education.

The motion analysis lab is moving forward, Bone Dexter has been overseeing several research projects including collaboration with Deana Mercer on the relative contribution of 5 ligaments of the first carpometacarpal joint to the joint's stability. In addition, Kathy Dieruf and Bone are planning to start a study investigating the effects of a unique upper extremity sling on gait dynamics in post stroke patients. The sling was invented by a local PT and OT. In addition, Bone has started testing children with cerebral palsy for gait abnormalities. We are moving forward to launch the clinical side, where we will be doing gait and motion analysis for children from Carrie Tingley Hospital. In the past, families have had to travel to Denver to receive this analysis and we are excited to be able to provide this service here at UNM.

Other research is also occurring. Ron Andrews and Bone Dexter have been involved with Dan Wascher, Bob Schenck and Dustin Richter in long term outcomes of surgical repair after total knee dislocation. In addition, Burke Gurney, in collaboration with researchers in Flagstaff Arizona, has just completed the data collection on an EMG study investigating the activity of the rotator cuff muscles during gait and several post-surgical rehabilitation activities. Fred Carey and Beth Jones recently presented an anatomical case study on hypertrophy of the subclavius accompanied by atrophy of the pectoralis major muscle post-mastectomy at the Combined Sections Meeting, the largest PT national scientific conference.

Many of the faculty are involved in clinical practice in various sites throughout the city, and the Division is working on developing a faculty practice at Sandoval Regional Medical Center that will allow us to consolidate our practice, as well as bring in some new clinical/teaching faculty. We plan on using the facility as a clinical rotation site for our students in addition to performing clinical research.

We are proud of the many accomplishments of our students and faculty, and are looking forward to continuing our service of the NM community into the next 40 years.

Pediatric Spinal Cord Injury and Functional Electrical Stimulation Cycling

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Introduction

The purpose of this case report and evidence-based analysis is to present information and discuss current and future interventions that were performed with a 7-month-old baby girl, Baby A, who sustained an incomplete spinal cord injury (SCI) due to non-accidental trauma. Baby A was referred for inpatient rehabilitation at Carrie Tingley Children's Hospital and received approximately 9 weeks of rehabilitation before being discharged to a foster home where she eventually received Early Intervention services through Inspirations. Research was performed to explore possible future interventions for Baby A.

Methods

Several search engines were used including PubMed, CINAHL, PEDro and Cochrane. Keywords: Pediatric, Spinal Cord Injury, Functional Electrical Stimulation (FES), Cycling, Bike were all used in various combinations during the search for articles. Eight articles were used for final review, analysis and comparison to the PICO question.

PICO Question: In children with SCI, does the implementation of FES cycling prevent secondary complications such as muscle atrophy, weakness and contractures compared to traditional SCI therapy not utilizing electrical stimulation?

Findings

Functional electrical stimulation cycling is a good option for intervention for patients that have sustained a spinal cord injury. Functional electrical stimulation has many benefits including but not limited to producing a muscular contraction, which maintains muscle size thus addressing the issue of muscle atrophy. It also maintains and/or improves the strength of the stimulated muscle, addressing the issue of weakness. Also, increased joint mobility is observed, keeping the joint healthy and without contractures. When she is old enough incorporating the use of FES cycling into her outpatient therapy sessions is anticipated. With continued and enhanced interventions including FES cycling in the future, the young child may not improve her functional status, but continue to maintain her status and prevent future secondary complications.

Conclusions

Spinal cord injuries frequently result in at least some incurable motor impairment even with the best possible treatment. There is also a high probability of prolonged issues including but not limited to GI, bowel/bladder, weakness, decreased range of motion, pathological fractures, skin integrity, heterotrophic ossificans, spasticity, scoliosis, etc. Continued traditional spinal cord injury therapy and eventual functional electrical stimulation cycling is anticipated for Baby A. Baby A may not improve her functional status, but continue to maintain her status and prevent future secondary complications as she learns how to live with her spinal cord injury.

Physical Therapy and the Treatment of Chronic Pelvic Pain: A Comparison of Pelvic Floor Exercises and Manual Therapy

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Introduction

Chronic pelvic pain (CPP) is defined as nonmenstrual pelvic pain occurring for an average of two weeks per month for at least 6 months duration and may be accompanied by symptoms such as urinary urgency or dyspareunia. The prevalence of CPP reaches 15-20% in the general female population and accounts for up to 10% of gynecological visits resulting in $2.8 billion annual expense. The purpose of this study is to determine whether pelvic floor muscle exercise or manual therapy is more effective in treating chronic pelvic pain.

Methods

Patient is a 52 year-old gravida 1 para 1 female presenting to physical therapy with chronic pelvic pain, dyspareunia, and urinary urgency. A search of the literature was performed to compare the efficacy of pelvic floor muscle exercises and manual therapy in the treatment of chronic pelvic pain and associated symptoms. A critical appraisal of the resulting articles was executed and several evidence-based interventions were integrated into the patient's plan of care.

Conclusions

While there are few studies with high levels of evidence investigating the use of manual therapy in the treatment of chronic pelvic pain, myofascial release and trigger point therapy are two manual techniques that have been used to successfully treat chronic pelvic pain and urinary urgency. As a patient's painful symptoms decrease, it is important for patients to maintain normal movement and function. Increasing strength of the pelvic floor muscles and obtaining a correct contraction are important in maintaining stabilization and appropriate support of the pelvic viscera after myofascial restrictions and trigger points are addressed.

How Exercise Affects Fatigue in Adults with Multiple Sclerosis

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Introduction

Fatigue is the most commonly reported symptom among those with a diagnosis of Multiple Sclerosis (MS). There are approximately 2.5 million people with MS worldwide. This is a research analysis looking at how exercise can affect fatigue in those with MS. It provides physical therapists evidence based findings regarding what interventions may positively change in patients' fatigue levels. Physical therapists play a key role in educating their patients how to positively affect fatigue and also have the ability to adapt exercise programs to suit the vastly different presentation and symptoms associated with MS.

Methods

Research conducted utilizing electronic databases, PubMed, Cochrane, PEDro and internet searches. Keywords used included Multiple Sclerosis, exercise, fatigue, physical therapy, systematic review and 2013. Initially 87 article abstracts were reviewed and narrowed down to 8 articles chosen that had the most relevance to the topic. Inclusion of all MS sub types, ages and use of fatigue outcome measures. Exclusion of articles published before 2005 and with subject numbers less than 30.

Findings

The evidence continually shows that exercise is beneficial to those with MS for reducing fatigue and also that decreasing fatigue has an inverse relation to patients' quality of life. With decreased fatigue comes increased quality of life. Exercise parameters are still being tested and researched in hopes of coming to more conclusive and significant findings regarding what type, dose, intensity and frequency is most appropriate for MS patients. What makes this difficult however is that MS patient presentation is heterogenous and therefore individualized programs must be made to suit each patients needs and also to ensure safe and effective patient interventions. The most commonly used fatigue outcome measures included the Fatigue Severity Scale (FSS) and the Modified Fatigue Impact Scale (MFIS).

Conclusion

Future studies need to focus on exercise parameters and also classifying those with MS into more identifiable patient characteristic groupings so that exercise interventions can match specific disease presentations. They also need to include differing types of MS as well as wider age ranges. No studies have shown that there were adverse, deleterious or negative effects on the disease progression or symptom presentation following increased exercise and activity. Encouraging increasing exercise levels is therefore a safe, cost effective way of intervening with these patients, however should be adapted by physical therapists to suit the patients' specific disease presentation and needs. Monitoring vitals and rate of perceived exertion can be helpful for physical therapists in order to make sure not to overwork their patients or increase the risk of relapse. Also educating patients on methods of energy conservation should be emphasized to decrease patient fatigue. The FSS and MFIS fatigue scales have been shown to have good validity and reliability and can be useful tools to monitor patients' response to exercise with regards to patent reported fatigue.

Gait Training Strategies to Optimize Functional Ambulation in Adults with Chronic Traumatic Brain Injury: A Review of the Evidence

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Introduction

Multiple studies have been conducted to establish the best gait training methods within the scope of physical therapy to improve ambulation function for patients with neurological conditions. However, the studies tend not to focus on patients with traumatic brain injuries (TBIs), but, instead those with conditions such as stroke (CV), spinal cord injury (SCI), and Parkinson's Disease (PD). Also, the studies that have included brain injured patients usually are done with acute TBI patients within a rehabilitation setting, not chronic TBI patients in an outpatient setting. Therefore, the purpose of this investigation is to use current literature to determine which gait training methods yield the most functional gains in ambulation for adult patients with chronic TBI.

Methods

CINAHL, PubMed® (MEDLINE), Cochrane, and PEDro databases were searched. Keywords used were various combinations of 'TBI' and: 'Gait', 'ambulation', 'locomotion', 'rehabilitation, and 'physical therapy.' Reference lists of chosen articles were also searched. Inclusion Criteria: Studies conducted between January 2000 and present, subjects with diagnosis of chronic (> 6 months) TBI, and all subjects were age 18 or older when TBI acquired. Exclusion Criteria: No gait/ambulation related outcomes measured, case studies, any studies that included children, studies in which only 1 or 2 chronic TBI patients were included, studies that did not separate out TBI subjects' results from the results of those with other neurological diagnosis.

Findings

No single gait training intervention within the scope of physical therapy is superior to any other method for this patient population. The various methods of gait training are each good at targeting and improving a specific deficit involved in the activity of gait. Body weight supported treadmill training is best for increasing self-selected velocity (SSV), and should be done without upper limb support for the most carry over. Robotic assisted treadmill training is best for improving the mobility domain of the Stroke Impact Scale (SIS). Non-aerobic exercise interventions significantly decrease step length asymmetry when compared to over-ground gait training.

Discussion

Because of the nature of chronic TBI, it is difficult to obtain a large sample size of homogenous subjects to participate in a study. Further research is necessary to gain a solid conclusion as to which gait training methods lead to the most functional gains for chronic TBI patients. Based on the current available evidence, all methods improve overall gait for patients with chronic TBI, while some target more specific areas involved in gait. Therefore, tailoring a gait training program to a specific chronic TBI patient's areas of weakness, and using more than one intervention, will provide the best outcomes. All studies taken together suggest that gait training should be intensive, repetitious, and task oriented.

Osteoarthritis of the Knee: Does Physical Therapy Intervention Alone Improve Functional Outcome Scores of the Timed Up and Go More Than Total Knee Arthroplasty?

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Introduction

Osteoarthritis affects a large population of adults and is the leading cause of disability in America, but has few effective treatments. The purpose of this review was to evaluate the effectiveness of physical therapy intervention versus total knee replacement on the functional outcome of the timed up and go test.

Case Description

Miss R, a 75-year-old female underwent a total knee arthroplasty to her left knee. She had physical therapy rehabilitation post-operatively at a skilled nursing facility for 26 days.

Outcomes

Miss R was discharged home to continue rehabilitation in an outpatient setting. During her rehabilitation she had progressed her functional deficits enough to return to her home and live independently. She was ambulating with a cane over 1000 feet and was independent for all transfers, bed mobility, and activities of daily living.

Methods

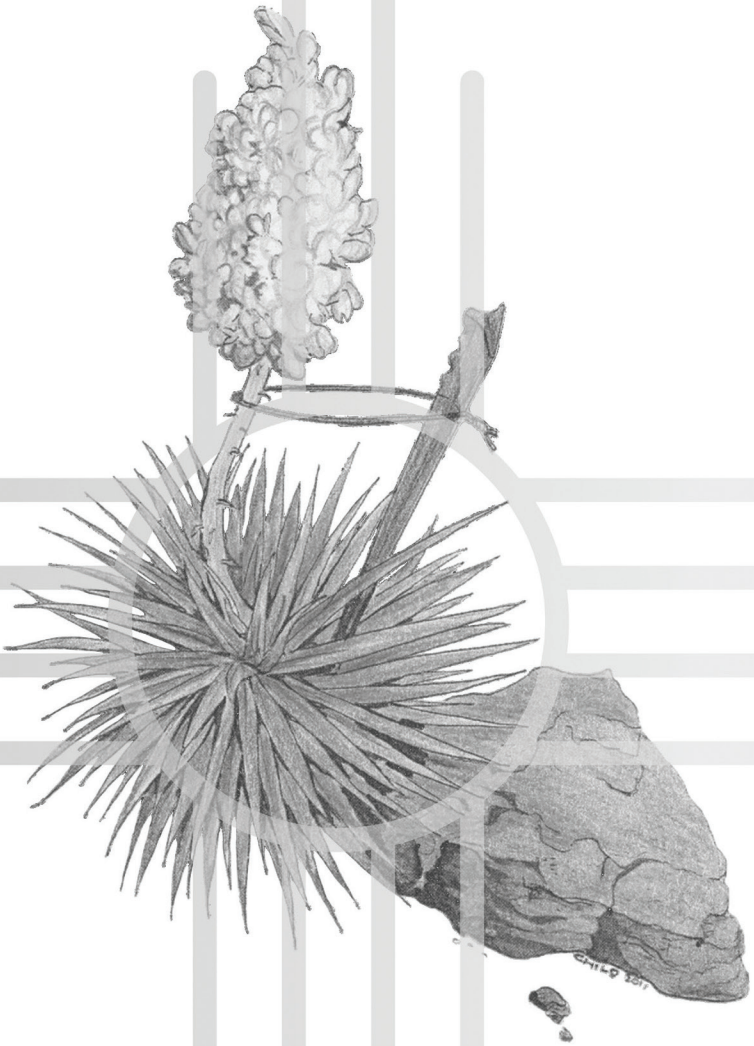
A literary review was conducted in three databases of PubMed, Pedro, and CINHAL. Keywords included: Osteoarthritis, knee, total knee arthroplasty, physical therapy modalities, timed up and go. 8 total articles were analyzed in depth.

Findings

Several studies revealed that overall timed up and go scores improved for patients with osteoarthritis that underwent a total knee arthroplasty or physical therapy interventions, however the improvements were often found to be not statistically significant or were not equivalent to healthy age-matched adult controls.

Conclusion

Physical therapy alone does improve functional scores for patients with knee osteoarthritis, however pain symptoms are often not improved and patients will choose a surgical method even with good outcomes with physical therapy. Patients who undergo a total knee arthroplasty do improve functional scores from immediately post-surgery, but rarely attain better than before surgery scores or scores similar to age matched controls with current rehabilitation standard of care methods post surgery. Research is suggesting a focus on quadriceps strengthening to improve functional scores for patients post total knee arthroplasty.



Letters from Landstuhl

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I had the privilege to participate in the Distinguished Visiting Scholar Program (DVSP) at Landstuhl Regional Army Medical Center (LRAMC) in Germany for two weeks in May, 2013. The DVSP, funded as a joint effort by The Department of Defense, US Army, the OTA, the Red Cross and the Wounded Warrior Project, was developed in 2005 as a way for faculty from US civilian trauma centers to share their trauma treatment experience with the military faced with large numbers of severe trauma from the wars in the Middle East. Prior to the wars in Iraq and Afghanistan (Operation Enduring Freedom - OEF) there had been a very long period of time where the military treated very few war casualties and the experience of military surgeons was very limited. The military developed a triage system for treatment of OEF casualties which included utilization of the LRAMC as an intermediary location in the treatment of the injured between the Middle East and the US. This intermediary site (LRAMC) was determined to be the safest position for visiting scholars to interface in this triage system.

After a rigorous and lengthy application and credentialing process I was approved to participate. My 25 years at UNMH Level 1 Trauma Center provided the experience and perspective to be of assistance to the military surgeons treating wounded warriors at LRAMC. With my emeritus status I had the time available to donate to the effort.

During this time I wrote daily reports of my activities and observations that I have now assimilated into this report so as to provide the reader with a glimpse of this experience including observations on the treatment of war injuries, the military system of medical treatment, the German culture and my observation of changes compared to other visits to Germany in prior decades. In addition, I happened to be reading a fascinating book on military survival at the time of my visit, and have sprinkled in a recounting of the travails of a US bombardier in the Pacific in World War II.

The most fundamental observation of this entire experience is that each soldier recognizes the risk of injury but has complete confidence in the military medical system. That the best system in the world exists to help them if and when they are hurt and that everything possible will

be done to extricate them, treat them to fullest possible recovery, and return them to active duty status.

Day 1 Saturday May 11

Depart Albuquerque 10 AM

Arrive Dulles 2 PM

I had 5 hours of layover at Dulles Airport in Washington DC so I took the opportunity to visit the Udvar Hazy Air and Space museum located on the airport grounds and only five minutes from the terminal. It was fantastic. All sorts of planes and space craft including Concorde, Blackbird, U2, Space Shuttle, many German, Japanese and American fighters and bombers from World War II, British, German and American planes from World War I. A perfect way to spend a couple of hours!

Depart Dulles 7 PM on Lufthansa to Frankfurt

I started reading my book "Unbroken" by Laura Schlesinger who also recently wrote "Seabiscuit". Denver Rawlings, a golfing friend and former Viet Nam War fighter pilot, had recommended it to me. It is about a WWII bombadier who survived a crash in the Pacific and floated on a raft for 3 months before washing up on a Japanese controlled island to be interred as a POW. His name is Louie Zamperini. He's a track star at University of Southern California and makes the US Olympic team in 1940. He is young and inexperienced and ends up in an event at the Berlin Olympics in 1940 that is much longer than any he has run previously. He is afraid he will run too fast at the first part of the race so goes out very slowly. Too slowly, it turns out. But he speeds up at the end and passes more than half the field to finish 8th place. That makes him one of the favorites for a shorter distance at the next Olympics in 1944. But, of course, World War II breaks out. Louie enlists in the Air Force and becomes a bombardier in the Pacific. That's as far as I've gotten. It's a great prelude to working at Landstuhl as it highlights the sacrifices and perspective of soldiers yanked from normal civilian life to fight in seemingly the worst circumstances imaginable.

Day 2 Sunday

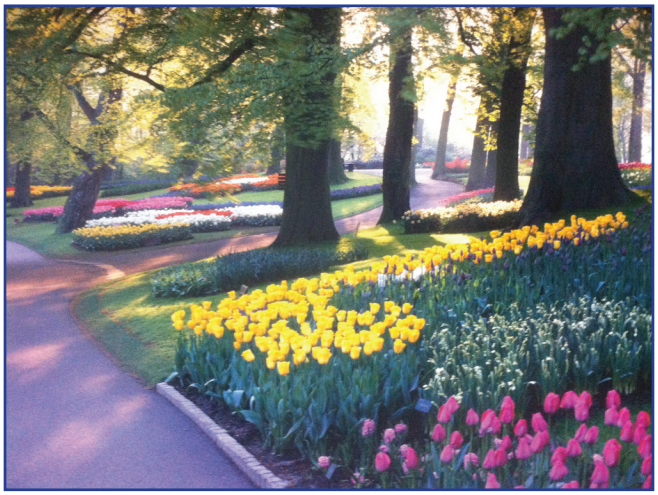
Arrived in Frankfurt. The first thing I heard over the loudspeaker was "Achtung Achtung!..." I immediately thought of WWII and the Gestapo and Hogan's Heroes. Then I thought of Dr. George Omer getting the attention of the "crowd" at the Ortho reception (that's for Rich Miller) in San Francisco decades ago. He used the same loud phrase to get people's attention. It had an intimidating and threatening effect on the crowd, not necessarily the response he anticipated. But that's Dr. Omer.

No one checking at customs. Sunday morning now. Pleasantly surprised that there was 100 times more English on the signage than my last trip to Germany 20 years ago.

Found Concourse C and the USO office and someone from Alex's Vans was there to pick me up. We boarded the shuttle and headed for Landstuhl. Three other military personnel were on the van ride. It was raining. Little did I realize what a harbinger of the weather to come this would be.

It ended up that it rained almost the entire two weeks. The amount of time it did not rain could have been measured it minutes. I virtually never saw the sun but I know it exists because the landscape is a virtual jungle of plants and trees, with lots of beautiful flowers and gardens. Amazing color! I enjoyed the rain and clouds after the past 9 months in NM with no precipitation whatsoever and the last 25 years in NM with very little. Literally it has rained more here in the last 6 days than my previous 25+ years in NM.

The drive on the autobahn was memorable. The driver drove 100 mph in this van!!! (160 km/h). When there is a speed limit on some portions of the autobahn, but it is very high at 130 km/h (~80 mph). But most of the time there is NO limit on the left lane of the "autobahn". The shuttle van spent the majority of the time in the far left lane and we were zooming past lorries (big trucks) in the far right lane which appeared to be puttering along at a mere 50 or 60 mph. We were passing the BMWs and Mercedes in the left lane at 100 mph. We even passed 2 Corvettes.



The routine seemed to be that the car ahead would pull to the right as you approached from the rear. If they had not pulled over by the time we got to about 300 meters, the driver would flash his headlights and the car ahead would immediately pull over and we would zoom past. The same occurred when a few Porsches and Audis zoomed past us at about 130 mph. I was aware of the speed on German autobahns, but it is different to experience it. Especially when you are in a shuttle van at 100 mph! When he came to

exit or interchange it was a total change of pace. The driver would slam on the brakes and slow down to 30 or 40 mph, and slowly negotiate through the interchange. Then when he got back on the autobahn he would accelerate 'like a bat out of hell' and then zoom back up to 100mph+. The 100 miles between Frankfurt and Landstuhl took only an hour by this mode of transportation!

I arrived at Landstuhl at the military hospital base on top of a hill overlooking the village. My recent visit to the Naval Postgraduate School in Monterey to visit my daughter Mallory had accustomed me to the military base security routines. At the gate you have to be on the "approved roster" with proper ID.

Fortunately all was in order and we got through that. Then the van and its contents were searched by guard dog. My "Hotel" reservation all in order (they don't do anything without an order and proper paperwork) but the room was not made up so I could not get in. That was fortunate because I had heard of a previous scholar whose orders had not gone through for some reason or another. He had spent the better part of a day standing in the rain waiting for someone to come on duty who could straighten it out. Did I mention that it was raining? Got into my room about 4 PM. Nice little studio apartment, kitchen, living room with TV, shower etc.

Walked to hospital which was a few hundred yards across the base. There were 3 dining options. The first was the "pasta bar". Unfortunately although the brochure said open Sundays it wasn't. Went to the dining room. It was not only open they took US Dollars! and everyone not only spoke English they were Americans and the prices were very reasonable and the food was good. Mostly "American" although I did have"pretzel bread" which was good but new to me. It turns out the Army base is, essentially US Territory. Dollars or Euros were taken equally. The products were very similar to a cafeteria or grocery store in the US. The third eating option was a Subway/Burger King combo but was not open on the weekend.

I found a map of a 5 k run around base so did that. Only got lost twice but there's a big fence around the base so I couldn't venture too far off track and it was impossible to unintentionally leave the base. Enjoyed the run in the rain since it has been SOOOO dry in NM. Not very many people around.

Landstuhl is not quite as deserted as NPS on the weekend, since it is a functioning hospital but with 90% outpatients and of the inpatients, half are in ICU there were not a lot of people in the hallways.

Stayed awake until 8 PM. It was still light out since Germany is at such a northern latitude. I had been up about 38 straight hours. Awoke at 4 AM wide awake. So read my book and made a pot of coffee in my kitchen.

I tried to call home Sunday, upon arrival. How do you make a phone call? Things that are routine at home take some figuring out when you are abroad. Just an example of logistical problems when traveling.

I wasn't sure if being on a US Military base in Germany would be easier or harder to figure out than merely traveling abroad. It is more like the US but military ways are often very different from civilian ways.

Most, but not all tasks can be done; but nearly all require some sort of special, largely unknown and not obvious or intuitive, facilitating step.

There were instructions for calling the US from the hotel room. However, that did not work. I went to the front desk and was told you had to put an 8 in front.

It then worked. Unclear why it would not be mentioned in the written instructions to start with an 8, a deficiency which rendered the instructions worse than useless.

If you had no information, you would ask. If you have instructions, then you follow them. Instructions that don't work are worse than no instructions. The cost of the call was also a mystery. The "instructions" suggested an ATT calling card was cheapest. I bought one at the "PX" with dollars.

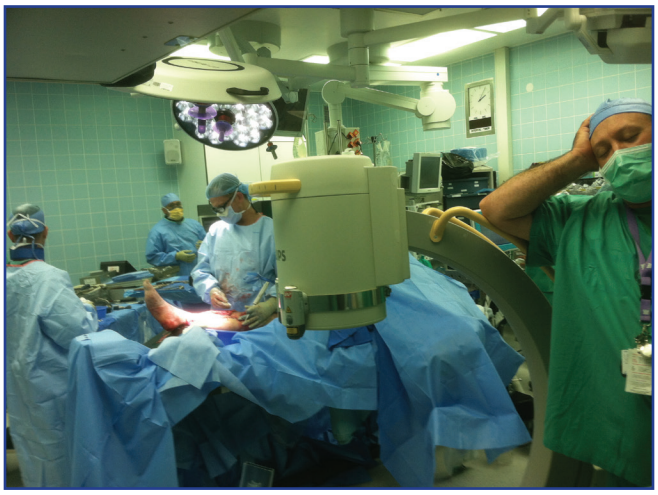
I followed the written instructions on the card which were different from merely calling from the phone. No go. Went to the front desk again. Was told that yes, the calling card was the cheapest and yes, you needed to follow the instruction on the card but that you needed to omit a middle 0 on the instructions. Again, I'm not sure why they would give you instructions that are not correct. That seemed to work, however, no answer at home.

Tried again later from a different phone and no answer and no answering machine so I wondered if the call actually went through or not. It sounded as if it was ringing. Found a USO "Warrior Center" and asked for help trying to call home. Volunteer at the USO was much more forthcoming

and helpful than the clerk at the hotel front desk. But he said "why don't you use our phone directly, that's what it's for."

Called directly and got through. A better solution, but I still don't know what numbers to dial for calling card to US. Maybe I can use the calling card at some point in the future.

I was also able to access the wifi at the USO center which allowed me to check email and go online. They did not allow ANY laptops or even memory sticks to be brought on base or used on base. Cell phones were allowed but it was very unclear what the coverage would be or the cost. There are many stories of ungodly high cell phone charges for people using their US cell phones in Europe. Even the cell phone companies have advertisements mocking the unwittingly high bills of US tourists in Europe using their cell phones. T-Mobile is a German company but that doesn't mean that your US T Mobile cell phone will work in Germany. I didn't want to find out that I had some gigantic cell phone bill when I got back home so I just used the landlines for everything but emergencies. Charging the phone was no big deal. When I had travelled in Europe previously, it was a big challenge to get the correct adaptors to charge phones, computers and even routine electrical appliances. Check in for "duty" is scheduled for 830 am on Monday.



Day 3 Monday

Monday early am. Went for a 5 k run in rain at 6 AM. Nice. breakfast at "DFAC" dining facility. Met program coordinator at designated spot for check in at 8:30. Then to security for IDs and a lecture (appropriate) on security. To ortho coordinator then ortho docs doing rotations at LARMC. There are 6 of them ages 30-50. 3 are "regular" Army on 2-3 year postings; and 3 are supplemental from the Navy or Air Force on 6 month postings. Since LARMC is getting so many casualties and has ramped up operations in support of OEF they have called upon medical personal from other services to staff the hospital.

Some of the military docs have been here a year; others less. One started today! The patients are a combination of war casualties (Afghanistan or OEF (Operation Enduring Freedom), non-combat military injuries from Europe, Africa or Asia (e.g. a car wreck in Italy involving US servicemen) and regional intermediate intensity issues (e.g. soldier's wife flexor tendon laceration from US military base in Munich) and local everything (distal humerus fracture in the 10 year old son of the base commander). Landstuhl is the only US military hospital in Europe. In the 1950's and 60's the US had a half dozen military hospitals in Europe but, in 2013 we have only one, LARMC. The military has infirmaries and clinics elsewhere, but only one hospital. They partner with European civilian hospital for acute treatment of injuries like car wrecks but longer term hospital care is provided by LARMC.

Rounds and then OR to assist in a variety of ortho trauma cases. Nice variety, hand, hip, young, old... Elective Sports and spine cases in other OR rooms.

Ortho does about 1/3 of all OR cases at LARMC. Hand is part of ortho, but spine affiliated much more with neurosurgery than orthopedics.

Completed rounds then went to the ER/and clinic for new admits and to pre-op tomorrow's cases. Quite similar to a day at UNMH with more of an emphasis on gunshot wounds.

Dinner at the DFAC (cafeteria); then read then to bed at 8.

Day 4 Tuesday

Wide awake at 5 AM. Jet lag persisting. Read a bit. Then 5 k run in the rain. Shower. Breakfast. Rounds at 7 AM. The PA's present radiographs of the cases that came in yesterday and the ones scheduled to come in today while the ortho docs discuss their initial treatment and plan. Again, very similar to our 6:30 AM rounds at UNMH with the addition of reliable information (actual radiographs) on patients scheduled to arrive later today.

OR for more cases. Inbound casualties reported. Apparently the snow is melting in the passes of Afghanistan. That means the enemy can begin moving around and that we can begin to pursue them. I was warned that the number of patients coming from Afghanistan was typically quite low until the snow melts in the mountain passes and then it markedly increases. I've assisted on more cases in 2 days than my predecessor did the entire 2 weeks she was here. More inbound casualties arrived in the afternoon and got sorted out. There are always some surprises but the information flow was much superior to the civilian system.

You could look at the actual radiographs and records of patients that were headed your way using online medical records. They have excellent information flow within

the military about condition, status and plan of various patients across the globe. This is important given the many interfaces of care that the wounded encounter and the great distances they travel.

I assisted on a wide variety of ortho cases today. Hand to hip, young to old. Mostly, but not all trauma. Elective Sports and spine cases were done in another room. I looked in on some of them between trauma cases.

Went to the ER and clinic to see tomorrow's cases. Some are inpatients surgery and some are outpatient surgery; all done in the same set of OR's.

Went outside the base gate for dinner with 2 ortho docs at a local German restaurant for various local "specialties". I ordered from the white asparagus menu which is a famous southern Germany specialty season in May. I had never heard of it before but heard a lot about it while I was there and subsequently. The growing asparagus is covered with soil so it is not exposed to the sun, hence "white". There is a short spring season when it is harvested fresh; somewhat like Morel mushroom season in the midwest. It is very tasty. I had a thin pizza topped with "Spargel" or "white asparagus, with melted white cheese. Highly recommended!

In the book "Unbroken" Louie has completed several bombing missions in the Pacific but has now crashed. He and 3 other survivors are on 2 rafts floating in the ocean. Unfortunately they are too far south and the ocean current seems to be drifting them west, toward Japan rather than east toward the US and safety. To make matters worse they have almost no supplies and sharks abound.

To bed about 9.

Day 5 Wednesday

I awoke at 5 and read a bit. Went for a 5k run in the drizzle. Rounds at 7.

Inbound flight from OEF at 10 AM. 3 casualties with BKA, through knee + acetabulum, multiple shrapnel to leg and face. Each went to the OR for re-debridements. They had been treated in Afghanistan with initial stabilization and debridement at the regional hospital. They were stabilized for a couple of days and then flown 8 hours to Landstuhl. Another patient was a pelvis ring disruption from car wreck in Italy of US serviceman 10 days old s/p external fixation at a civilian hospital in Italy. Orthofix fixator familiar as an Italian company.Outpatient clinic in the pm. Mostly post-op followup. Interesting case of a US serviceman with an unstable syndesmosis 5 months after plate fixation plus syndesmosis screw done in Italy private sector. The syndesmosis screw was 2.7mm x 3 cortex. Syndesmosis looked a bit wide but it wasn't real clear why he was having considerable problems. We got an external rotation stress view under fluroscan in clinic and it showed the syndesmosis to be very unstable. The screw just slid in and out of the tibia at the fibula translated laterally with stress and the syndesmosis opened up. It was an excellent use of clinic fluroscan. The diagnosis was confirmed and the patient was scheduled for future revision surgery.

Wednesday night we walked out the south gate to the base and down a long hill about a mile into the town of Landstuhl. The hill is known as "cardiac hill" because the military uses it as a place to train and the run back up the hill is tough. We had dinner at Greek restaurant. Very good. They also had the Spargel - white asparagus - special menu but I opted for Greek kabob since the restaurant seemed to be run by Greek people speaking Greek. Then we walked a few more blocks to the train station (bahnhof) but there is only an automated ticket kiosk, no person from whom to get information. I did see the daily train schedule with about 50 trains a day. Most of them are east west but varied from twice an hour small trains to "K-town" or Kaeselringschlosss to twice a day trains to Paris and Berlin and more exotic destinations.

Louie and 2 comrades are drifting west battling off aggressive sharks with oars and trying to dodge Japaness strafers who put 47 holes in their rafts; but one is still floating and they've survived a month on the sunny salty ocean. The previous

record of survivors was 21 days afloat). Unfortunately but unbeknownst to them, the US search has been called off and they are listed as MIA presumed KIA. What they've endured so far is unbelievable but I'm only half way through the book so I shudder to imagine what lies ahead. It's not looking good for them.

Day 6 Thursday

Thursday was, you guessed it, raining. If the Eskimos supposedly have 100 words for "snow" then Germans must have 1000 words for "rain".

I'm sure there are lots of places where it rains for a week straight. But I'm used to the Southwest for the last 30 years where it doesn't rain often. My recent experience of the last 9 months in Albuquerque there has been NO precipitation. None. To me, it's a pleasant change of pace and a joy to have rain and humidity. But it is also a shock to experience rain every day after you haven't seen it for soooo long! Like most places where the weather is a common topic of conversation, it gives everyone at the hospital something to complain about.

They have a Morbidity & Mortality conference on the third Thursday morning of each month where they review the problem cases from the past month. There is no inbound flight from OED on Wednesday so few new admits to review. 4 cases presented very well with insight and an appropriate amount of analysis and literature references. There was enough basic information /data to have facts to discuss. I provided some perspective. They struggled with a revision ACL where the femoral tunnel was drilled all the way through the lateral cortex and the graft got pushed out the lateral cortex. The young guys had never done an open lateral approach; only all inside/arthroscopic. They tried to retrieve the graft arthroscopically for quite a long time. Finally an older partner stopped by and made a lateral incision to retrieve the graft, replace and tension it, and then fix it with an interference screw from lateral (outside in.) It was interesting that NONE of the under 40 surgeons had ANY experience with an even partially OPEN surgical exposure for ACL reconstruction. That severely limits their salvage options, especially when a problem occurs. It is a problem for all of orthopedics, but is especially common in the military where few surgeons stay beyond age 50.

We also discussed the perspective of examiner for Boards Part 2 when presenting cases in general and complications in particular. 3 of the docs here are in or approaching their collection period. They were particularly interested in how best to prepare for Part II of the ABOS Certification Examination and what to expect. I discussed overall strategies on presenting complications and how to prepare for the exam which was of great interest to them.

I assisted on the pelvic ring disruption case from Italy. The posterior pelvis (sacral fracture, zone 2, vertical, lateral displacement) was reduced closed with manipulation of the fixator and iIio-sacral screws were placed into S1 and S2. The Italian XF pins were trans-osseous through the iliac wing. Supra-acetabular location was unavailable do to supra-acetabular fracture line left ilium. So revised them to intra-osseous wing pins with good illustration of fluroscopic guidance of the iliac tables and use of a spinal needle on the inner table for orientation. I think it is especially important to make sure the crest pins are intra-osseous and not exiting medially or laterally when the followup is going to be somewhere else (e.g. US) by someone else (other docs). Trans-osseous pins can provide sufficient stability until healing if you control the patient's activity and monitor the frame stability consistently. But if you are sending the patient elsewhere to have everything looking good and sturdy and stable. Then I got to illustrate techniques for obtaining inlet and outlet (Pennal) views of the pelvic ring. Logistically they faced all the same problems we encounter every day. OR delays. Equipment missing from sets. They have no equipment reps here so many of the problems are even worse. Dr. K has a good attitude of not giving in and not getting mad but persistence. Kinda like a young Dr. Echols. I see now how Echols developed his mannerisms and understand better how the VA system has come to be as an extension of military medicine. Anyway after 2 attempts at getting inlet outlet we went down to x-ray with the patient. I let them try again but the films were way under-penetrated. I mentioned that the "Bucky filter" designed to lessen scatter artifact might be causing the under-penetration. The techs were impressed that I knew what a "Bucky" was. The obliquity of the x-ray beam made hitting the plate AND the region of anatomic interest a challenge (they had missed numerous times). I helped them aim too. We got 2 good films and the screw position and reductions were confirmed as good. As nothing ruins results like follow-up, I subsequently learned that the receiving surgeons at Bethesda considered the posterior reduction "unacceptable" and revised the fixation further.

Went to the "semi-private" restaurant "Bruno's" on base tonight. They had a "spaghetti" special which I ordered for $9. They asked if I wanted parmesan and, fortunately, I said yes. Well it was a plate of spaghetti noodles with parmesan cheese. No meatballs. No nothing else. No tomato sauce, no spices. Maybe a little olive oil in the bottom. Reminded me of college days and macaroni and cheese. I guess that's what they mean by "spaghetti" here: just noodles.

Louie and one surviving mate have washed up on an island. So they made it out of the ocean to land. Unfortunately the island is controlled by the Japanese who initially treat them roughly but subsequently even worse. Out of the frying pan

(adrift on the Pacific) into the fire (Japanese internment camp). Japanese apparently treated prisoners much worse than anyone else including the Germans. Starvation, brutality and enslavement as well as medical experimentation and terrible physical abuse.

Day 7 Friday

Got up for an early morning run and then rounds and then breakfast and then OR for a several re-debridements and simple reductions. A big shipment of injured soliders from "Operation Enduring Freedom" was expected but didn't arrive. Subsequently learned that several of them were too critical to transport so they had held the flight. Perhaps tomorrow. More observations on the Army ways. John Ruth had gone to Landstuhl a couple of years ago and warned me about some of the idiosyncrasies, including the fact that "They don't do ANYTHING without orders."

Friday night a group of us went downtown with ortho and a neurosurgeon and a gregarious occupational medicine doc who has done 6 deployments including the current one as he says: "in support of Operation Enduring Freedom." This terminology implies you are actively involved in the fighting/conflict "in country" but the country is actually the relative safety of Germany and not hazardous Afghanistan or Iraq. It took as long to drive home (the long way around town) as to walk up "cardiac hill."

Day 8 Saturday

Only cloudy in the AM. No rain for a change. Went by the hospital. No arrivals yet but maybe later today or tomorrow. Took train to Waterloo battlefied in nearby Belgium, which was only about 100 miles from Landstuhl. Wellington led his British Army with his Prussian Allies to defeat Napoleon in the first week of June, 1815. It was the "end" of any French Empire and certainly the end of Napoleon as a military force. This European war also kept the British from devoting too much effort fighting the US in the end of the war of 1812; so helped us indirectly. Nice day but, unfortunately there wasn't much there to see. There was a very large anthill with a monument upon it. Apparently built right after the war from ground piled up from surrounding territory. Even Wellington who came back to the battlefield 5 years later, said "they have destroyed my battlefield". A few museums. The battlefield is of great historical importance but just not much to see. Apparently they have a re-enactment each June and the 200th anniversary is coming up in 2015. The people to whom it holds the most significance are the English but it is not on their territory and the Belgians don't seem to make much ado about it. I also went through Bastogne, the key town in the Battle of the Bulge in WWII. It was the last German offensive and the biggest American casualty battle of the war. Patton movie seems to have represented the facts very well, at least similar to version portrayed locally. I found another guy traveling to the battle sites who spoke both English and German so the mysteries of the train system were overcome. He told me what to do. I didn't really figure out how to buy a ticket and where to go on my own but did make it to and from.

Returned to Landstuhl 4 PM and checked with Dr. K at the hospital. The inbound flight with multiple casualties from OED had arrived about 2 PM. 30 patients from OEF (Afghanistan)! 24 "outpatient" with relative small injuries, fractures and the like. Enough to knock them out of fighting but not life threatening. 6 inpatients all seriously injured; 3 of them critically injured. This was what I had expected before coming here but hadn't yet seen. 2 of the soldiers with 3 extremity amputations. Very serious and sad. Fortunately the upper extremity amps were fingers so they will be "functional" if they survive. They had been stabilized in AStan and were taken to OR for repeat cleansing of the wounds here. Impressive blast injuries. One guy's 10 meter guard tower was blown up and he fell with it, breaking his femur. He was then shot in the same thigh,... but survived. One triple amputee was a medic who had responded to the initial attack and was then hit by secondary action while caring for injured. We maintained as much length as possible in the amputated limbs while

cleansing everything. The military efficiency was quite good. 3 other orthopedists showed up here at the hospital (not on call but somehow knew to come by) so all 4 injured extremities were addressed simultaneously.

OR had adequate suction, cautery, irrigation and instruments for 4 simultaneous procedures. Only one circulator and not much x-ray support but great orthopedic "assets" and sufficient support to get things done quickly. The second case I functioned as a second scrub nurse since we had more surgeons (4) than scrub techs (1) to simultaneously treat the 4 extremities. Then back to the ICU and next patient. Others got started evaluating and splinting the outpatients. No support staff in clinic. Most of the patients were "coalition forces", meaning they were from countries allied with the US in this fight. 8 were from Georgia (the former Soviet Republic now with the "coalition") who did not speak English. They were accompanied by a Georgian "doctor" who translated for us. It turned out he's a dentist but at least he spoke English and had knowledge of medical terminology. Dr. K said this is the most patients he's seen in one day since he's been here. One of the docs who was here 4 years ago said it was much busier then (when wars were active in both Iraq and Afghanistan, especially during the "surge") but this was still the biggest day he had seen. Glad to be able to be of assistance when needed.

Day 9 Sun

Up early. No ortho cases in the OR in the morning since they were doing neurosurgery and ophthalmology cases that filled the weekend OR capacity. So I went with some others for a 20 km (12.4 miles) hike in the woods, referred to locally as "volksmarche". Light drizzle early then it stopped. But then it turned very cold. Almost snowing. Certainly in the 30's. My hands went numb. I was under-dressed but walked faster to generate some heat and finished in 2.5 hours. Apparently after WWII the German government took ownership of most of the land of Germany. The records of who owned what were largely destroyed and there had been so many political changes that it wasn't clear who had the best claim to almost everything, including the land. So the government took ownership of almost all the countryside land. So now if you want to grow crops, you get a lease from the government for a certain patch of land for a certain period of time. There are NO homes out in the country. Everyone, including farmers, seem to live in towns or villages. The forests have been replanted and are "managed". If you want to cut timber, even firewood, you "lease" the right. One consequence of this is that there is an incredible set of trails through the woods since all the land is "public" and you don't have to cross any "private land". Also, there are virtually no fences. Our 20 k hike included part of at least marked 10 trails. Plus we crossed another 90, at least. Some were dirt, some paved; some narrow, some wide. Some go for hundreds of miles others are local. Most are for hiking but some for road bikes, mountain bikes, cross country skiing in the winter etc. The 20 k walk was "organized" by a local chapter of the DVV (Deutscher Volkssport Verband e.V.), the national chapter of the International VV. You pay 2 euros for a card and they stamp it every 5 k to "document" your participation. Trophies go to the Club with the most finishers. Individuals collect and accumulate these stamps over the year in a quiet competition. One American guy has done 300 hikes and over 3000 km in the past 2 years. He does one or two nearly every weekend. You can run or walk, but 90%+ are done walking. Young and old. Dog friendly. They have tea along the way. Free beer at 15 k!! Then a luncheon in a hall at the end; kind of like St. Patrick's 4th of July. There are 5k, 10k and 20 k options typically (at least at this one) and the "course" is set up for the weekend (Saturday and Sunday). You can start anytime between 6 AM and noon and finish by 4 PM. I would guess there were 1000 people who did this hike today. Kind of like 10 k runs in the US except mostly walking, no formal race or start time, more participants of all ages, and more of the events (probably 3 within 50 miles this weekend). But they were keen on "documentation" and keeping records. Apparently all for personal satisfaction/ bragging rights and good health. There were no times kept and no "winners". But gregarious participation. Completing the course on your own schedule seemed to be the point of the exercise.

Back at 3:00. They didn't need my help in the OR but I watched a couple of re-debridements that were done after the spine and eye cases. Dinner trip by train to Heidelberg. 90 minutes. Nice German dinner of bratwurst and some sort of bean//potato soup. Apfel torte for dessert. Beautiful castle on the river.

Louie transferred off "Execution Island" (good). Apparently the majority of American prisoners were executed by the Japanese. However his treatment, other than not being killed, is worse. More beatings. Less food. He, and the rest, seem to be starving much to the delight of their Japanese guards. He is considered an "enemy combattant" by the Japanese, in contrast to a "prisoner of war". Apparently that's some kind of military distinction that isn't good for the prisoner. Interestingly, it seems to be how the US has categorized Iraqi prisoners.

End of week one.

Day 10 Monday

Steady rain. Not merely drizzle but downpour all day and night. Ran in the morning. A little sore from the 20 k walk yesterday but not too bad.

So the logistics of my address have been interesting. I am staying at the "Ramstein Inn" in building 3724 on Einbahnstrasse. But several confusing aspects. Strasse is German for street. But it is spelled with a capital Beta symbol in place of "ss" in strasse. But there is no Beta symbol on keyboards, so it is going out of common usage in most printed material. The next confusion is that there is the town of Ramstein, the Air Force base called Ramstein, and the town of Landstuhl with the US hospital at Landstuhl. I'm staying at the Ramstein Inn but it is not located at either the town of Ramstein nor the Ramstein Air Force base. Furthermore, after telling people where I was staying I finally realized that the sign for "Einbahnstrasse" isn't the address but means "One way street". So I had been telling people I was staying at "3724 One Way Street." No one corrected me. The Americans didn't seem to know the difference or understand. The German people must have quietly thought I was an idiot.

Day 11 Tuesday

More rain but it started to let up during the day. Mostly a clinic followup day with only a couple of re-debridements in the OR.

Some observations on Army "ways":

The Surgeon General of the Army, a nurse with a rank of General, has an initiative to promote healthy living in the military including diet, exercise, sleep, stress management...A good idea. The DPAC (cafeteria) has healthy food options including vegetarian egg white omelettes cooked to order as well as many good healthy options at each meal; plus some less healthy but more popular ones and some standard ones (pizza etc.). There is also a Subway and a Burger King in the hospital giving standard and relatively healthy fast food options.

The military also promotes an "Individual Prosperity Plan" where everyone has to write down goals (1-2 year time frame) for:

Relational Goals (community, family, friends, international. marital, work)

Personal Goals (athletic competition. relaxation technique, fitness, financial, personal health, local cultural awareness, recreation and leisure)

Professional goals (Achievement, promotion, career, education, nominations, relocations, competitions individual and team, social development)

Spiritual Goals (ceremonies, growth, participation, holidays, practices, study, support, volunteerism)

Most of the people scoff at it but nearly everyone does "something" and most think they've gotten some good out of the process; albeit silly at times.

Another observation is the "4 day weekend". Apparently this is an Army phenomenon. They have 6 days a year designated as "training days" where people are to devote their efforts that day to achieving items on their "Prosperity Plan". Routine activities are suspended that day; a pseudo-holiday. "IF" you are already up to date on achieving the goals of your Prosperity Plan then it is a holiday. These "training days" are scheduled the Friday before Monday holidays; hence, "The 4 day weekend= Friday training day, Saturday, Sunday weekend and Monday holiday". It is a chance to take a little longer trip that usual or to extend one week off into 10 days; especially good for people stationed overseas. This weekend is one; although I'm headed home on Saturday so can't really take advantage of it. I think the idea of these "4 day weekends" might have great utility in the US.

I went back to Bruno's and explored and discussed the menu in greater depth. I realized that they order pasta like pizza, that you pick the toppings to add to it; even though they aren't necessarily listed as separate items. So when I had ordered "spaghetti with parmesan" it was like ordering a cheese pizza. So tonight I ordered spaghetti with olives and mushrooms and clams. It was excellent. Live and learn.

Louie is being transferred from one terrible concentration camp to something that is even worse. The only good news is that Japan is losing the war. Even that is a problem, because it seems widely known that the Japanese have orders to kill all the prisoners if defeat is imminent.

Day 12 Wednesday

I've been living in fear of losing my passport or something else important and irreplaceable (wallet, ID, red cross credentials, confidential patient information access credentials, glasses, cell phone....) What with changing

scrubs every day. Sure enough I left my Red Cross ID tag on my scrubs Tuesday night. Fortunately when I went early this morning to the dirty laundry bin, my scrubs with the ID were on top. Some consolation for being the last to leave and the first to come in the next day (although some people wear their scrubs home). Hopefully that's the only loss I'll suffer this trip.

4 more cases today all went well. We did a comminuted distal humerus fracture. Dr. K was pleasantly surprised at how well and fast things went and credited my assistance. He said he'd never done one without having the let the tourniquet down at 2 hours (we were done in 1 h 45). He also thanked me several times saying "This has been like a 2 week trauma fellowship for me with lots of patients and expert direction." and "I think I've learned more in 2 weeks than in 4 months of fellowship." I'm not sure exactly what he's learned but it was nice to be appreciated in such a way. The medic with 3 amputations had his parents and wife arrive today. They are, of course, devastated. The volume of casualties is numbing. As Rich Miller mentioned, it is barely on the news anymore in the US but there we are certainly still actively fighting a war with associated casualties. Someone here estimated there will be 10,000 amputees from these 2 wars when all is over. Wow.

Casey is an Army medic who was responding to an injured soldier when a second blast blew off both legs and parts of both hands.

All the soldiers have tourniquets applied to their thighs as part of their equipment and these were immediately inflated, probably saving his life. He was immediately evacuated to the local then regional hospital where ventilators were need for breathing and direct control of bleeding replaced the tourniquets and the wounds were cleansed. After several days he was evacuated to Germany aboard the military airplane ICU. We cleansed his open wounds and were able to salvage the majority of his hand and fingers while maintaining support for his breathing and overall metabolism. His wife, mother and father all flew to Landstuhl to be with him. I will never forget the looks on their faces as they sat with him daily. His general condition stabilized and he was transferred to Bethesda, still in critical condition. The outcome in this case is much less certain. The best case scenario is still a very difficult future.

Although many of the soldiers are making history with their recovery and function there are many others struggling with their new reality. As we go forward, the intense support and resources available to them from a variety of sources including the Wounded Warrior Program, are likely to fade, leaving them with great long term difficulties in coping with their physical and psychological challenges.

A group of NFL players from the Chicago Bears came through to see the patients today. Matt Forte and Johnny Knox. They seemed genuinely concerned with the patients although it was clearly a photo op PR project. I got to meet them and shake hands and have them tell me thanks. So that was nice, too. It was commonplace for the workers here to have visiting dignitaries passing through and the workers barely took notice of them. But it was special and unique for the patients and the short time workers like me who all seemed to enjoy the visit. The Romanians and Georgian patients weren't so clear on who these guys were, but the Americans were all impressed.

I saw a special on TV of the German Soccer Bundesliga All Star team with commentary by the coaches. I recognized the Bayern Munich coach. Ginny and I had played golf with him and his wife at Torrey Pines last summer. I remember at the time I asked him where he was from and he said Germany. I asked him where and he said Munich. I told him we had lived in Munich for a month in 1986 (big deal). I asked him what he did and he said coach soccer. I asked him where and he said with Bayern Munich. I was happy/proud to know they were a big time soccer club but didn't realize he was the head coach and this was like playing golf with Nick Saban or Vince Lombardi. Anyway, it was nice to recognize him on TV commenting on the players. I recall he was impressed that Ginny not only beat his wife at Torrey Pines but also beat him! I won't say how we fared against each other.

I went to "Salvatori's" Italian restaurant and tennis complex for dinner. This is a local tradition with lots of pictures of US servicemen and military dignitaries from the past 50 years. They also have 6 clay tennis courts. It was pouring down rain when we arrived for dinner, and had been for days. The rain stopped during dinner. By the time we left (~1 hour later) all of the courts were filled with players! Not only had the clay courts dried out but people had time to get there before dark and arrange games. Incredible! I would have guessed it would take a month for those courts to dry out but it took less than 30 minutes!

Day 13 Thursday

Grand Rounds

Presented my grand rounds in the morning. It was a bit of a logistical challenge because they did not allow computers (laptops) or even thumb drives onto the base as a security precaution. I could only bring CD's or have attachment to email messages. But the email messages had to be opened on "secure" laptops and then transferred to the projectors in a compatible format. I had my talks on both CD and as email message attachments and I had tried to load it the day before to make sure all was ok but it didn't show up on my disk list. Apparently internal security built into the laptops was blocking me from opening the files. Other talks (some but not all) that I had loaded were there. There are lots of security issues with military computers, and which accessories they will allow, which programs they will run and even which files they will open. Not only are thumb drives 'verboten' but the USB ports are all disabled. Many of the computers, including in the conference room, are restricted to no internet access either way. You can't hook a lap top to any of the equipment here (like projector). Even the telephones require an ID card inserted to work for anything but 911 calls!

Anyway, I was able to get the talks on knee dislocation and damage control loaded and the Grand Rounds was a huge hit. Partly because the military has suspended paying for any CME travel or activities since the "sequester" in February 2013 as a response to the US congressional budget crunch. But the medical personal all still need CME. So they look for local opportunities to get CME without traveling. The military also supports the local CME in partial compensation for cutting off funding for outside CME. I had lots of forms and documents to complete in advance. I had expected the 10-12 people that usually come for morning rounds but the room was packed as people wanted the CME. My talk was also broadcast to all the military bases in Europe and there was a coordinator there fielding questions that were called in. I was surprised. Half the audience was probably not orthopedists (PA's, nurses, other MDs). They were primarily motivated for the CME not the content of the lectures. But a big crowd. The other half was mostly sports med orthopods but from the Q & A's they very much had the "old school" attitude toward knee dislocations that these were rare. Half said they had never seen one. No one could remember seeing one here at Landstuhl. Some multi-ligamentous knee injuries but no bi-cruciate/KD. A few seemed to have more clinical experience/exposure and had more "advanced" questions. I had the 2-10 y Wascher/Schenck/Richter followup talk to refer to for them. I didn't go through the whole thing but just showed a few of the slides from the second talk. It is always good to leave them wanting more. They want me to give another talk, so that's a good sign.

Five OR cases today. It has been a really big week. Nailed a segmentally comminuted tibia that went very well. Another plated distal humerus fx. I had been told that they didn't do any fracture fixation surgery here but clearly that's not the case; as they do a lot. It is true that open wounds in US military personal from OEF get washed out and ex fixed and sent to Bethesda for later definitive internal fixation.

Sun almost came out this afternoon. Kendall, the neurosurgeon, decided to take advantage of the break in the weather to have a cookout at his apartment on base. But it was pouring rain 30 minutes later so the cookout was moved indoors, grilling on the deck. Someone disabled the smoke alarm which most agreed was unnecessary because it undoubtedly wasn't working anyway. Interesting conversation with people there. 2 kids ages 2 and 5 perfectly content on their i-pads ignoring the adults. Not many other kids to play with on an average day, is my guess. A 12 year old who could give Thor a run for his money in the childhood savant competition.. He's in the German advanced high school, taking 3 languages amongst a myriad of courses. "Woefullly underskillled" in soccer, by his own assessment, so he plays "tennis." At Salvatori's restaurant and tennis academy where I went Wednesday night. It is a small town. The adults at the party were a potpourri of vagabonds. Kendall was most interesting. As he says, "I'm living the American dream." Born in a town of 100 in S Korea just south of the DMZ, his father came to Denver on promise of a job but upon arrival no job. Went to public school where they hired a special teacher who spoke Korean for his sister and him; only. Went to a community college for a semester and then transferred to CU Denver. Did well there and somehow Yale offered him a scholarship so transferred there and graduated. Then went to Dartmouth medical school and Harvard for neurosurgery and now is practicing at Mayo Clinic. What a ride!!! He felt a duty to the country so he joined the Navy Reserves and they promptly sent him to Germany. He's been here 1 month and loving it. He got the chance to fly to Afghanistan on the CCAC (another acronym) which is the hospital airplane/mobile ICU. He got to ride in the cockpit on the way out! Flew 8 hours into Bagram over the site of the C135 that crashed on steep takeoff (?load shift) 10 days ago. Sobering! He was impressed with the austerity and security presence in Afghanistan as well as the mobile medical care.

Kendall flew back with 15 patients on the plane, including young injured soldier on ECMO and another older "private contractor". They originally wouldn't let him deploy to Afghanistan because he was on a blood thinner Plavix after a femoral artery bypass graft. So he just

stopped taking the Plavix and they said OK now that you are not taking Plavix you can deploy to Afghanistan. He gets there and clots off his graft and ends up with a dead leg and an amputation and now is being flown back.

Day 14 Friday

Observations on informed consent.

The Romanians and Georgians have little idea what we're talking about when it comes to informed consent. They understand, I think, our description of their injuries (broken leg or tibia) and anticipated resultant problems (can't walk until it is stabilized) and seem to have some sort of understanding of our recommended treatment. They have no idea when it comes to signing informed consent or what that means. The Romanian guy today says, "You want to help me? Go ahead. You want my permission to help me? That's crazy." He's also the tough guy that scoffed at the injured American soldier taking Percussid for post-op pain.

International smothering.

The next patient was a Marine in full gear with night vision who was chasing a bomber at night (4 AM) down a hill, following the "sweeper" or minesweeper. He figured that was the safest route. As he was running he felt the ground "slipping away" under him and then a 75 foot drop into a dry well. He had stepped on the edge of what the minesweeper had stepped over, the opening into the well. So even though he was following closely the first guy stepped over the well hole but he stepped in it. Somehow they got him out of there in about 1 hour. Pretty good accomplishment for someone who had fallen down a 75 foot well in the middle of Afghanistan in the middle of the night! The "CMG's" or some acronym constructed some sort of extraction device and pulled him out. MLA=Military Loves Acronyms. Everyone knows what they mean but almost nobody knows what they stand for, literally. He had a femur broken in two places and multiple other fractures but they got him out of there. He got to the in country hospital for traction and then and back to Landstuhl in a couple of days on the C-130 hospital plane. We fixed most of his fractures and are planning to send him back to the States. On rounds the next day he says, "We've got a big problem. My mother is conducting "international smothering" and has to be stopped. She's calling me 4 times a day and is threatening to fly here. That can't happen. She will bring this hospital to a standstill. You've got to tell her that I'm coming home tomorrow. I don't care when you send me home just tell her it is tomorrow so she doesn't come here." Then the classic part: (after coining the phrase "international smothering") "You've had me sign about a hundred things. How about if I give you consent to lie to her?. Tell her anything you want. Make up the wildest story you can imagine. I'll sign anything but the woman has to be stopped." He's on the plane to Bethesda tomorrow. At least that's what we told his mother. His prognosis is good for a full recovery but it will likely take 6 months or more.

Day 15 Saturday

0700 Up and pack

845 Alex Shuttle pick up and drive to Frankfurt on the autobahn. Sunny with many fields of yellow flax wafting in the breeze. Probably as fast as the drive down but I didn't notice as much.

Arrived at Frankfurt airport and checked through security fine for Lufthansa flight back to US. Had a better seat this time with much more leg room.

Arrived into Denver and breezed through security. The customs agent even thanked me for my service, in contrast to the usual gruff reception you get.

Then flight back to Albuquerque and home safely.

Conclusion

Although we were quite busy during my two weeks, I only saw a few of the severely injured multiple amputation patients. One of my predecessors from a couple of years ago saw so many that he got depressed and came home 4 days early. As with most "volunteer" activities, I am grateful for the opportunity to have participated in the DVSP and my experience at LRAMC. I received far more than I gave. I am appreciative of the work done by all of the military health care workers. Roosevelt said "The cost of freedom is eternal vigilance." There are times when vigilance is not enough and action is required. My deepest gratitude goes to the injured warriors and their families who clearly and willingly demonstrate that freedom is not free and that a "free" society requires individuals willing to sacrifice personal safety for the overall benefit. It follows that society then owes those individuals the best possible medical care when they need it.

What Cost to "Buy" Academic Accomplishments?

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In 2008, the National Institutes of Health implemented a policy stating that "all investigators funded by the NIH submit . . . an electronic version of their final, peer-reviewed manuscripts . . . to be made publicly available." [1] Since that time, there has been an explosion of "open access" (OA) journals, about half of which require the author to pay a publishing or page fee or article processing charge, usually ranging from $1000 per article to $1000 per page. Such journals often boast rapid turnaround, with "peer review" in 7-10 days and publication within months. For comparison, the Journal of Pediatric Orthopaedics takes 2-3 months for peer review, and often 8-10 months for actual publication.

Does this make it possible for a person of means to "buy" academic prestige and a long curriculum vita? Does this exclude excellent non-funded studies from publication? Do article processing fees exclude authors from developing countries or less well-funded research facilities and universities?

Advantages to the OA model include lower costs to libraries and free access to scientific journals for medical professionals and patients, especially those in developing countries. A major disadvantage is potential damage to the peer-review system: the medical community carries out peer review for free, yet publishers gain billions of dollars for physicians to read the final product. Given that income is dependent on the number of papers an OA journal publishes, an impetus to accept substandard articles exists.

A graduate student at Cornell University produced a paper using software that generates grammatically correct but nonsensical text and submitted it to an OA journal under pseudonym. He decided to submit the fake after receiving several unsolicited invitations by email to submit under the "author-pays-for-publication" model. He wanted to test if the publisher would "accept a completely nonsensical manuscript if the authors were willing to pay." The article was accepted for publication.[2] This "experiment" has been repeated with similar outcome, although critics cite "lack of control group."

New OA journals generally lack the reputation of subscription journals. However, Bjork and Solomon studied OA publishing compared to subscription journals, using average number of citation as a proxy for impact factor. They concluded that "OA journals indexed in Web of Science and/or Scopus are approaching the same scientific impact and quality as subscription journals, particularly in biomedicine and for journals funded by article processing charges." [3] Does this suggest quality in OA publishing, or simply ease of citation given that Google and other search engines supply "data" regardless of validity or accuracy?

Established subscription journals are also reacting to the financial crunch of publishing: the Journal of Bone and Joint Surgery has established a $250 fee, not for publication, but for merely reviewing a manuscript submitted to the journal.

The European Union sponsored "Study of Open Access Publishing" surveyed 50,000 researchers regarding their thoughts on OA publishing. Eighty nine percent of respondents felt that OA was helpful to their field, and 53% said they had published at least one OA manuscript. But 40% felt that author fees were a deterrent, and 30% felt that high-quality open access journals in their field were limited.[4]

The "open access" fee-for-publication model is undoubtedly here to stay. No fewer than 5 to 10 emails daily solicit manuscripts for such journals. Given that academic medicine has always placed a premium on publication, will "deep pockets" be the new guarantee to academic success?

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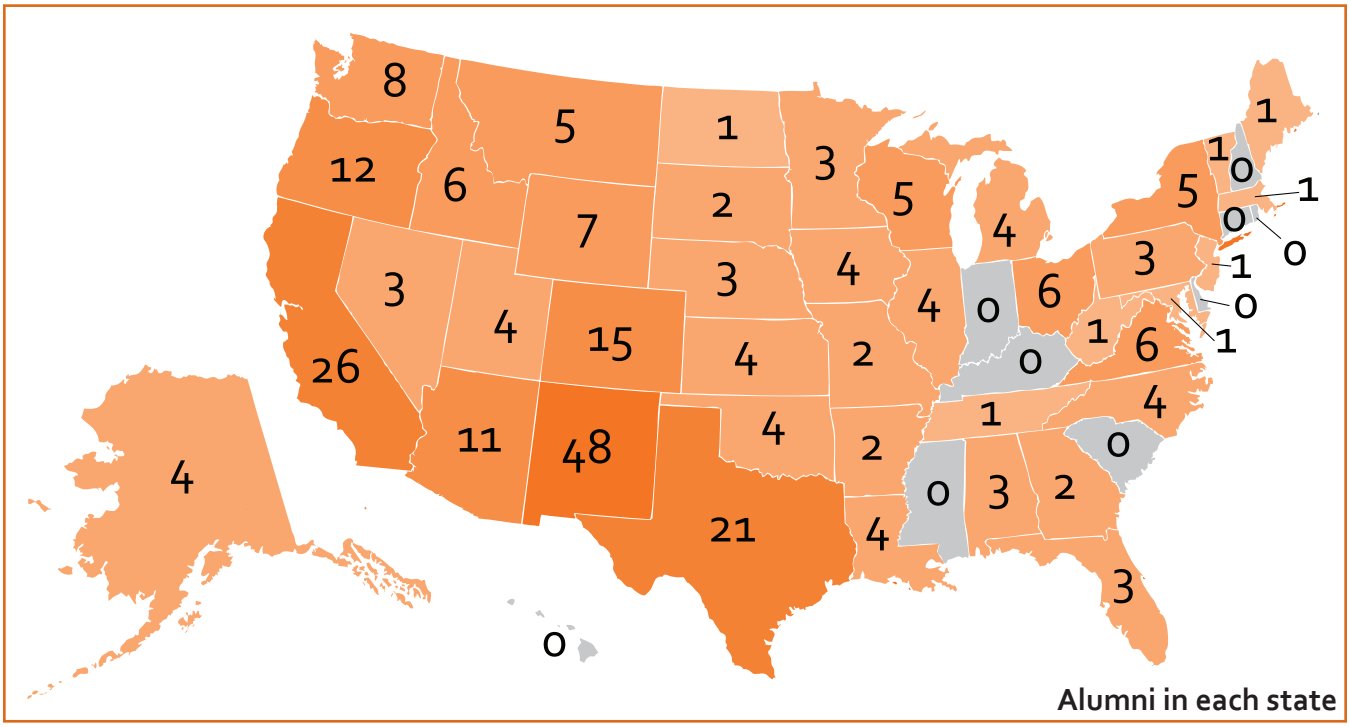
3. Bjork B, Solomon D. Open access versus subscription journals: a comparison of scientific impact. *BMC Medicine*. 2012;10(73).

4. Vogel G. Quandary: Scientists prefer reading over publishing "Open Access" papers. *Science Insider*. January 2011.



University of New Mexico Department of Orthopaedic Surgery Alumni

Hand Surgery Fellows

Damon Adamany (AZ)	2007
Ahmed Afifi (OH)	2008
Jeffrey Aldridge (OR)	1987
Valdemar Ascencio (CA)	1984
John Bax (WI)	1985
William Blair (TX)	1979
John Bolger (WI)	1980
Daniel Boudreau (TX)	1973
Boyd Bowden*	1972
Bradlet Britt*	1984
Mark Buchman (NE)	1989
Randy Bussey (CO)	1980
David Capen (TX)	1975
Edwin Castaneda (IA)	1988
James Clark (NM)	2013
Anthony Dalton	1980
Alex de Carvalho (KS)	2005
William Doherty (MA)	1993
Gregory Duncan (CA)	1992
Thomas Eiser (OK)	1979
Edgardo Espirtu (TX)	1985
Hani Fahmy (EG)	1993
Ronald Ford (MI)	1997
Bruce Freedman (VA)	1988
Eric Freeh (NM)	1983
Bonnie Fraser (NV)	2007
Jeffrey Garst (IL)	1994
David Gerstner (MI)	1988
Richard Gobeille (NM)	1985
Douglas Gordon (OH)	1987
Matthew Green (UT)	2012
Dominic Gross (ID)	1997
Robert Hamas (TX)	1974
Conrad Hamilton (NM)	2011
Terry Happel (AZ)	1986
John Hayden (AZ)	1983
Aaron Hoblet (OR)	2013
Karl Hofammann (AL)	1983
Thomas Howey (SD)	1992
Jing Hsien (CA)	1986
Patrick Hudson (NM)	1978
Davis Hurley (CO)	2003
Tariq Hussain (NY)	2002
Perry Inhofe*	1994
William Irey (IA)	1982
Glenn Johnson (MN)	1998
Jann Johnson (CA)	1984
David Johnston (CANADA)	1995
Terrell Joseph (CO)	2006
Jon Kelly (CA)	1993
Alan Koester (WV)	1995
Shankar Lakshman (CA)	2004
Scott Langford (MO)	2000
Kenna Larsen (NM)	2009
Thomas Lehman (OK)	2002
Charles Leinberry (PA)	1990
David Long (OR)	1971
Paul Luce (MI)	1999
Joseph Mann (CA)	1981
Deana Mercer (NM)	2010
Elizabeth Mikola (NM)	2001
Gary Miller (MO)	1986
Steven Miller (AZ)	2009
Robert Morrow (LA)	1980
Anastasos Mourikas (GR)	2004
Louis Murdock (ID)	1996
Abdul Mustapha (OH)	2000
Thomas Narsete (TX)	1981
William Niedermeier (WI)	1979
Gavin O'Mahony (OK)	2012
Gerald Olmstead (WA)	1971
Don Oschwald (NC)	1985
Larry Patton (UT)	1979
Ralph Pennino (NY)	1986
Charles Phillips (FL)	1971
Jeffrey Pokorny (NC)	2002
Ram Prabhakar (CA)	1980
Charles Pribyl (NM)	1989
Milos Radwick (MD)	1971
Michael Ravitch (NV)	1974
Allison Richards (NM)	2008
Hector Rosquete (ME)	1990
John Russin (NM)	1984
Robert Saide (AZ)	1983
Ehab Saleh (MY)	2005
Scott Schemmel (IA)	1987
Joseph Serota (CO)	1983
Swati Shirali (VA)	1999
Victoria Silas (WA)	1996
Richard Sleeper	1988
Duret Smith (OH)	1982
Osama Suliman (FL)	1985
Scott Swanson (CO)	2010
Steven Taylor (WI)	2006
Ronald Tegtmeier (KS)	1976
Kenneth Teter (KS)	1993
Erik Torkelson*	1984
James Trusell (AR)	1973
Gregory Voit (NJ)	1996
Catherine Walsh (CA)	2011
Howard Weinberg	1978
InSok Yi (CO)	1998
Robert Yoo (MA)	1977
Steven Young (IL)	2001
Elmer Yu	1979

Sports Medicine Fellows

Roy Abraham (IA)	2006
Matthew Ferguson (TX)	2013
John Jasko (WV)	2010
Adam Johnson (NM)	2012
A. John Kiburz (NM)	2009
John Mann (AL)	2010
Ben Olson (CO)	2002
Toribio Natividad (TX)	2011
Ralph Passerelli (PA)	2007
Brad Sparks (AK)	2008
Brad Veazey (TX)	2007
Jonathan Wyatt (AR)	2012

Trauma Fellows

Shahram Bozorgnia (GA)	2008
Max de Carvalho (MN)	2011
Fabio Figueiredo (ME)	2007
Shehada Homedan (NY)	2006
Victoria Matt (NM)	2005
Gary Molk (WY)	2010
Leroy Rise (NM)	2012
Modhia Urvi (IL)	2013
Zhiqing Xing (AL)	2009

Residents

Alexander Aboka (VA)	2011
Christopher Achterman (OR)	1977
Brook Adams (TN)	2011
Zachary Adler (NM)	2007
Amit Agarwala (CO)	2002
Owen Ala (PA)	2013
Lex Allen (AUSTRALIA)	2002
Alan Alyea (WA)	1986
Frederick Balduini (NJ)	1981
Adam Barmada (OR)	2001
Jan Bear (NM)	1991
Jeremy Becker (NM)	1997
Kambiz Behzadi (CA)	1994
Robert Benson (NM)	1973
Eric Benson (NM)	2007
Ryan Bergeson (TX)	2008
Thomas Bernasek (FL)	1986
C. Brian Blackwood (CO)	2011
David Bloome (TX)	2001
Dustin Briggs (CA)	2013
William Burner (VA)	1980
Dwight Burney (NM)	1980
Dudley Burwell (MS)	1987
Dale Butler (CA)	1973
Everett Campbell (TX)	1973
Bourck Cashmore (AZ)	1997
Richard Castillo (NM)	1988
Zachary Child (TX)	2011
Joel Cleary (MT)	1985
Mitchell Cohen (CA)	1992
Harry Cole (WI)	1992
Matthew Conklin (AZ)	1988
Clayton Conrad (NM)	2009
Geoffrey Cook (AZ)	1988
David Cortes (WA)	2005
Mark Crawford (NM)	1994
Aaron Dickens (CA)	2013
Grant Dona (LA)	1993
Daniel Downey (MT)	1992
Shakeel Durrani (VA)	2010
Paul Dvirnak (CO)	1996
Paul Echols (NM)	1978
Daniel Eglinton (NC)	1983
James Fahey (NM)	1978
James Ferries (WY)	1995
Thomas Ferro (CA)	1990
Jennifer FitzPatrick (CO)	2010
John Franco (NM)	2003
John Foster (NM)	1974
Orlando Garza (TX)	1977
Jan Gilmore (NM)	2012
Robert Goodman (CO)	1980
Stan Griffiths (ID)	1989
Speight Grimes (TX)	2004
Christopher Hanosh (NM)	2001
Gregg Hartman (CA)	1997
Robert Hayes (TX)	1975
William Hayes (TX)	1996
David Heetderks (MT)	1990
Thomas Helpenstell (WA)	1991
Fredrick Hensal (AL)	1982
Bryon Hobby (CA)	2012
Daniel Hoopes (WA)	2013
David Huberty (OR)	2005
Sergio Ilic (CA)	1977
Kayvon Izadi (NE)	2008
Felix Jabczenski (AZ)	1989
Robert Johnson (ND)	1981
Orie Kaltenbaugh (ID)	1978
Daniel Kane (IL)	1977
David Khoury (WY)	2007
Roger Klein (CA)	1984
Dennis Kloberdanz (NM)	1988
Ken Korthauer (TX)	1985
John Kosty (TX)	1983
Letitia Lansing (NY)	2010
Loren Larson (WA)	2006
Earl Latimer (NM)	1993
Robert Lee (ID)	1995
Corey Lieber (NM)	2006
Peter Looby (SD)	1995
Joel Lubin*	2001
Norman Marcus(VA)	1983
Charley Marshall (UT)	2005
Roberto Martinez (FL)	1984
Victoria Matt (NM)	2002
Timothy McAdams (CA)	2000
Victoria McClellan (OR)	1984
Thomas McEnnerney (NM)	1984
Kevin McGee (NM)	2008
Laurel McGinty*	1991
Michael McGuire (NE)	1995
Matthew McKinley (NM)	1998
Deana Mercer (NM)	2008
Richard Miller (NM)	1990
Brent Milner (WY)	2003
Frank Minor (CA)	1982
Rosalyn Montgomery (OR)	1991
Kris Moore (OR)	2008
Ali Motamedi (TX)	1998
David Munger (AZ)	1969
Fred Naraghi (CA)	1981
Joseph Newcomer (IL)	1998
Lockwood Ochsner (LA)	1986
Andrew Paterson (NM)	2004
L. Johnsonn Patman (UT)	2012
William Paton (AK)	1977
Matt Patton (NM)	2002
Chris Peer (MI)	2005
Eugene Pflum (CO)	1976
Dennis Phelps (CO)	1985
Gregg Pike (MT)	2004
Mario Porras (NV)	1977
Julia Pring (PA)	2009
Jeffrey Racca (NM)	2000
Shannah Redmon (AZ)	2009
Stephen Renwick (OR)	1994
Jose Reyna (NM)	1983
Allison Richards (NM)	2002
Brian Robinson (NM)	1998
Peter Rork (WY)	1984
Kenneth Roth (CA)	1967
Michael Rothman (NM)	1974
David Rust (MN)	2012
Peter Schaab (AK)	1990
Ted Schwarting (AK)	2003
Jonathan Shafer (WA)	2006
Sanagaram Shantharam (CA)	1992
Paul Shonnard (NV)	1995
Selina Silva (NM)	2010
Robert Simpson (NY)	1976
James Slauterbeck (VT)	1993
Christopher Smith (WY)	1974
Dean Smith (TX)	2000
Jason Smith (LA)	2007
Robert Sotta (OR)	1987
Richard Southwell (WY)	1980
Daniel Stewart (CO)	2012
Christopher Summa (CA)	1995
Kenneth Teter (KS)	1993
Eric Thomas*	2004
Gehron Treme (NM)	2006
Krishna Tripuraneni (NM)	2009
Randall Troop (TX)	1989
William Tully (CA)	1972
Cathleen VanBuskirk (CO)	1999
Tedman Vance (GA)	1999
Andrew Veitch (NM)	2003
John Veitch (NM)	1978
Edward Venn-Watson (CA)	1975
Eric Verploeg (CO)	1987
Joseph Verska (ID)	1994
David Webb (TX)	1977
Richard White (NM)	1979
John Wiemann (OH)	2011
Michael Willis (MT)	2000
Bruce Witmer (CA)	1982
Jeffrey Yaste (NC)	2009

*Deceased

Journal Submissions

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