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PATHOLOGICAL AND SURGICAL EVALUATIONS
OF POLYTETRAFLUOROETHYLENE IMPLANTS
TO CORRECT MEDIAL PATELLAR LUXATIONS
IN THE CANINE SPECIES.

Iowa State University of Science and Technology
Ph.D., 1962
Health Sciences, pathology

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1963

PATHOLOGICAL AND SURGICAL EVALUATIONS OF POLYTETRAFLUOROETHYLENE IMPLANTS TO CORRECT MEDIAL PATELLAR LUXATIONS IN THE CANINE SPECIES

by

Phillip Theodore Pearson, [illegible]

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of
DOCTOR OF PHILOSOPHY

Major Subject: Veterinary Pathology

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

Head of Major Department

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Dean of Graduate College

Iowa State University
Of Science and Technology
Ames, Iowa

1962

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INTRODUCTION

Medial patellar luxations of the canine stifle joint are primarily inherent or congenital, especially in certain breeds of dogs, such as the Toy French Poodle, Chihuahua, Manchester Terrier, Pekingese and Boston Terrier. Because of the increased popularity of small and toy breeds of dogs, this type of luxation is being seen more frequently. Medial patellar luxations are now the most common condition of the canine joints requiring surgical correction. If surgery is not performed on these patients, severe lameness and a deformity of the hind legs frequently develop.

The primary cause of medial patellar luxation was usually a defect in the development of the distal end of the femur., Frequently a secondary factor such as trauma was needed to cause the patella to luxate. In order to correct this patellar luxation, both the primary and secondary factors had to be rectified.

The most frequent developmental defect of the distal extremity of the femur appeared to involve the medial and lateral condyles. More frequently the medial condyles were involved, being poorly developed or entirely absent. These condyle defects appeared to start a chain reaction which frequently resulted in medial patellar luxation. The earliest change in this disease process was a stretching or rupturing of the poorly developed lateral patellar ligament, resulting from inadequate patellar support by the deficient medial condyle. Since the patellar support from both the medial condyle and the lateral patellar ligament was gone, medial patellar luxation was the usual result. The luxated patella then exerted medial pressure on the straight patellar ligament and caused a posterior-medial deviation of the tibial crest in growing puppies. The combination of these stifle joint changes resulted in abnormal stress on the articular surfaces of the joint, and osteoarthritic changes frequently were observed.

In the last sixty years, various methods have been devised to help correct medial patellar luxations. All of these procedures have been directed principally at correcting the secondary factors in inherent or congenital patellar luxations, rather than the primary factor. These surgical procedures have frequently produced good clinical results in traumatic patellar luxation and in very mild inherent or congenital cases, but the recoveries have been unsatisfactory in the majority of the inherent or congenital luxations.

Therefore, there was a very definite need for a new surgical procedure that would more adequately correct the primary cause of the majority of the inherent or congenital medial patellar luxations in the canine species. After a thorough review of the anatomy and physiology of the canine stifle joint, a new surgical technique was devised to supplement the deficient medial femoral condyle. The necessary materials utilized in this surgical procedure were chosen, fabricated, implanted and observed for as long as two years. Many of the physiological effects of this surgical procedure on the dogs were evaluated. The macroscopic and microscopic tissue changes caused by this procedure were studied. After this new surgical technique had been properly tested in experimental dogs, it was employed and evaluated in actual clinical cases of the above mentioned patellar luxations.

LITERATURE EVALUATION

A thorough understanding of the normal and abnormal canine stifle joint should be known before corrective surgery is attempted. The anterior aspect of the stifle joint is formed by the quadriceps femoris tendon, the patella, the straight patellar ligament, the medial and lateral femoropatellar ligaments (medial and lateral patellar ligaments), the muscle aponeuroses and the tibial crest. The patella is considered to be a sesamoid bone and is situated in the common tendon of the quadriceps femoris muscle and lies between the medial and lateral condyles of the femur. The patella insures a smooth, gliding movement of the tendon in the intercondylar area. This gliding movement is necessary to allow the quadriceps femoris muscle to exert its full extensor power on the hind limb.

The patella is kept in its proper position in the intercondylar area by the medial and lateral condyles of the femur and by the fascia making up the pliant medial and lateral femoropatellar ligaments. The normal gliding action of the patella on the femur depends on the normal tibial attachment of the straight patellar ligament. Parapatellar fibrocartilaginous structures located in the quadriceps tendon are normally found as expansions on either side of the patella. Since these structures contact the femoral condyles, they may also help to prevent patellar luxations.

The condyle development of the femur may vary from normal to nonexistent. The medial condyle is frequently more deficient than the lateral condyle. In dogs with deficient condyle development the patella usually luxates to the medial side of the femur either before or shortly after the birth of the puppy. The medial and lateral patellar ligaments are very poorly developed at this age and as a consequence they appear to play very little part in these patellar luxations. Singleton (51) and Shuttleworth (49) stated that in most cases they felt there was a degree of congenital deformity present which was predisposed to injury brought about by forces which would have little or no effect upon a normal joint. Shuttleworth (49, p. 772) stated

> The balance of the patella is more dependent upon the development of the trochlear lips and the correct alignment of the three cardinal points, the origin and insertion of the extensors and the path over the trochlear [sic], than upon the adjustment of the lateral capsules, so that rupture or stretching of these structures alone will have little effect in bringing about a permanent luxation.

Vierheller (58) reported that in a high percentage of the cases palpation of the trochlear portion of the femur revealed an absence of the central groove and trochlear ridge. He was of the opinion that this was probably the primary cause of patellar luxations in these young patients.

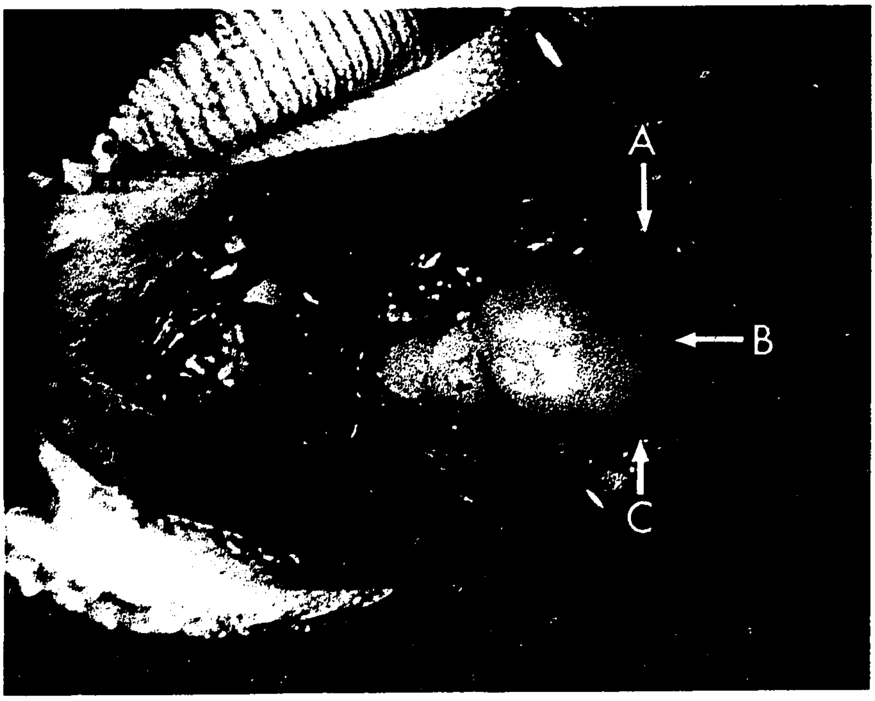
As the young animal grows, the medial location of the patella causes medial and posterior deviation of the proximal tibial crest. If the condition progresses, the remainder of the tibia deviates medially. This causes the stifle joint to point medially, the hock joint to point laterally and the metatarsus to point ventro-medially. In severe cases the foot of the involved leg may actually touch the medial side of the opposite hind leg (Figure 1). It is frequently hard to replace the dislocated patella into its normal position in these cases because of the contractions of the medial patellar ligament, the quadriceps femoris muscle group and their common tendon. These patellae are often undeveloped and may fuse to the medial side of the femur. Because of the lack of normal movement between the patella and the femur, the condyles and the intercondylar area may never develop properly (Figure 2). Vierheller (58) reported that these legs are narrow from a lateral view and broad from the anterior or posterior view. These animals stand in a partial squat position, their gait is wobbly and the hind limbs appear abducted.

Traumatic medial patellar luxations involving older dogs with normal or nearly normal stifle joints are less frequent. Again there is usually some anatomical defect present which predisposed the patella to luxation. Deformed condyles play a smaller role in luxations of the patella in these patients. Traumatic damage to either the medial or lateral patellar ligaments accounts for most of these luxations. In the

Figure 1. The appearance of a typical clinical case of inherent or congenital medial patellar luxation. This dog, clinical case #118, was six months old.

Figure 2. The distal extremity of the femur from a 12-year-old dog that was destroyed. This dog had a history of chronic medial patellar luxation. Note the lack of condyle development of the femur.

A. Medial condyle of femur
B. Intercondylar area of femur
C. Lateral condyle of femur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traumatic luxations, the patients frequently have a history of sudden lameness which occurs at various intervals and for different lengths of time. These patellae can usually be luxated by medial rotation of the tibia or by lateral pressure on the patella. The tissue changes are usually less severe in these cases than in the congenital cases.

Many different treatments have been used in an attempt to correct medial patellar luxations. Livesey (28) used a special leash to give the dogs forced exercise at one mile per hour for ten minutes twice daily. Hobday (21) used bandages, stimulating applications, sedative lotions and massages, but he reported that congenitally deformed joints seldom responded to these treatments. Craver (10) used patellectomy as a last resort in cases where the lateral ligaments of the patella were torn and the patella was riding on the medial surface of the stifle joint. This method did relieve some stifle joint pain, but most of the dogs walked with a slight limp. Schmoker (47) reported good clinical success with removal of the lateral half of the patella. He used this technique in all cases of patellar luxations that were repeated or where the femoral condyles were flat. Research results by DePalma and Flynn (12) pointed out the danger of partial or complete removal of the patella. They stated that removal of part or all of the patella caused hypertrophic arthritis which resulted in pain and dysfunction.

Several different methods have been used to replace or strengthen the weak or ruptured lateral patellar ligaments. Shuttleworth (49) stated that plication or tucking of the lateral ligament held at first, but later broke down or stretched. Quitman (43) shaved the hair off the stifle joint and painted the entire area with full strength tincture of iodine and put the leg in a plaster of Paris cast in either a natural or a slightly flexed position for two weeks. McLean (31) advocated the injection of glycerine into the patellar ligaments to cause additional connective tissue and strength.

McCunn and Formston (30) sutured the lateral capsule with kangaroo tendon. Lacroix (26) did a mesial patellar desmotomy which was consistently helpful in traumatic cases of recent origin. He reported that this method was not effective in animals where the trochlea had become badly worn. Jones (23) inserted a living fascial strip from the fascia of the biceps at its junction with the fascia lata into the patellar aponeurosis. Stader (53) used a strip of tensor fascia lata to reinforce the lateral patellar ligament. This strip of fascia passed from the patella to the lateral sesamoid bone. If the bone structure and the alignment of the stifle joint were normal, this method was usually successful. Price (42) was not satisfied with the results of the Stader technique because of the insufficient length of the fascia strip and the insecure anchorage obtained. Therefore, Price replaced the lateral patellar ligament with a double strand of #30 or #28 gauge stainless steel wire. He reported good clinical results in nine out of nine cases. Singleton (50) reported good clinical results with the use of Stader's technique (53) plus a cast for three weeks in cases of recent traumatic origin. In more persistent traumatic cases, he advised a patellectomy.

Archibald (2) passed a nylon suture through the skin and under the insertion of the biceps femoris and quadriceps femoris muscles, through the skin, then returned the suture through the same opening. The suture then went subcutaneously over the same two muscles, back through the first skin puncture and was anchored while the stifle joint was flexed and extended.

The above clinical procedures were devised mainly for correcting traumatic patellar luxations and are less successful in inherent or congenitally deformed cases. The inherent or congenital type of case is the hardest to treat and provides the greatest challenge to the veterinary surgeon. Several methods have been devised to help correct this type of luxation. If the condition were caused by genu varum, Shuttleworth (49) advocated a radical low cuneiform osteotomy. He stated that this technique was not effective if the condyles were not developed.

In some of the inherent or congenital medial patellar luxation cases, the tibial crest is deviated medially and posteriorly. In order to correct the patellar luxation and restore the normal patellar arc, the tibial crest is moved more laterally. This method was advocated for congenital patellar luxations by Singleton (51) and by Pezzoli and Bignozzi (40). This method produced good clinical results, provided there was some development of the condyles. For congenital cases, Vierheller (58) combined two of the above techniques plus a new modification. He utilized the Stader (53) technique, moved the tibial tuberosity laterally and also pared out the intercondylar area. These patients started using their legs in two to three days without any splintage. He reported good results in sixteen joints. No tissue studies or long term reports were given.

In cases of human patellar luxation, Albee (1) raised the lateral trochlear lip by inserting a bone wedge into the trochlea. In pilot studies for this project, both bone and cartilage were tried as implant materials. Neither body tissue proved to be satisfactory. Cartilage was too flexible and bone was reabsorbed before its function was completed. The results indicated that a synthetic material probably would be better.

According to Brown _et al_. (7), many tissue substitutes have been used, such as: metals, celluloid, breast bone of a duck, leather, latex, rubber and various plastics. Some of the more common medical synthetics used now are nylon, orlon, silicones, dacron, teflon[1], marlex and Kel F[2]. These substances are used in congenital, traumatic, developmental, neoplastic, surgical and infectious deformities of the chin, nose, cheek, forehead, eye orbit, skull, jaw, ear, breast, tendon and other specific indications. These same synthetic substances are also being considered for wider applications in joint, tendon, bone and genito-urinary work. Some other uses of these tissue substitutes recorded in literature have been for the repair or replacement of blood vessels (11, 18, 41), ureters (14, 59), bile ducts (17, 25, 34), soft tissue substitutes (7) and skull defects (22). Sis (52) has recently successfully replaced the occluded horizontal external ear canal with a teflon tube.

In this project a rigid substance that could be imbedded in tissues and not cause adverse tissue reactions was desired. Of the available synthetics, teflon seemed to be the logical choice. Brown *et al*. (7) stated that teflon was best for replacement of bone in cases of traumatic, neoplastic or congenital defects. They believed that bone replacements were successful in deeply placed positions, if the teflon was held rigid by fixation.

---

[1] Teflon (polytetrafluoroethylene). DuPont de Nemours Company, Wilmington, Delaware.

[2] Kel F (polytrifluoromonochloroethylene). Minnesota Mining and Manufacturing Company, 900 Bush Avenue, St. Paul, Minnesota.

Brown et al. (7) noted a number of advantages of teflon as an implant substance. It was easily obtained, could be shaped into a variety of forms, had no antigenic activity, caused minimal tissue reactions, was homogenous, did not calcify or degenerate as cartilage did, was inexpensive and could be repeatedly sterilized in an autoclave or antiseptic solution. LeVeen and Barberio (27) reported that teflon was more chemically inert, less wettable and incited less tissue reaction than any of the plastics studied. Pratt (41) stated that teflon was electrically neutral and was stable to temperature variations, stress and chemicals. It was also moisture and friction resistant and did not adhere to the body tissues. Usher and Wallace (56) found less foreign body reaction with teflon and marlex than they did with nylon, orlon and dacron. LeVeen and Barberio (27) reported that teflon was not absorbed by the tissues, had interfacial tension and was semiflexible. Cholvin (8) found that solid teflon appeared to be less irritating to tissues than silicones, polyethylene and polyvinyl chloride.

Although teflon causes very little foreign body reaction, a number of workers have reported that this material is capable of producing neoplasms in rodents. So far, no neoplasms have been reported in dogs or humans. Oppenheimer and his workers (36-39) have done the most work in this field. In 1953 Oppenheimer _et al_. (37) reported that malignant tumors appeared within one to two years after plastics were imbedded in rodents. In 1955 Oppenheimer _et al_. (36) reported malignant tumors in 23.5% of the teflon implants in a specific strain of mice. In the same experiment, malignant tumors were also produced by a number of other substances, including glass cover slips. These tumors developed in one to two years from the connective tissue capsule surrounding the implant. These tumors were mesenchymal in origin, being primarily fibrosarcomas but also a few osteogenic sarcomas and rhabdomyosarcomas. These tumors seemed to replace the connective tissue capsule and were found next to the implant. There was very little evidence of metastasis of these tumors. These workers felt the tumors might have been caused by the teflon being degraded and metabolized in the body of the rodent.

In 1958 Oppenheimer _et al_. (38) reported that if the plastic films were removed within six months, no tumors resulted. If the plastics were removed later, the connective tissue pocket also had to be removed to prevent tumor formation. These tumors were observed in a transition between proliferating fibroblasts and true sarcoma cells, representing a presarcomatous phase. In 1960 Oppenheimer _et al_. (39) reported that both the film and the capsule were necessary for oncogenic activity.

Results of other research workers are less alarming as to the occurrence of neoplasms from medical plastics. Brown et al. (7) reported no tumors in 284 implants placed in 245 small animals nor in over 100 clinical cases. They felt that medical plastics might act differently in dogs and humans than they did in rodents. Brown (5) stated that one species might retain certain synthetics better than other species. Brown et al. (6) reported one fibroma in 300 laboratory animal observations and no clinical reports of tumors in humans from the use of teflon. These same individuals thought more time and studies were needed before the final answer to this question of tumor production by medical plastics would be answered. Russel et al. (46) studied 299 rats for 300 days with five tumors occurring. Of these five tumors, four were spindle-cell sarcomas and one was undifferentiated. These workers also agreed that more work was needed in this area and that all species might not be as reactive to these plastics as rodents. Creech et al. (11) have also reported tumor formation in mice from cover slips and medical plastics.

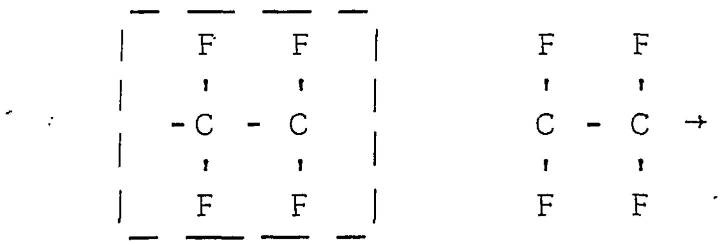
Since teflon does not adhere to surrounding tissues according to Pratt (41), it must be solidly anchored. Of the various anchoring substances, stainless steel alloy wire 18-8 SMO was chosen. O'Connor (35) listed the following advantages of stainless steel suture material. It was easily sterilized, pliable, nonirritating to tissues, sufficiently strong, noncorrosive, resistant to chemical actions and it could be tied with little or no loss in strength. Venable and Stuck (57) stated that tantalum wire caused less tissue reaction than stainless steel, but that it was not as strong. Of the stainless steel sutures, he considered 18-8 SMO the best. Vitallium was too brittle to be drawn into a wire, but could be employed in bolts or screws. Cholvin (8) used 18-8 SMO stainless steel alloy wire to attach electrodes to bone in his work with dogs. He reported that electrolysis of the wire with the tissues caused a high incidence of electrode detachment. He also stated that apparently most types of stainless steel wire, when kinked or tightly wound, would fatigue and break upon exposure to tissue fluids and mechanical stress. Key (24) reported good resistance of 18-8 SMO stainless steel to vibration in comparison to vitallium.

MATERIALS AND METHODS

Implant Materials

Teflon

Teflon is made by polymerization of tetrafluoroethylene gas at high temperatures and pressures. Its basic formula is:



$$\left[-\overset{F}{\underset{F}{C}} - \overset{F}{\underset{F}{C}} \right] \quad \overset{F}{\underset{F}{C}} - \overset{F}{\underset{F}{C}} \rightarrow$$

Teflon is chemically inert and there are no known solvents. It has a specific gravity of 2.1 and is stable from -195°C to +326°C. Mack (32) reported that when teflon was heated above 400°F, it formed a toxic gas known as perfluoroisobutene, which was about ten times as toxic as phosgene. Since this possibility exists, all teflon scraps should be buried, rather than burned. Teflon is waxy and is best formed by machining or whittling. Other characteristics of this substance were discussed previously.

18-8 SMO stainless steel wire

Number 20 gauge 18-8 SMO stainless steel alloy wire was used for this teflon implant procedure. This wire contains 18 parts of chromium, 10 parts nickel and 70 parts steel. This gauge was large enough to give good support to the implant, but yet flexible enough to be easily placed into position. Number 28 gauge stainless steel wire was used in four of the first experimental cases, but it was found to be too fragile to hold the implant in place.

Construction of Implant

The teflon implant was whittled from a 1/2 inch diameter rod of teflon. The overall height of the implant varied from 1/4 inch to 3/4 inch and the width from 1/8 inch to 3/8 inch. The implant was kept small because smaller ones caused less tissue reaction. This has been pointed out by LeVeen and Barberio (27) and by Cholvin (8). The lower half of the implant was shaped to conform to the contour of the medial, distal portion of the femur, just proximal to the medial condyle. The upper half of the implant was straight and was slightly higher than the quadriceps femoris tendon, which glides on the teflon implant. After the implant was whittled with a knife, it was sanded with coarse, medium and fine sandpapers. The sanding was followed by an emery cloth polishing. Two holes were then drilled in the lower half of the implant, so that the #20 gauge 18-8 SMO stainless steel alloy wire could be passed through the implant and later used to anchor it to the bone (Figure 3). The entire implant was washed thoroughly with a medicated detergent[1], and rinsed with a 1-1000 antiseptic solution[2] to remove any dust or foreign material from the teflon and stainless steel alloy wire.

Implant Surgery

Teflon implants were placed bilaterally in 34 experimental dogs and in the legs of 28 clinical cases. Table 1 indicates the length of time the experimental dogs were observed after the teflon implant surgery. Two additional dogs were used as control dogs. One of the control dogs was kept with the experimental dogs for one year, but no surgical procedures were employed on this animal. This dog was a two-year-old, male, 16-pound Terrier cross. The other dog, a three-year-old, female, 13-pound mongrel Terrier, was used as a control dog for bone reactions to wire, bone reactions to drilling and muscle reactions to teflon. A #20 gauge 18-8 SMO stainless steel wire mattress suture was placed in both

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[1] Phisohex. Winthrop Laboratories, New York 18, New York.

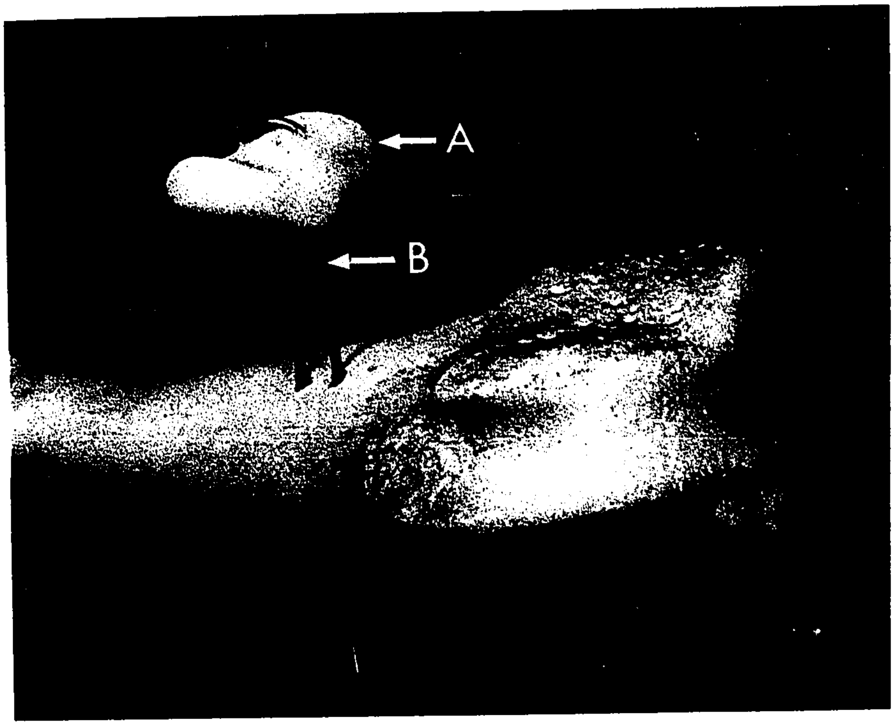
[2] Aqueous Zephiran Chloride. Winthrop Laboratories, New York 18, New York.

Figure 3. Teflon implant and stainless steel alloy wire on the distal extremity of the femur.

A. Teflon implant
B. Stainless steel alloy wire

Figure 4. Surgical instruments and equipment used for teflon implant surgery.

A. Orthopedic stockinette
B. Teflon implants
C. Bone drill
D. Wire cutters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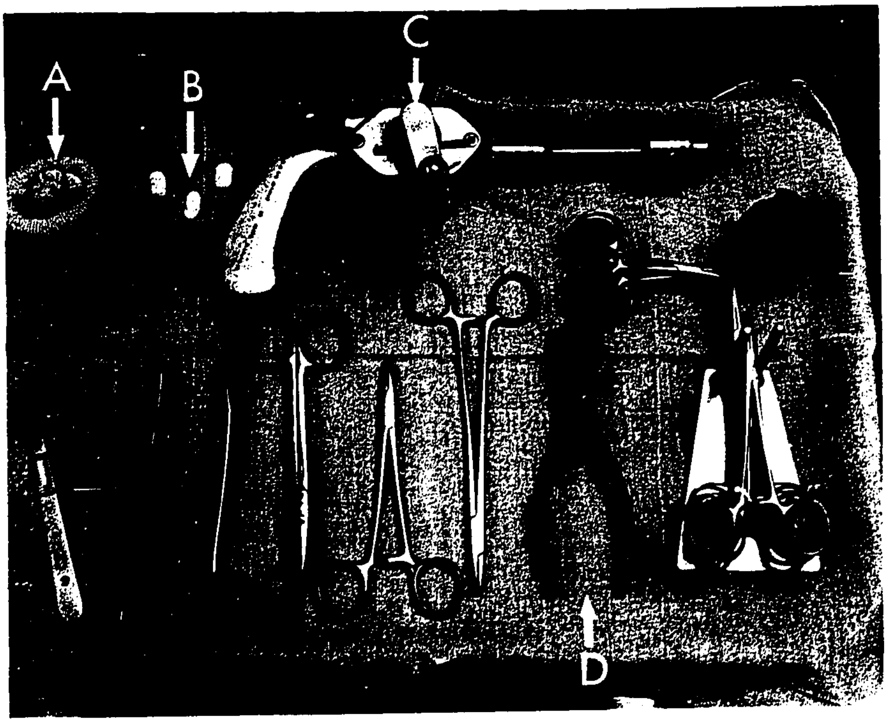
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Table 1. Experimental teflon implant cases

Length of time since surgery	Series numbers	Number of legs treated surgically	Number of legs lame
2 years	160 to 660	12	1
1 year	3951 to 3956	12	1
6 months	4721 to 4726	12	0
3 months	3921 to 3926	12	0
1 month	7921 to 7923	6	0
2 weeks	9321 to 9323	6	0
1 week	1021 to 1023	6	-

femurs at the implant surgery location. These wires were in the right femur for six months and in the left femur for three months. At the time the wires were put in place, two additional holes were drilled dorsal to the wires in both femurs. Teflon implants were also placed in the bellies of the rectus femoris muscles for equal lengths of time.

Selection and care of experimental dogs

Thirty-five dogs of mixed breeding were used in the experimental portion of this study. Since most of the patellar luxations occur in small dogs, an attempt was made to secure dogs of twenty pounds of body weight or less. Dogs of all ages and both sexes were used, ranging in age from three months to twelve years.

All of the dogs obtained for this project were given a complete physical examination to make certain that they were healthy and to determine whether or not any existing stifle joint abnormalities were present. To aid the physical examination, a considerable amount of clinical laboratory work was done. This included a leucocyte count, differential leucocyte count, erythrocyte count, photoelectric colorimetric hemoglobin determination, micro-hematocrit reading and blood sedimentation rate. The specific gravity, pH, color, albumin, sugar, methylene blue liver function test and urinary sediment were checked on urine samples. Serum glutamic oxaloacetic transaminase and serum glutamic pyruvic transaminase values were run on nine experimental dogs before surgery was done. All dogs positive for intestinal parasites were wormed. Radiographs were taken of the stifle joints of the experimental dogs before surgery.

All dogs with uncertain vaccination histories were prophylactically treated against hepatitis and distemper. When new dogs were received, they were kept in the kennels for two weeks to allow them to adjust to their new environment and to make certain they were healthy before being entered into the study.

The dogs were kept in painted steel cages, except for a five-month period when the two-year and one-year dogs were kept in two large indoor runs. The caged dogs were placed in a large exercise room for at least one hour each day. The cages and runs were cleaned with hot water and chemically disinfected at least once daily, or more often if necessary. Water and a good grade of commercial dry dog food containing 10.5% protein were fed ad libitum.

Preparations for surgery

No solid foods were given to the experimental dogs for a period of 24 hours before surgery. The dogs were anesthetized for surgery with an intravenous administration of sodium pentobarbital given to effect. No more than 30 milligrams per kilogram of body weight was ever given. All sides of the hind legs were clipped from the coxofemoral joint area down to the hock joint. The legs were scrubbed at least eight minutes with a germicidal detergent[1]. Three alternate applications of tincture of zephiran and 50% isopropyl alcohol were applied to the clipped areas. If the patient experienced any difficulty in breathing, an endotracheal catheter was inserted into the patient's trachea.

The surgical patient was placed on its back on the surgery table and secured. Surgical lights, instrument trays and suture material were placed in proper position.

---

[1] Germicidal Detergent. Parke, Davis and Co., Detroit, Michigan.

The teflon implants, surgical instruments, drapes, rubber gloves, cloth towels and surgical gowns used in the teflon implant surgery were all sterilized in a steam autoclave. A surgical cap and mask were put on by the surgeon. The hands and arms of the operator were scrubbed thoroughly with a surgical scrub brush and a germicidal detergent. Following drying with a sterile towel, a sterile surgical gown and sterile surgical gloves were donned.

The legs of the surgical patient were covered with a sterile orthopedic stockinette. The covered legs were then placed through a small opening in a sterile, plastic surgical drape. Another sterile drape was placed on the instrument table and the sterile instruments were arranged for surgery (Figure 4).

Surgical procedures

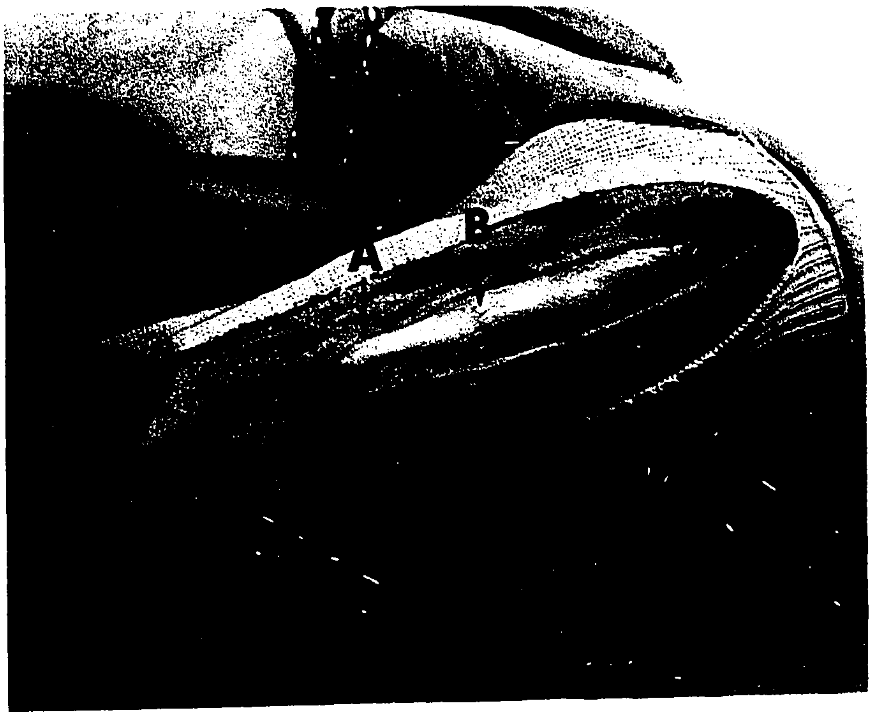
A four to five inch skin incision was made over the anterior surface of the stifle joint, extending from two to three inches above the patella to slightly below the tibial crest (Figure 5). Any severed blood vessels in the skin layer were clamped with mosquito hemostats. The subcutaneous fascia covering the stifle joint was incised to expose the underlying muscles and tendons. A longitudinal incision was made separating the rectus femoris muscle, patella and straight patellar ligament from their medial attachments,

Figure 5. Skin incision on the anterior surface of the stifle joint.

A. Area of tibial crest
B. Area of patella

Figure 6. Severence of the medial patellar ligament and the medial portion of the stifle joint capsule.

A. Area of tibial crest
B. Area of patella
C. Tendon of quadriceps femoris muscle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B

A

which are the cranial belly of the sartorius muscle, vastus medialis muscle, medial patellar ligament and stifle joint fascia (Figure 6). This incision was continued down through the joint capsule, thus exposing a portion of the stifle joint articular surfaces (Figure 7). Again, any severed blood vessels in the layers incised were clamped with mosquito hemostats. The articular surfaces of the femur and patella were checked for gross lesions.

Next the adipose tissue dorsal to the severed joint capsule, on the anterior medial side of the femur, was removed; and any joint bursa present was reflected aside to prepare the site for the teflon implant. Several sizes of implants were tested at this location to find a proper fit (Figure 8). The base of the implant should fit snugly to the distal end of the femur. The top of the implant should just barely project above the surrounding muscles, on both complete flexion and extension of the stifle joint. The implant must be placed on the anterior-medial side of the femur, just dorsal or proximal to the severed joint capsule. The medial portion of the dorsal part of the implant must be in line with the medial edge of the patellar groove. In this correct position the quadriceps femoris tendon rubbed gently against the implant as the leg was extended and flexed.

The proper position for the implant was determined and the area for drilling the wire holes was located. This was

Figure 7. Exposure of the condyle area of the femur. The patella has been reflected laterally.

A. Area of tibial crest
B. Area of patella
C. Tendon of quadriceps femoris muscle
D. Condyle area of femur

Figure 8. Testing for the proper fit of the teflon implant.

A. Teflon implant
B. Lateral condyle of femur

done by holding the implant in its correct location and by passing a #20 gauge hypodermic needle through the wire holes in the implant and then continuing into the periosteum far enough to leave an indentation. This procedure was done for both of the holes. A hand drill was used to drill the holes (Figure 9), but a power drill could also be used. Stark (54) recommended a 500 r.p.m. electric drill as being the best. Several types of small drills were used, but the author preferred to use a stainless steel #20 gauge hypodermic needle for this procedure. The bone was drilled at an angle so that the drill would penetrate through the anterior-lateral surface of the femur, directly opposite the implant.

The implant and wire were then put into position (Figure 10). Before the wire was tightened the position of the implant was given a final check (Figure 11). Mild adjustments in position were accomplished by making new holes in the implant. The proper position was obtained and the ends of the wire were twisted together until the implant was snug on the distal end of the femur.

In four of the first cases operated on, two #28 gauge strands of wire were used instead of one #20 gauge strand of wire. The excess wire was cut off and the wire stump was bent against the lateral surface of the femur and covered with the connective tissue fascia in that area.

To follow the teflon implant procedure frequently used

Figure 9. Demonstration of the method used to drill the holes in the femur for the stainless steel alloy wires.

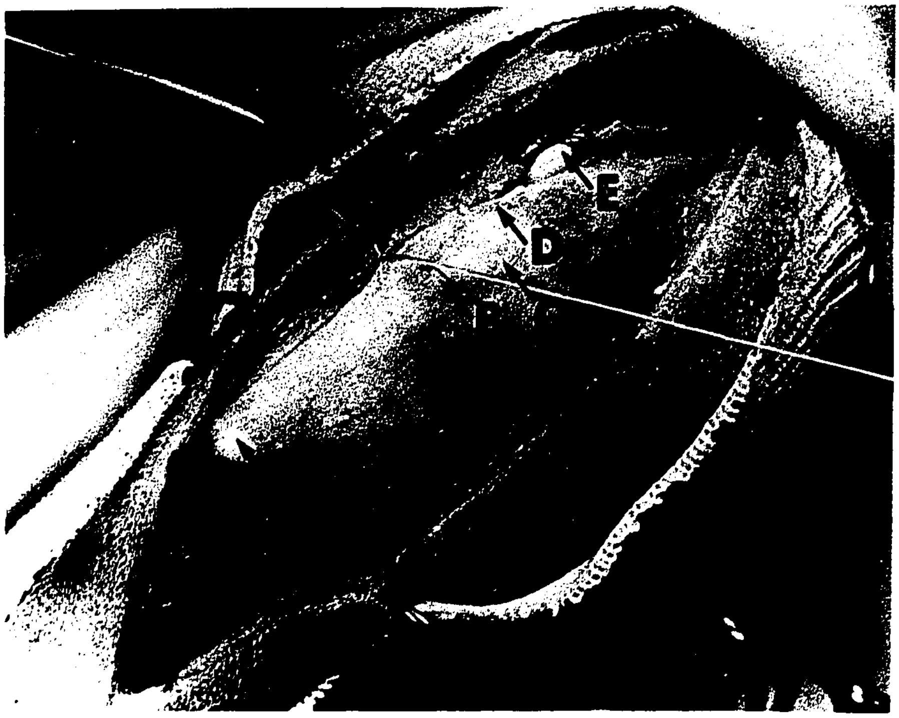
Figure 10. Teflon implant in its proper position on the medial side of the femur. The wires have not been twisted or trimmed. The patella has been reflected laterally.

Figure 11. The teflon implant in its desired relationship with the patella and the tendon of the quadriceps femoris muscle.

A. Area of tibial crest
B. Area of patella
C. Tendon of quadriceps femoris muscle
D. Teflon implant

Figure 12. Suturing of the medial patellar ligament and the medial stifle joint capsule.

A. Area of tibial crest
B. Area of patella
C. Location of the second suture if the lateral ligament was incised
D. Tendon of quadriceps femoris muscle
E. Teflon implant


E
D

in clinical cases, the lateral patellar ligament and joint capsule were incised. Any excess lateral patellar ligament and capsule were removed. Starting at the proximal tip of the patella, the medial joint capsule and the medial patellar ligament were sutured as one layer with a heat-sterilized, medium-weight, nonabsorbable, synthetic suture material[1] (Figure 12). The separation between the quadriceps femoris tendon and the vastus medialis muscle from the patella proximal was not resutured. This area was left open to allow the implant to glide against the exposed tissues. The second suture was placed in the lateral patellar ligament and lateral joint capsule at the proximal tip of the patella in the cases where the lateral patellar ligament was incised. The two sides were sutured alternately until both incisions were closed. The alternate suturing made it easier to achieve even pressure in the two patellar ligaments.

The stifle joint was flexed and extended and an attempt was made to luxate the patella. If the patella did not luxate and if the implant did not cause any noticeable irritation to the surrounding tissues, the remaining layers were sutured. The subcutaneous fascia was closed with continuous 000 chromic catgut sutures (Figure 13) and the skin was sutured with mattress sutures using medium-weight synthetic suture material.

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[1] Vetafil Bengen. Bengen and Co., Hannover, Western Germany.

Figure 13. A continuous catgut suture was placed in the subcutaneous tissue.

A. Area of tibial crest
B. Area of patella
C. Teflon implant

Postoperative care of dogs

Thomas-Schroeder splints were used on all clinical cases that had a medial deviation of the tibial crest. These splints were left in place for one to two weeks, depending on the severity of the deviation. Splints were not used on any of the surgically treated legs in the experimental series.

No antibiotic injections were given to any of the experimental cases. Penicillin-dihydrostreptomycin injections were given twice daily for at least three days to all of the clinical cases.

The body temperature, appetite, bowel movements and surgical areas were checked at least once daily during surgical recovery. The surgical areas were observed for evidence of swelling, pain, local heat, drainage and crepitation. The daily progress the dogs made in the use of the legs that had been treated surgically was recorded.

Clinical laboratory tests, as listed below, were performed on the experimental cases immediately, 24 hours, 48 hours or 96 hours after surgery. All of the experimental cases were checked during at least two of these periods. Blood studies such as leucocyte counts, differential leucocyte counts, erythrocyte counts, photoelectric colorimetric hemoglobin determinations, micro-hematocrit readings and sedimentation rates were made. The specific gravity, pH, color, albumin, sugar, liver function and urinary sediment were determined on urine samples from the experimental cases. Serum glutamic oxaloacetic transaminase and serum glutamic pyruvic transaminase levels were checked every 24 hours for five days on nine experimental dogs.

Radiographs were taken at least twice and sometimes three times following the surgery, except in the one-week, two-week and one-month dogs. Even in these dogs, radiographs were taken at least once following the surgery. Anterior-posterior and medial-lateral views of both hind legs were taken in most cases.

Pathological study of experimental cases

Euthanasia of the experimental dogs was achieved by the intravenous administration of pentobarbital sodium. To avoid as many post mortem changes as possible, the stifle joint areas were examined first. The skin was checked for any evidence of irritation or drainage. The surgical scar area was examined for lesions. After the subcutaneous fascia was examined, the stifle joint was flexed and extended and the behavior of the stifle area and the implant was noted and recorded. Lesions of the muscles, tendons or ligaments were observed and recorded.

The lateral side of the stifle joint was opened to observe any joint changes. Twenty stifle joints were opened aseptically and cultures were taken of the joint fluid. The joint fluid was also checked for any changes in color, consistency or amount. The size and the type of connective tissue capsule surrounding the implant were observed. Any osteoarthritis on the distal end of the femur was noted. The inside of the joint capsule was checked for any evidence of suture material penetration. The implant was tested for any abnormal movement or displacement. The stainless steel wire was examined for any breaks or weakened areas. The implant was removed and the bone was closely observed for any abnormal changes. Photographs were taken of most of the treated stifle joints, especially the unusual or more severe cases. Tissues were saved for microscopic study from at least one leg and in many cases from both legs of all the experimental cases. Tissues routinely saved were muscle and tendon in the area of the implant, the bone in the area involved and any pathological femoral condyles or patellae.

The tissues were placed in 10% neutral formalin within 15 to 20 minutes after euthanasia. They were refrigerated and fixed for four to five days. The soft tissues were trimmed and transferred to 70% alcohol until the time of embedding. Following fixation the ossified tissue was decalcified in 5% formic acid for four to eight days. The bones were decalcified until they were rubbery in consistency and cut very easily with a razor blade, or until they appeared decalcified upon radiographic examination. The decalcified bone tissues were trimmed and washed in running tap water for 24 hours and stored in 70% ethyl alcohol until processed.

The soft tissues and decalcified bone tissues were processed using Technicon dehydrant and clearing agent. All of the tissues were embedded in Altman's paraffin and were sectioned at 8 to 10 microns. The tissues were stained with hematoxylin-eosin stain and Gomori's trichrome stain.

Clinical cases

The clinical cases selected for this teflon implant surgery were the medial patellar luxations that were accompanied by a shallow or absent patellar groove. Many of these luxation cases were considered inherent or congenital while others were chronic luxations resulting in worn medial condyles. This surgical procedure was not used on any acute, traumatic luxations when a satisfactory patellar groove was present. The status of these patellar grooves was ascertained by palpation before surgery.

The clinical cases were given physical examinations. Laboratory work was done to help evaluate the patient as an anesthetic and surgical risk.

Only the inherent or congenital luxations that were complicated by a medial deviation of the tibial crest were placed in a Thomas-Schroeder splint for one to two weeks. The other clinical patients were given cage rest for 3 to

10 days, depending upon their activities and dispositions. Penicillin-dihydrostreptomycin was given intramuscularly for at least three days in all the clinical cases. Laboratory work and radiographs were used as indicated.

Progress reports were obtained on all of the clinical cases. One clinical case of medial patellar luxation was destroyed, because of several severe congenital deformities. A necropsy was performed on this patient and tissues were taken for microscopic examination.

RESULTS AND DISCUSSION

Research Cases

Clinical laboratory results

The reasons for running the clinical laboratory work were twofold. The first reason was to ascertain if the experimental cases were good surgical and anesthetic risks. Second, the results were obtained to determine if the teflon implant procedure had any adverse effects on some of the physiological functions in these dogs.

Four experimental dogs that were purchased for this project were rejected because of the findings of the physical examinations and the laboratory work. The general health of the other experimental dogs was considered satisfactory. The blood determination values of the experimental dogs before surgery were as follows: hemoglobin from 10.37 gm./100 cc. to 16.97 gm./100 cc. with 13.01 gm./100 cc. as an average; hematocrit readings from 37% to 54% with 42% as an average reading; erythrocyte count with a range from 6,100,000 cells/mm.^{3} to 8,790,000 cells/mm.^{3} with 7,164,000 cells/mm.^{3} as an average; leucocyte count from 6,840 cells/mm.^{3} to 16,680 cells/mm.^{3} with 11,805 cells/mm.^{3} as an average. In the leucocyte differential count, the basophils varied from 0 to 1%, eosinophils from 1% to 8%, band neutrophils from 22% to 33%, segmented neutrophils from 43% to 55%, monocytes from 0 to 9% and lymphocytes from 8% to 34%. The sedimentation rate for 60 minutes varied from 0 mm. to 23 mm. with an average of 4 mm.

The urine from the experimental dogs before surgery had the following analysis. The color was consistently a light, clear yellow. Specific gravity readings varied from 1.015 to 1.045 with an average of 1.034. The reaction varied from 6 to 8. Albumin levels ranged from negative to 30 mg.%. The experimental dogs' urine was negative for urine sugar. The methylene blue liver function test ranged from 2 drops to 5 drops with an average of 3 drops. Urinary sediments ranged from negative to those containing epithelial cells, granular casts, leucocytes, erythrocytes, uric acid crystals, hyaline casts, phosphate crystals, mucous threads or triple phosphates.

The serum glutamic oxaloacetic transaminase values before surgery ranged from 14 Sigma-Frankel units to 48 Sigma-Frankel units with an average of 29 Sigma-Frankel units. The serum glutamic pyruvic transaminase levels varied from 0 Sigma-Frankel units to 30 Sigma-Frankel units with an average of 19.3 Sigma-Frankel units.

About one-half of the experimental dogs were negative for parasite ova with the fecal flotation method. The next largest group of dogs contained ova of the taenia species. Dogs also were found that contained one or more of the following species of parasites: ascarids, ancylostoma or trichuris ova or coccidial oocysts. Although most of the dogs responded well to the use of anthelmintics, a few unsatisfactory results were obtained in treating for tapeworms and hookworms.

The teflon implant procedure had little adverse effect on the hemoglobin, hematocrit, erythrocyte, leucocyte differential count or sedimentation rate values. Any changes in the hemoglobin, erythrocyte or hematocrit readings were usually a mild decrease from the original readings, but still within the normal range. The sedimentation rates frequently increased a few millimeters immediately after surgery, but usually returned to the previous reading in 24 hours. The leucocyte differential count frequently showed a mild lymphocyte increase for a few hours following surgery. Other than a slight increase in the urine specific gravity, the urine showed no significant changes related to the surgery. The greatest significant change occurred in the leucocyte counts for the period during surgery to about 12 to 18 hours after surgery. This change was a fairly consistent leucopenia with an average decrease of 3,000 cells/$mm.^3$. In most cases the leucocyte count was back to its original count in 24 hours or it showed a mild leucocytosis. This work agreed with that previously done by Graca and Garst (16).

Serum glutamic oxaloacetic transaminase and serum glutamic pyruvic transaminase values performed on nine experimental dogs before surgery, immediately after surgery and every 24 hours for four days following surgery, failed to show any significant increases induced by the surgical trauma of the skeletal muscles. Apparently this surgical procedure did not cause enough muscle necrosis to be determinable by these laboratory tests.

Radiographic results

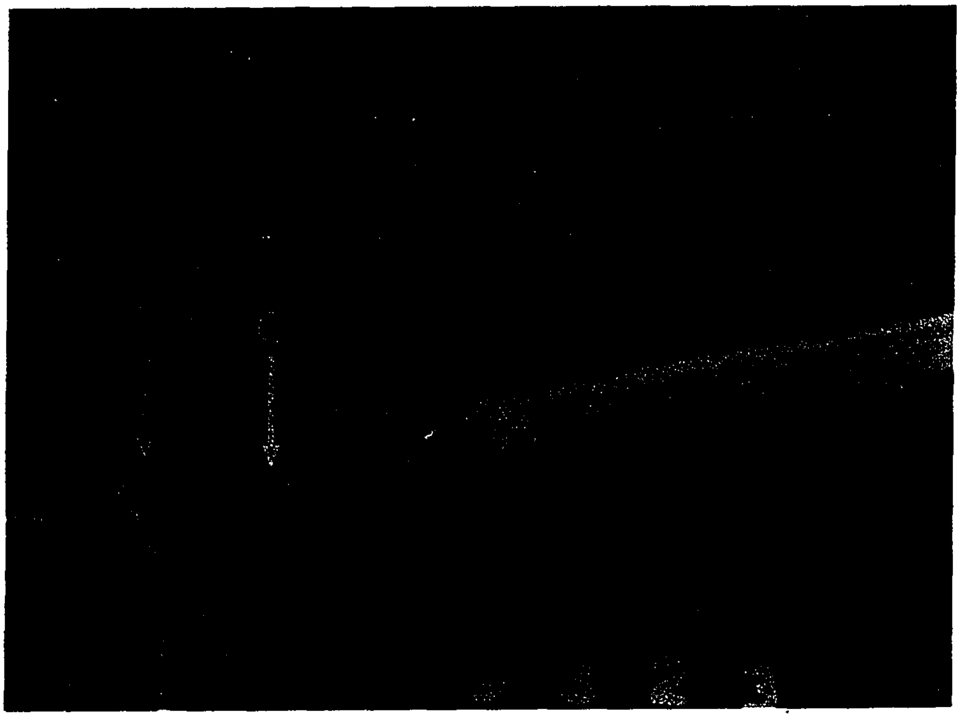
No bone changes were visible on the radiographs until the teflon implant had been in place in the experimental animal at least two weeks. Case #R-9323 at two weeks following surgery had a slight thickening of the periosteum at the point where the stainless steel alloy wire was twisted (Figure 14). The next changes were noted at 40 days after surgery in case #4725. Increased cortex density, bone necrosis from the implant and a thickened encapsulation of the teflon implant were found in the right leg (Figure 15). The left leg had a thickened periosteum in the region of the teflon implant and a connective tissue capsule was beginning to form around the teflon implant. Mild bone necrosis was present around the stainless steel wires in both legs. The most severe bone changes were found on radiographic examination in case #R-3952 (Figure 16). These changes were bone necrosis from the implant and the stainless steel wire, decreased cortex density,

Figure 14. Anterior-posterior radiograph of R-9323 two weeks following the teflon implant surgery. Note the thickening of the periosteum in the zone where the wire was twisted.

A. Teflon implant
B. Area of periosteal thickening
C. Patella

Figure 15. Medial-lateral view of R-4725 taken 40 days following teflon implant surgery. Note the increased density of the cortex, the bone necrosis adjacent to the teflon implant and the connective tissue capsule formation proximal to the teflon implant.

A. Teflon implant
B. Area of increased density of cortex
C. Area of bone necrosis
D. Connective tissue capsule



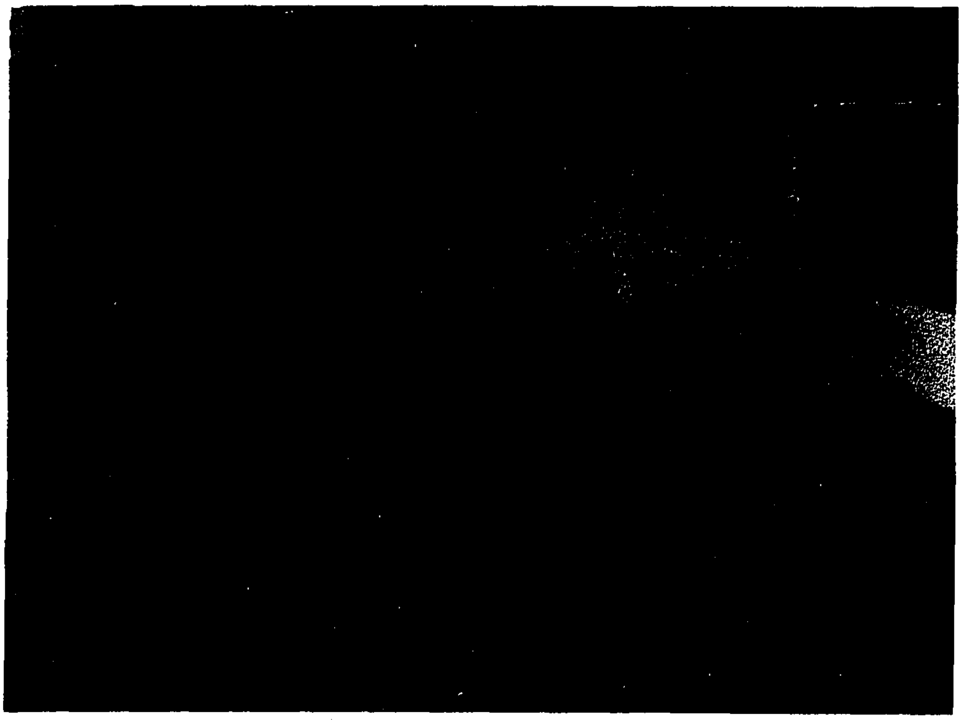
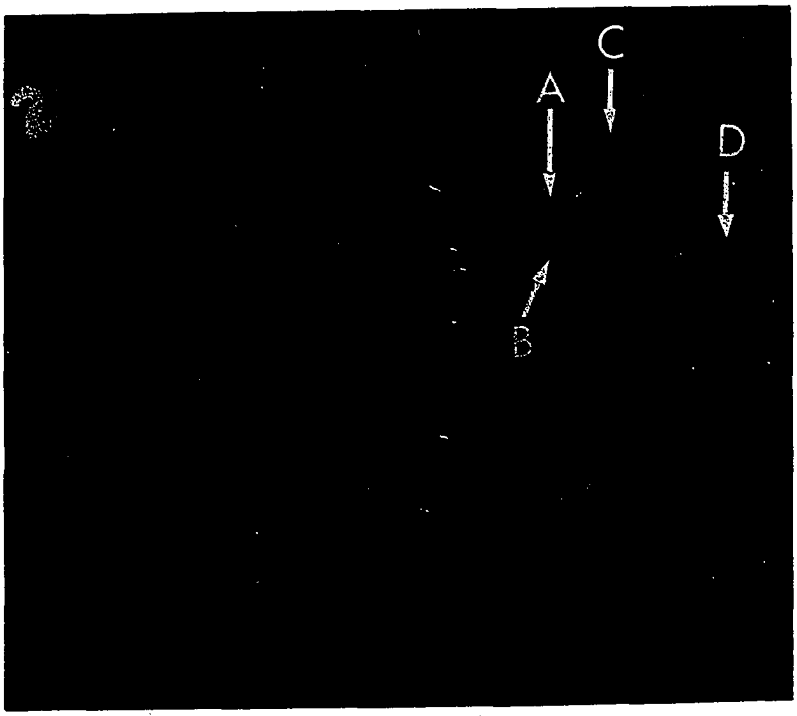


Figure 16. Bone necrosis, decreased cortex density, periosteal thickening and localized osteomyelitis were tentatively diagnosed with the use of this radiograph in R-3952 one year following surgery.

A. Area of decreased bone density
B. Area of bone necrosis and osteomyelitis
C. Teflon implant
D. Periosteal thickening

Figure 17. Medial-lateral radiographic view of L-160 in which the #28 gauge stainless steel alloy wire broke 17 months following the teflon implant surgery.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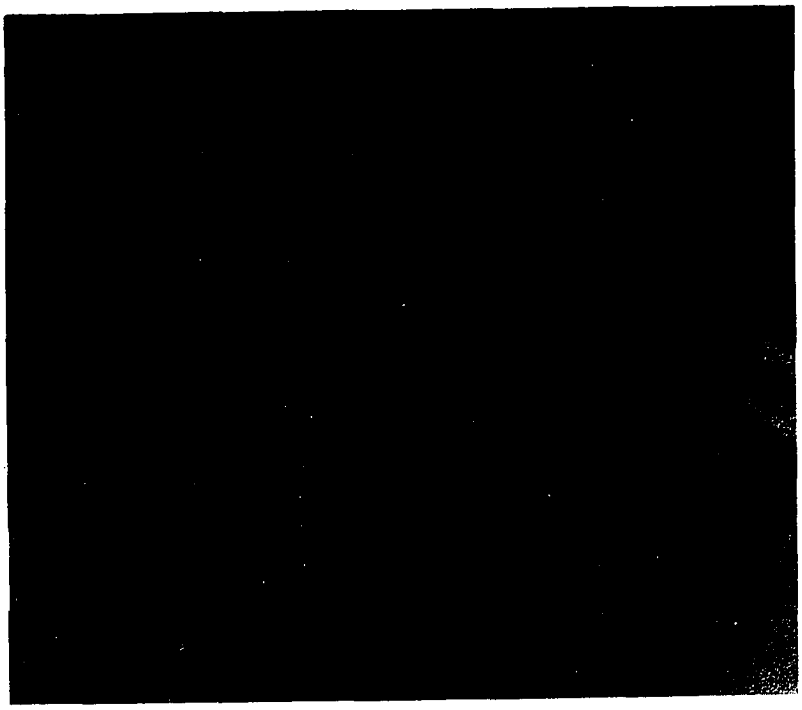


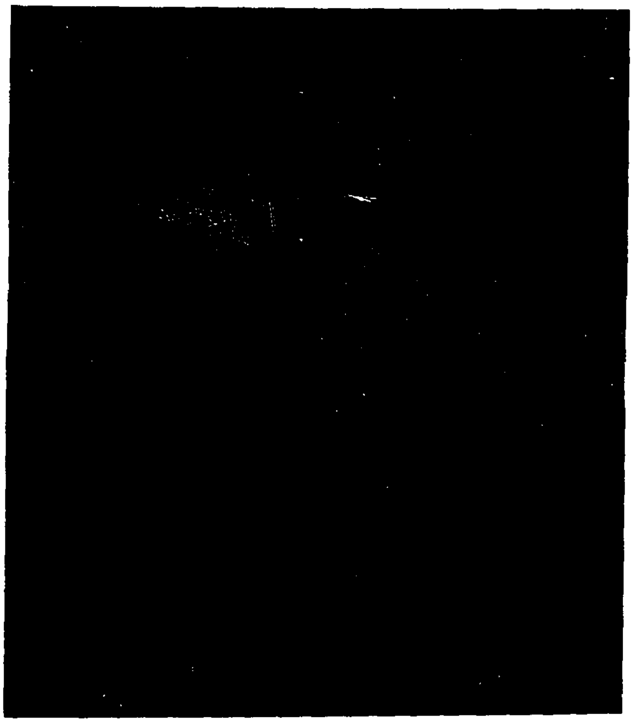
periosteal thickening and localized osteomyelitis.

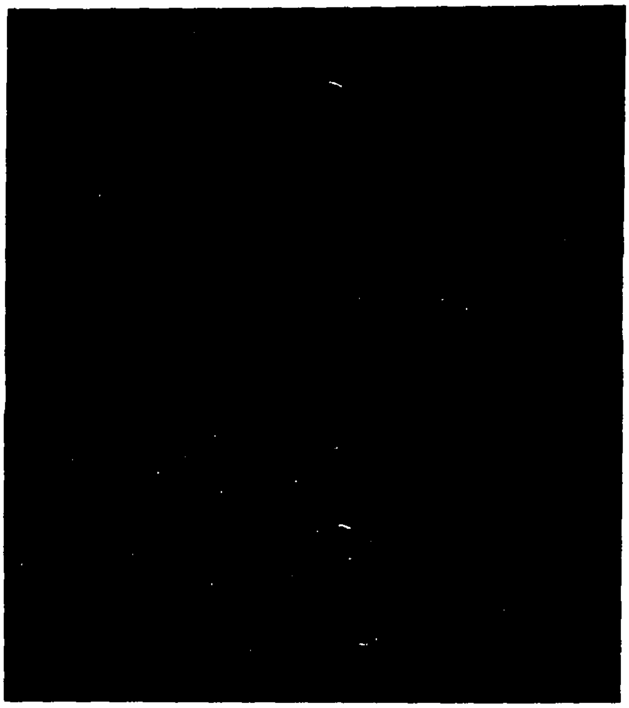
All of the #28 gauge stainless steel wires used in four of the first experimental dogs had broken by 17 months (Figure 17). Only two teflon implants were held in place by the connective tissue capsules; the rest of the teflon implants were lying next to the femurs. Except for some pressure necrosis, no bone resorption was visible in any of these eight legs. The #20 gauge stainless steel alloy wires broke in cases #L-3925, #L-4724, #L-3953 and #L-3956. The teflon implants were held in place by the connective tissue capsules. Other than a thickened capsule and some mild bone necrosis, no other lesions were visible.

The femurs which showed the most severe tissue changes were those in which the implant was secured too tightly or too loosely or infection developed. If the implant were put on properly and the wire did not break until a good connective tissue capsule had formed to hold the implant in place, the bone changes were mild. The two most frequent findings were a mild periosteal thickening near the implant and mild bone necrosis surrounding the stainless steel wire. In a few cases more severe lesions were present, such as more extensive bone necrosis, severe periosteal thickening, excessive capsule formation and osteomyelitis. However, even in the one-year (Figure 18) and two-year dogs (Figure 19), most of the tissue changes were mild. The stainless steel alloy

Figure 18. Radiograph of L-3955 taken one year following surgery. The dog had periosteal thickening, bone necrosis and increased bone cortex density.

Figure 19. Medial-lateral radiograph of R-660 taken two years after the teflon implant surgery. Note the bone necrosis, increased bone density and periosteal thickening.





attachments seemed to be the cause of the majority of the above tissue changes. If this material could be replaced with a less irritating substance that would also be more reliable and easier to secure properly, a large portion of the adverse tissue changes could be eliminated.

Postoperative results

The dogs evidenced pain in their treated stifle joints the first day following teflon implant surgery. Some swelling was present in all of the surgical areas and severe swelling was present in a few cases. Although the rectal temperatures of the patients remained in the normal range, the stifle joints were all warmer than normal for a few days following surgery. The pain from the surgery usually subsided sufficiently in two to three days so that the dogs could support weight on their hind legs. Most of the patients were walking cautiously in three to five days. Although a few of the dogs were walking well in four to five days, it took most of them two to three weeks to regain good use of their hind legs. One case, 3953, had a constant draining fistula of its right stifle joint. This dog refused to use this leg for the entire one-year observation period. Pain was evinced in this leg but no crepitation was palpable. The stifle joint could be fully extended and flexed, but the dog had pain during these procedures. This was one of the earlier teflon implant cases and the difficulty was probably caused by faulty surgical technique. Cultures of the joint fluid failed to produce any pathogenic bacteria.

Sporadic lameness was noted in another experimental case, L-460, during its entire two-year observation period. Although stifle joint crepitation was present, no soreness was evident when the joint was palpated. One was able to extend and flex this leg. Faulty surgical technique may have been responsible for this lameness. The cultures taken of this joint were negative for pathogenic bacteria.

All of the other long-term, experimental cases regained normal use of their hind legs and retained it until they were destroyed. All of these legs were free of pain and crepitation when they were palpated. The quadriceps femoris tendons could be felt gliding past the teflon implants, but this did not seem to cause any clinical symptoms. Normal flexion and extension were present in all these legs. Some of the short-term dogs were destroyed before they had an opportunity to regain full use of their legs.

Macroscopic tissue results

One-week dogs

The one-week dogs had good skin apposition and the skin was healing satisfactorily following the teflon implant surgery. The continuous 000 chromic catgut sutures were still visible in the subcutaneous tissues. The muscle tissues appeared normal in color and were free of any gross lesions. The incised medial and lateral patellar ligaments were still being held in apposition by the synthetic sutures. Healing of these ligaments was taking place, but was only about half completed. The ligaments readily separated when the sutures were removed. The quadriceps femoris tendons and patellae seemed free of any gross lesions. The joint fluid appeared normal in amount, color and consistency. The teflon implants were tight and were partially covered by a thin, friable film of fibrin. The stainless steel alloy wires were in place and a fibrin capsule was forming around the twisted ends (Figure 20).

When the teflon implants were removed from the femurs, no gross bone changes were observed. The joint capsules were starting to show marked signs of regeneration. No gross tissue lesions were present on the condyles or the patellar grooves.

Two-week dogs The two-week dogs had good skin apposition and healing. All of the skin sutures had been removed. A few small pieces of 000 chromic catgut were still visible in the subcutaneous tissues. The quadriceps femoris muscle in L-9323 had some petechial hemorrhages, but all of the other muscles appeared normal. These hemorrhages were probably caused by surgical trauma. The medial and lateral patellar ligaments were nearly healed and the synthetic sutures were

Figure 20. Teflon implant and the local acute inflammation of the surrounding tissues in R-1023 one week following the teflon implant surgery.

A. Teflon implant
B. Medial condyle of femur

Figure 21. Case #R-9322 with a teflon implant and local subacute inflammation of the surrounding tissues as a result of implantation surgery.

A. Teflon implant
B. Connective tissue capsule
C. Reflected patella

9322

intact. The quadriceps femoris tendons and the patellae all seemed free of any gross lesions. The joint fluid appeared normal in color, consistency and amount. The teflon implants were in place and tight, but they were covered by a definite thin connective tissue capsule, which was especially well-developed around the base of the implants. These connective tissue capsules were more developed than those seen in the one-week dogs. The stainless steel wires were intact and a definite connective tissue capsule was forming around the twisted ends (Figure 21).

When the teflon implants were removed, no gross bone changes were observed. The joint capsule was healed and no lesions were visible on the condyles or in the patellar grooves of the femurs.

One-month dogs The one-month dogs had well-healed skin incisions with little evidence of scar tissue as a result of the teflon implant surgery. A few very small bits of 000 chromic catgut sutures were visible in the well-healed subcutaneous connective tissue areas. The muscles in the surgical areas were free of gross tissue changes. The medial and lateral patellar ligaments were healed and they appeared stronger than before surgery. The synthetic sutures were intact in the patellar ligaments. The quadriceps femoris tendons and patellae were all free of any gross lesions. The joint fluids appeared normal in color, consistency and volume.

The teflon implants were in place and tight. The connective tissue capsules surrounding the teflon implants were thicker than those seen in the two-week dogs. As formerly described, the capsule was most thoroughly formed around the base of the implant in these animals. The stainless steel wires were intact and the twisted ends were well-covered by a connective tissue capsule (Figure 22).

The femurs under the teflon implants appeared free of any gross tissue changes, except for some periosteal thickening. The joint capsules were well-healed and no lesions were apparent on the articular surfaces.

Three-month dogs The skin was well-healed and free from ulcerations in all of the three-month dogs. In the subcutaneous fascia, small bits of 000 chromic catgut sutures were still visible. All of the muscles in the surgical areas were free of noticeable gross lesions. The medial and lateral patellar ligaments were well-healed and they contained the synthetic sutures used during the teflon implant procedure. The patellae would not luxate and no gross lesions were noted in the quadriceps femoris tendons or in the patellae incased in these tendons. All of the teflon implants were in place (Figure 23), but those in R-3922, L-3922, R-3923 and R-3926 were slightly loose. The wires were still intact in the three-month dogs except in L-3925.

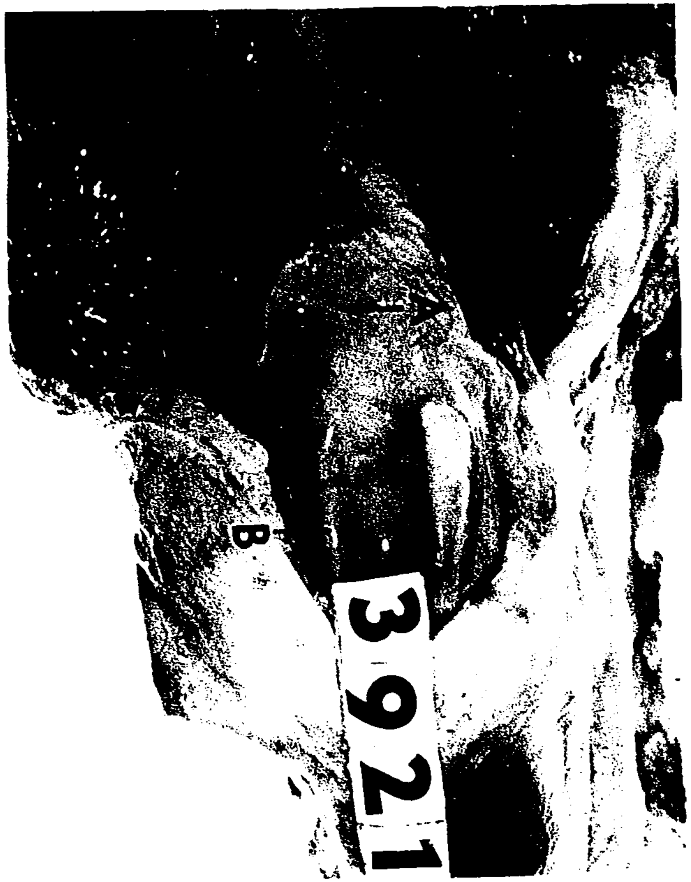
Mild bone resorption caused by pressure or movement was

Figure 22. The distal extremity of a femur from L-7921 with the teflon implant and a portion of the connective tissue capsule still intact one month following teflon implant surgery.

A. Teflon implant
B. Connective tissue capsule
C. Medial condyle

Figure 23. A teflon implant encapsulated by a connective tissue capsule in L-3921 one month following surgery.

A. Teflon implant covered by a connective tissue capsule
B. Medial condyle of femur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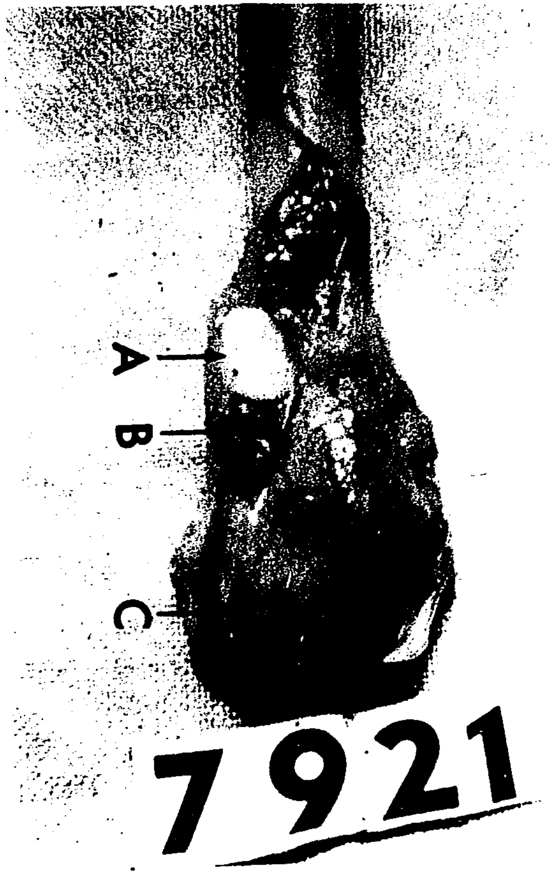
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7921

present in R-3922, L-3922, R-3923, L-3923, L-3925 and R-3926. The color, amount and consistency of the joint fluid appeared normal in all legs of the three-month dogs, except R-3923 which contained excessive amounts of fluids of thick consistency. Mild erosions of the condyles in R-3921, R-3922, L-3922, R-3924 and R-3926 probably resulted from synthetic suture material irritation (Figure 24). Cultures taken of the joint fluids from R-3924, R-3925 and R-3926 were negative, but Staphylococcus aureus was isolated from R-3923. This organism was coagulase positive and both beta and alpha hemolytic. The definite origin of this infection was unknown and no clinical symptoms were noted.

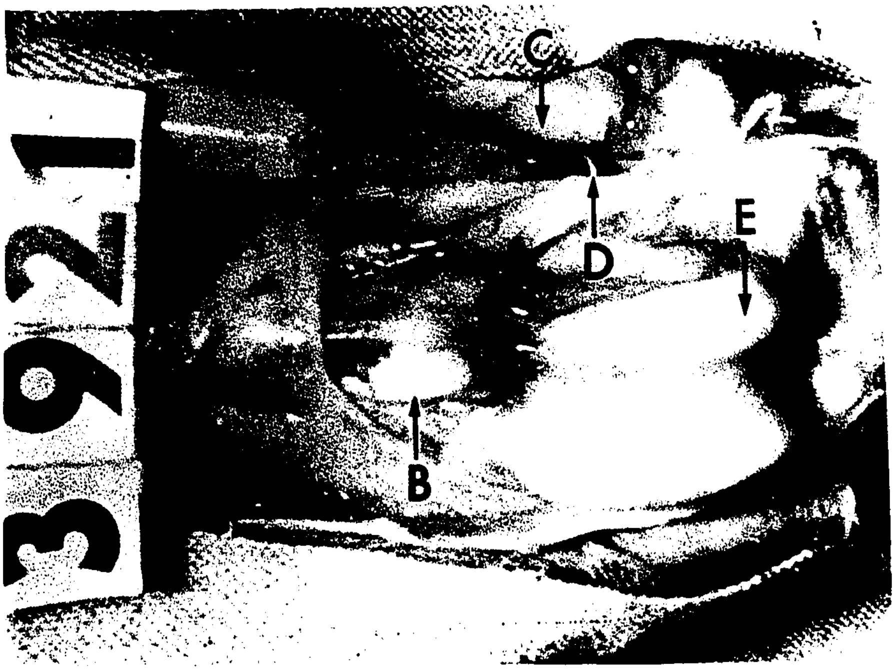
Six-month dogs   Except for post-surgical scar tissue, no gross lesions were observed in the skin or subcutaneous tissues. The muscles were free of gross abnormal changes. The medial and lateral patellar ligaments were well-healed and they contained synthetic sutures. No medial or lateral luxations of the patellae existed. The quadriceps femoris tendons and patellae were free of gross changes. Mild connective tissue capsules covered the implant devices in R-4721, L-4721, R-4722, L-4722, R-4723, L-4723 and R-4724 (Figure 25). Well-developed capsules covered the implant devices in L-4724, R-4725, L-4725, R-4726 and L-4726. All of the teflon implants were in place and tight except R-4723, L-4723, R-4724 and L-4724, which were slightly loose. The stainless steel alloy

Figure 24. Connective tissue repair of R-3921 three months following teflon implant surgery. A portion of the connective tissue capsule had been removed from the teflon implant area. The lead pencil was placed under the suture which was probably responsible for the condyle erosions.

A. Lead pencil
B. Teflon implant
C. Patella reflected medially
D. Synthetic suture material
E. Erosion on medial condyle of femur

Figure 25. The connective tissue capsule had completely encapsulated the teflon implant in case #L-4721 six months following surgery.

A. Connective tissue capsule covering teflon implant
B. Lateral condyle of femur


3921
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B

4721

wire used in L-4724 was the only one that broke in this series.

Mild bone resorption from both the teflon implants and the wire was present in the legs in this series (Figure 26). The cause of this lesion was probably from pressure and movement of the teflon implant. Excessive amounts of normal appearing joint fluid were present in R-4724 and L-4724.

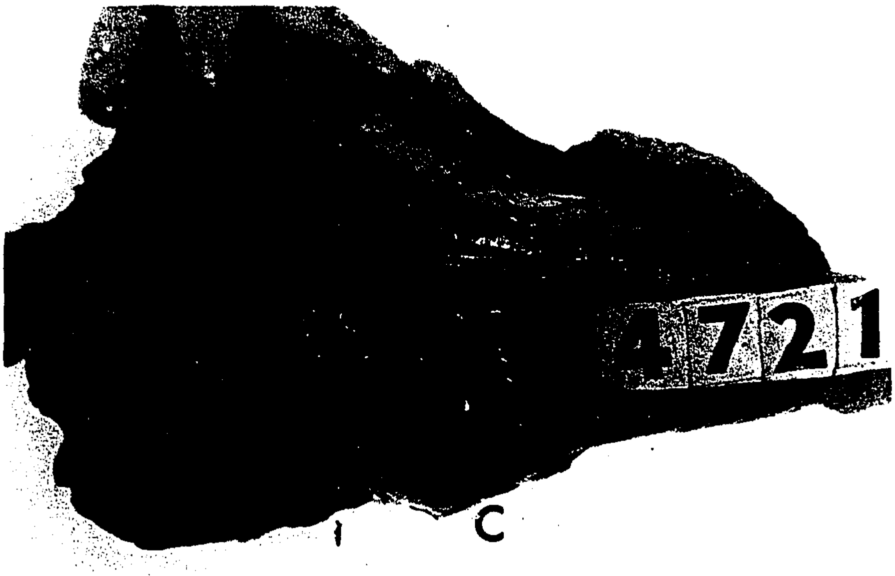
Mild osteoarthritis characterized by small erosions and cartilage hyperplasia was noted in R-4724, L-4724, R-4726 and L-4726. Synthetic sutures penetrating into the joint capsule were found in all of these cases. All of the other stifle articular surfaces from the treated legs appeared free of gross changes and no evidence of penetrating sutures was found in the joint capsules. The joint fluid from six legs of this group was cultured for bacteria. Three cultures, R-4723, R-4725 and R-4726, were free of any growth. Micrococcus species was found in R-4722 and R-4724 and Bacillus subtilis was isolated from R-4721.

One-year dogs The skin was well-healed and free of gross lesions in all one-year dogs, except R-3953. This stifle joint contained a small fistula about 2 mm. in diameter. A thin serous discharge exuded from this fistula. The remainder of the dogs had well-healed skin and subcutaneous tissue areas, with only an occasional fragment of 000 chromic catgut suture material visible (Figure 27). Some gross

Figure 26. The teflon implant had been removed from the leg of L-4721 six months following surgery, leaving the connective tissue capsule intact. Note the marked indentation in the capsule where the teflon implant had been.

A. Indentation in connective tissue capsule where teflon implant had been located
B. Connective tissue capsule
C. Patella reflected medially

Figure 27. The subcutaneous tissues in R-3956 one year after the teflon implant surgery. No lesions were visible.


4721
C

connective tissue infiltration was present in the muscle tissue in R-3953 in the area of the teflon implant. No other muscles or legs were involved. All of the medial and lateral patellar ligaments were well-healed and contained synthetic sutures. None of the patellae would luxate either medially or laterally. The quadriceps femoris tendons and patellae were all free of visible lesions. Aside from R-3951, R-3952 and R-3953 which were slightly loose, all the implants were still in place. The loose implants resulted in bone resorption which was most severe in R-3953 (Figure 28). They also caused thickened connective tissue capsules (Figure 29). The stainless steel wires had broken in L-3953 and L-3956. Highly developed connective tissue capsules had held these teflon implants in place, however mild bone resorption resulting from movement was present in these two cases. The twisted ends of the wire were covered by well-developed connective tissue capsules.

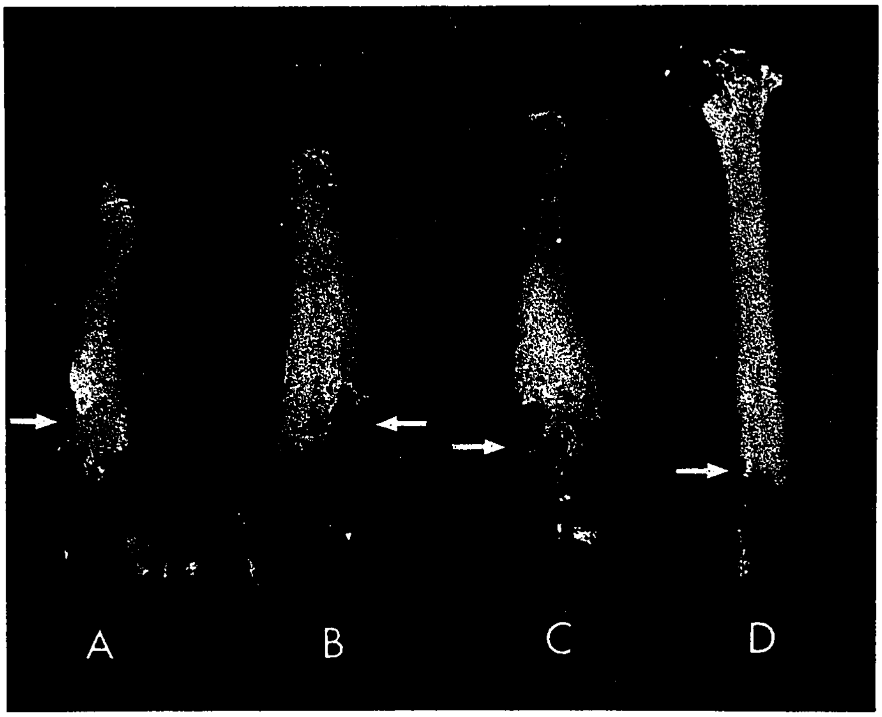
Bone erosions were present on the medial condyles of both legs in 3951, 3953, 3954 and 3955 (Figure 30). Erosions were also present on the lateral condyles in 3953. In these same cases synthetic sutures were found on the inside of the joint capsules and these sutures were contacting the articular surfaces in the erosion areas. In the joints where the condyles were normal, no suture material could be found inside the joint capsule (Figure 31). These findings certainly

Figure 28. Bones removed from three of the one-year experimental dogs and from one clinical case that had had teflon implant surgery. Note the mild bone resorption in B. The arrows point to the previous locations of the teflon implants.

A. Femur from R-3954
B. Femur from R-3955
C. Femur from L-3956
D. Femur from clinical case #110

Figure 29. The stifle joint which was not used by R-3953 during the entire one-year observation period. Note the large connective tissue capsule and the erosions on the femoral condyles.

A. Connective tissue encapsulation of teflon implant
B. Erosion on medial femoral condyle
C. Erosion on lateral femoral condyle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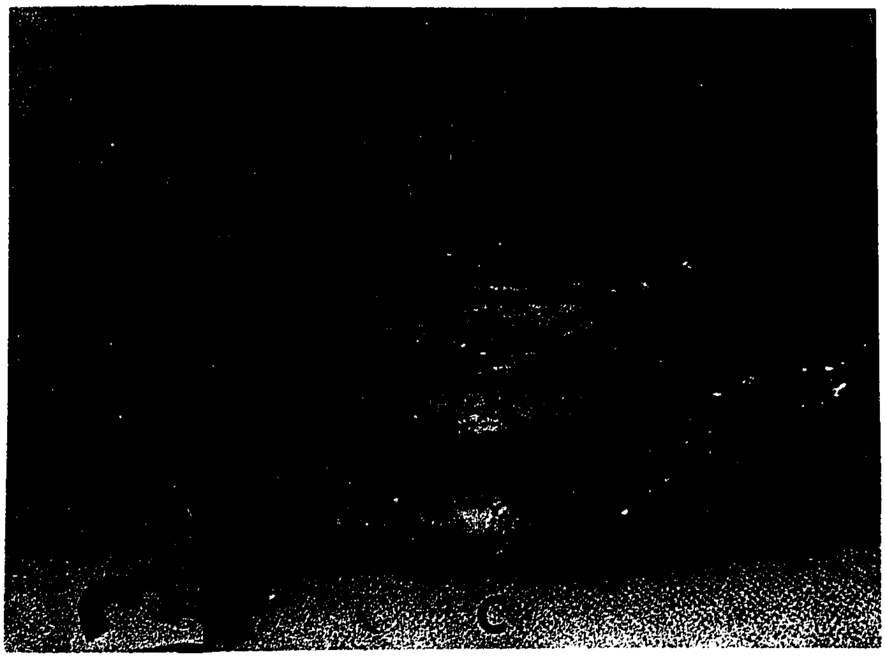
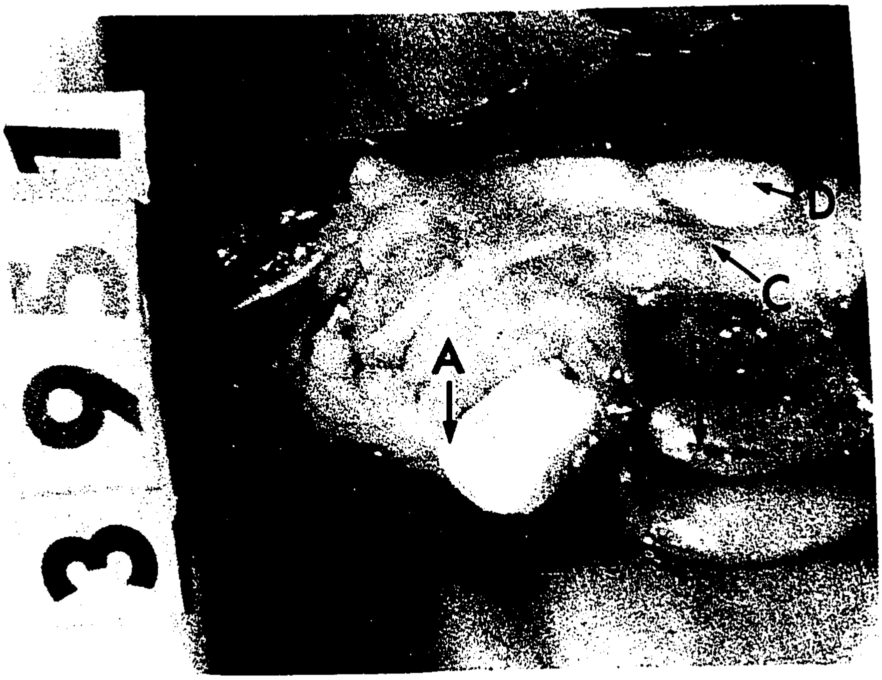


Figure 30. Erosions of the medial condyle of the femur in R-3951 one year following the teflon implant surgery. The erosions were probably caused by irritation from the synthetic suture material.

A. Teflon implant
B. Erosions on medial femoral condyle
C. Area with synthetic suture material
D. Patella reflected medially

Figure 31. Medial and lateral femoral condyles free of erosions in R-3956 one year after implantation surgery. Suture material was not contacting the articular surfaces of this femur.

A. Teflon implant encapsulated by connective tissue
B. Medial condyle of femur


3951
A
C
D

3

emphasize the importance of keeping the articular surface of the joint capsule free from any nonabsorbable suture material.

Four joint fluid specimens were checked for bacterial growth in this group. Micrococcus species was isolated from R-3953, Staphylococcus aureus was cultured from R-3952 (Figure 32), while R-3951 and R-3954 were free of any bacterial growth. The Staphylococcus aureus isolated from R-3952 was coagulase positive and beta and alpha hemolytic. The definite origin of the infection was unknown and the patient had no clinical signs of infection. It appeared to have good use of this leg throughout the entire one-year observation period.

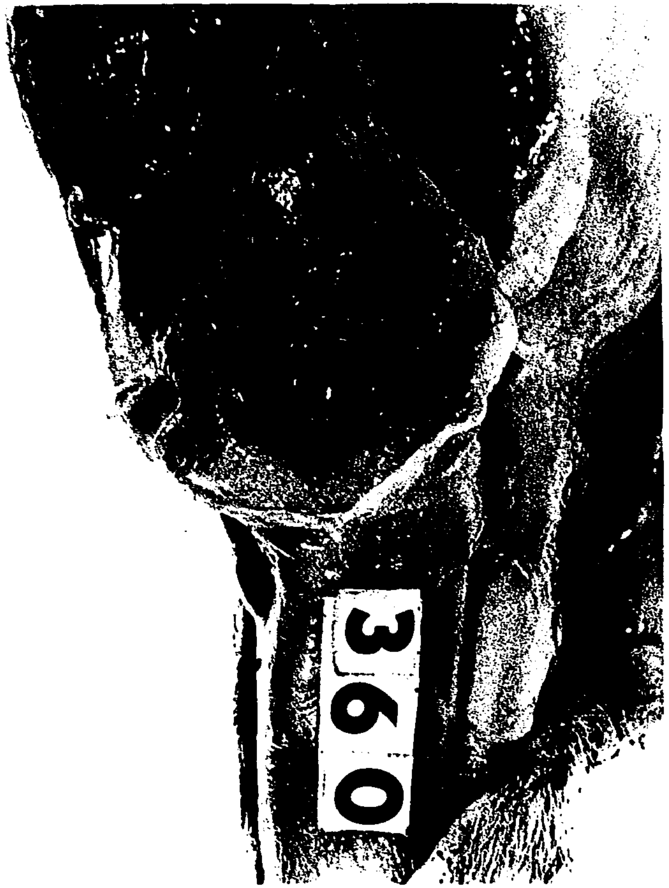
Two-year dogs No abnormal surgical lesions were present in the skin, subcutaneous fascia or muscle layers of the legs which had undergone surgery. All of the medial and lateral patellar ligaments were completely healed and they still contained synthetic sutures. No medial or lateral luxations of the patellae occurred. The quadriceps femoris tendons and their contained patellae appeared normal upon gross examination. None of the teflon implant connective tissue capsules was excessive, except those found in R-360 and L-360 (Figure 33). These two capsules contained fluid similar to joint fluid and the capsules extended down into the joint proper, causing a beginning mild pannus (Figure 34). These two implants had been placed too close to the

Figure 32. The stifle joint from L-3952 one year following teflon implant surgery. _Staphylococcus aureus_ was isolated from the surgical areas of this experimental patient. Note the excessive connective tissue reaction in this joint.

A. Excessive connective tissue encapsulation of teflon implant
B. Lateral condyle of femur

Figure 33. The teflon implant was placed too close to the stifle joint in L-360. The encapsulation of the teflon was excessive and fluid was contained inside the capsule.

A. Encapsulation of teflon implant
B. Lateral femoral condyle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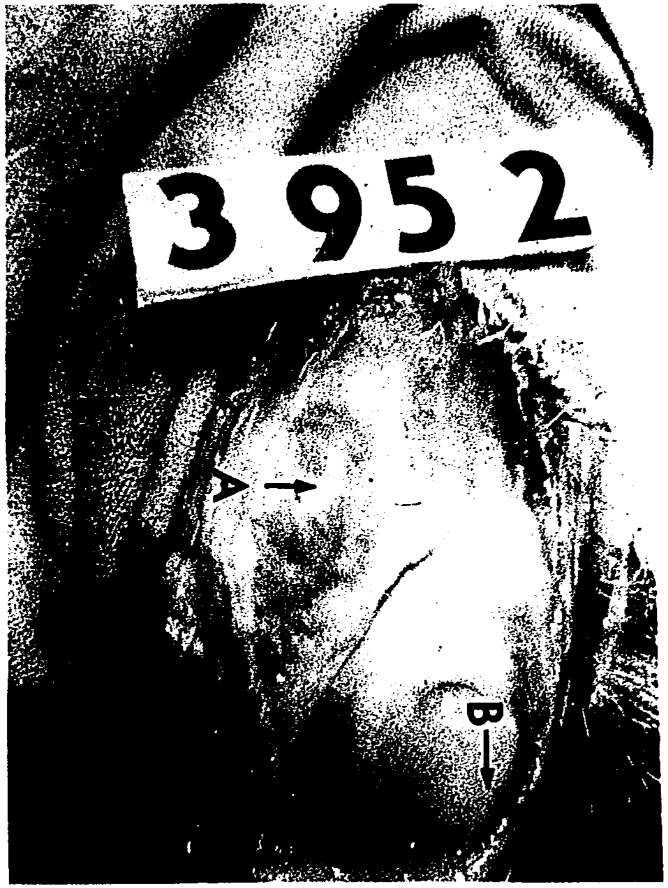
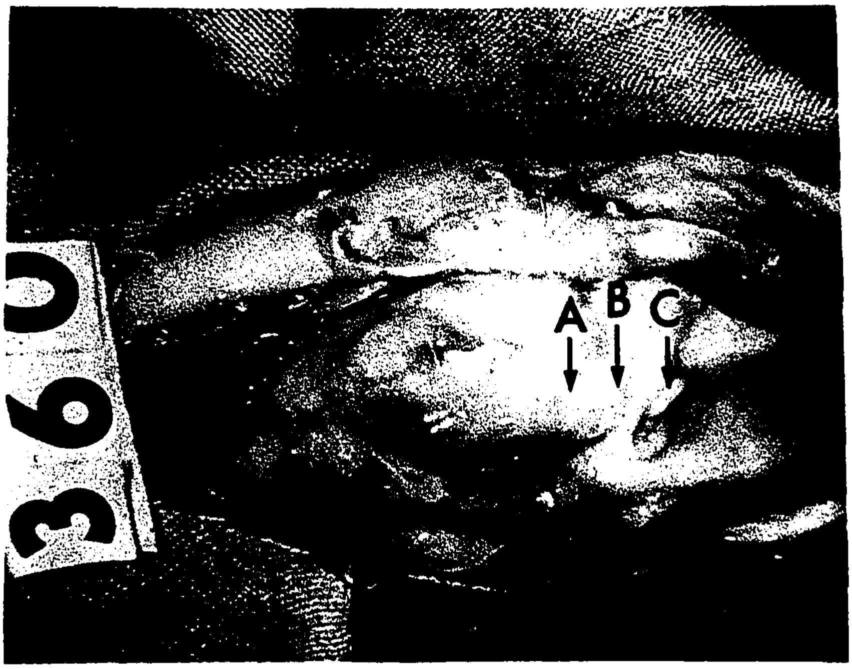

3952
A
B

Figure 34. Beginning pannus in the stifle joint of R-360, caused by the teflon implant being too close to the joint surface. Excessive encapsulation of the teflon implant had taken place and fluid was contained within the capsule two years following implant surgery.

A. Encapsulated teflon implant
B. Proximal level of articular cartilage covered by a layer of connective tissue
C. Pannus formation

Figure 35. The connective tissue capsule had been removed from the teflon implant in L-660. This two-year experimental stifle joint was free of adverse tissue changes following the teflon implant surgery.

A. Teflon implant
B. Lateral condyle of femur


360
A
B
C

660

joint and they appeared to be covered by a synovial membrane, rather than white fibrous connective tissue.

Positioning the teflon implant on the femur was one of the critical points of this surgery. If the implant were placed too distal, the patella would contact the teflon implant during extension of the stifle joint and this would prevent full extension. If the implant were placed too proximal on the femur, excessive muscle irritation and less effective prevention of medial patellar luxations resulted. When the teflon implant was placed too lateral on the femur, it interfered with the smooth action of the quadriceps femoris tendon and caused excessive irritation to the tendon. If the teflon implant were placed too far to the medial side, it was less effective in preventing medial patellar luxations.

In this group eight implants were originally held in place with two strands of #28 gauge 18-8 SMO stainless steel wire and four implants were held in place with one strand of #20 gauge 18-8 SMO stainless steel alloy wire. All of the #28 gauge wires broke within a period of 17 months. All four of the #20 gauge wires were still intact at the end of two years. The consistent failure of the #28 gauge stainless steel wires prompted the use of #20 gauge wires.

In two of the eight cases where the #28 gauge wire broke, the teflon implants were held in place by the connective tissue capsules. In the other six cases, the implants were lying alongside the medial surfaces of the femurs.

The four implants held in place by #20 gauge stainless steel wire (Figure 35) were in place, but R-360 and L-360 were slightly loose. Very mild bone resorption was present in these legs.

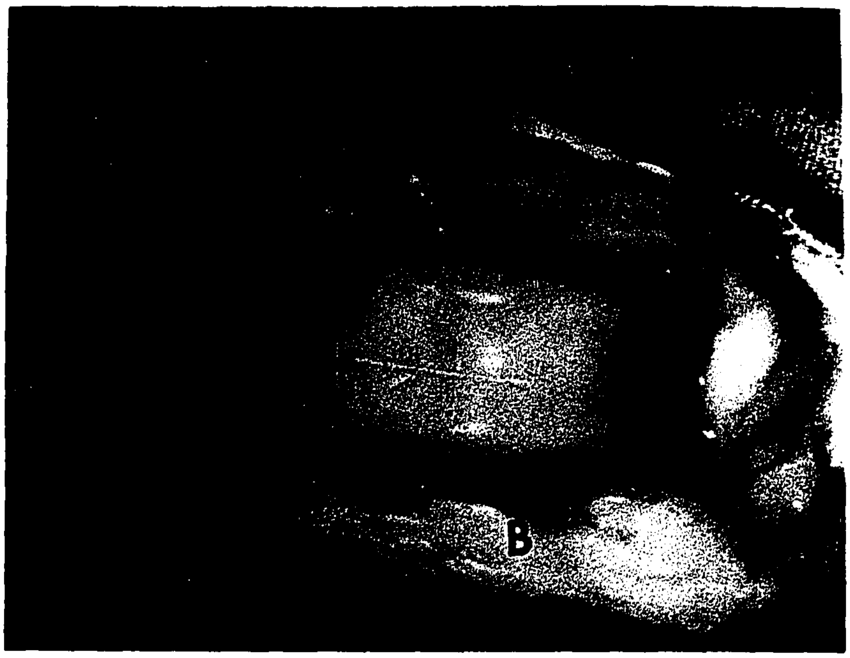
The joint capsules appeared normal, with the exception of R-560 and L-560. Both the medial and lateral condyles were worn smooth, but no erosions, cartilage hyperplasias or exostoses were noted. Four joints in this group were cultured for bacteria. Micrococcus species was isolated from L-460 and L-560. The other two joints, L-260 and L-660, were negative for bacterial growth.

Control dog No gross lesions were visible in either leg in the skin, subcutaneous tissues, muscles, ligaments, tendons, bones or stifle joint areas (Figure 36). The patellae were normal and no luxating actions were present. The joint fluids appeared normal in color, amount and consistency and the bacterial cultures were negative.

Wire, drilling and teflon control dog The skin, subcutaneous tissues, muscles, ligaments and tendons contained no visible lesions on either the three-month leg or the six-month leg, except for a normal amount of surgical scar tissue. The #20 gauge stainless steel wires were surrounded by a definite connective tissue capsule near the twisted ends. The wires also caused some bone resorption in their areas

Figure 36. A stifle joint which appeared free of visible lesions taken from the control dog which had been kept with the experimental dogs for one year.

A. Area where teflon implant would be placed
B. Medial condyle of femur


B

of contact with the femurs. There appeared to be no gross differences between the leg containing wire for three months and the leg containing wire for six months.

The drilled holes were barely visible as small, raised areas on both the three-month leg and the six-month leg. The six-month-old drilled areas were a little less prominent than the three-month-old areas. No abnormal gross tissue reactions were seen in the surrounding areas.

The teflon pieces placed in the bellies of the rectus femoris muscles were surrounded by thin connective tissue capsules. No gross differences were present between the three-month implant and the six-month implant. No other gross lesions were visible as a result of these teflon implants.

The joint fluid and the joint surfaces in this control dog appeared normal. The cultures of the joint fluids were negative for pathogenic bacteria.

Microscopic tissue results

One-week dogs

Tissue sections of muscles, tendons, teflon implant capsules and bones from the surgical areas of three dogs were studied. Evidence of subacute inflammation was present in the synovial membranes lining the quadriceps femoris tendons where they contacted the teflon implants. Edema, active hyperemia, connective tissue proliferation and focal areas of hemorrhage were present. Excessive amounts of macrophages, plasma cells, lymphocytes and neutrophils were seen (Figure 37).

The muscle tissues taken from the teflon implant areas had foci of edema, active hyperemia, hemorrhage and various stages of traumatic degeneration. One muscle section contained focal areas of suppuration and another contained one area of calcification. Bone dust in focal areas was causing a foreign body reaction and was surrounded by neutrophils, macrophages, lymphocytes and plasma cells. The synthetic suture material was causing a similar foreign body reaction (Figure 38).

No connective tissue capsules were found encapsulating the teflon implants one week following surgery. Strands of fibrin were seen in the implant areas.

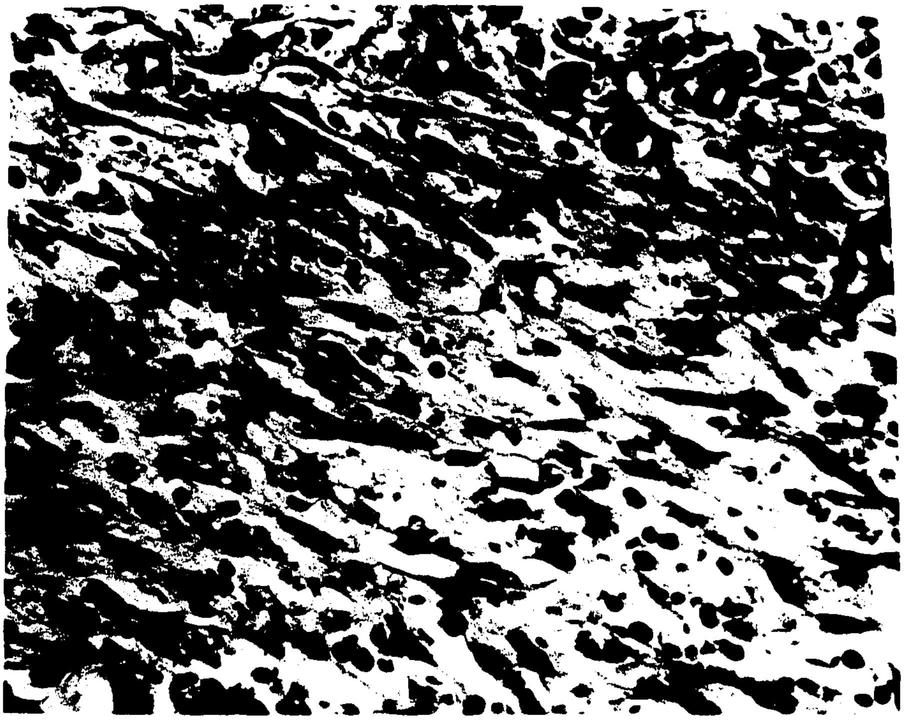
The periosteum in the surgical region had increased in activity in both the fibrous layers and the cambium or osteogenic layers (Figure 39). The increased periosteal activity was probably caused by the mild pressure of the teflon implant. This increased activity was characterized by large, round periosteal cells. Edema, active hyperemia and focal hemorrhages were also present in these periosteal areas. Osteoblasts were visible and new periosteal bone was being formed in the cambium layer.

A few focal areas of periosteum from the teflon implanted

Figure 37. A tissue section of a synovial membrane from R-1022 one week after teflon implant surgery. Note the connective tissue proliferation with numerous macrophages, plasma cells, lymphocytes and neutrophils. Hematoxylin and eosin. X 400.

Figure 38. Foreign body tissue reaction to synthetic suture material in R-1023 one week following implantation surgery. Note the neutrophils, macrophages, lymphocytes and plasma cells. Hematoxylin and eosin. X 400.

A. Cross section of synthetic suture material
B. Tissue reaction to suture material



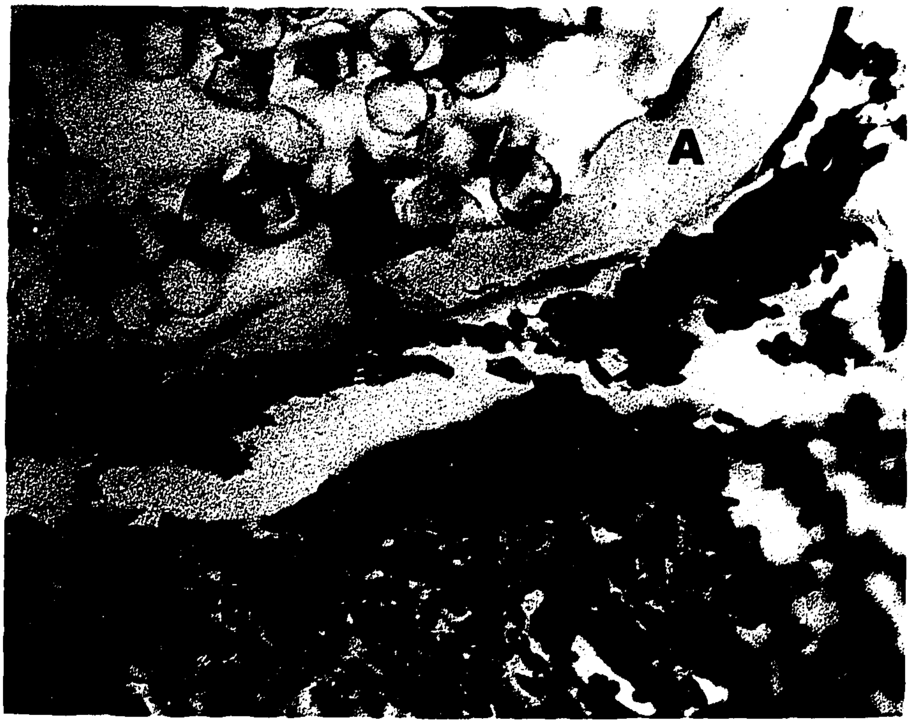
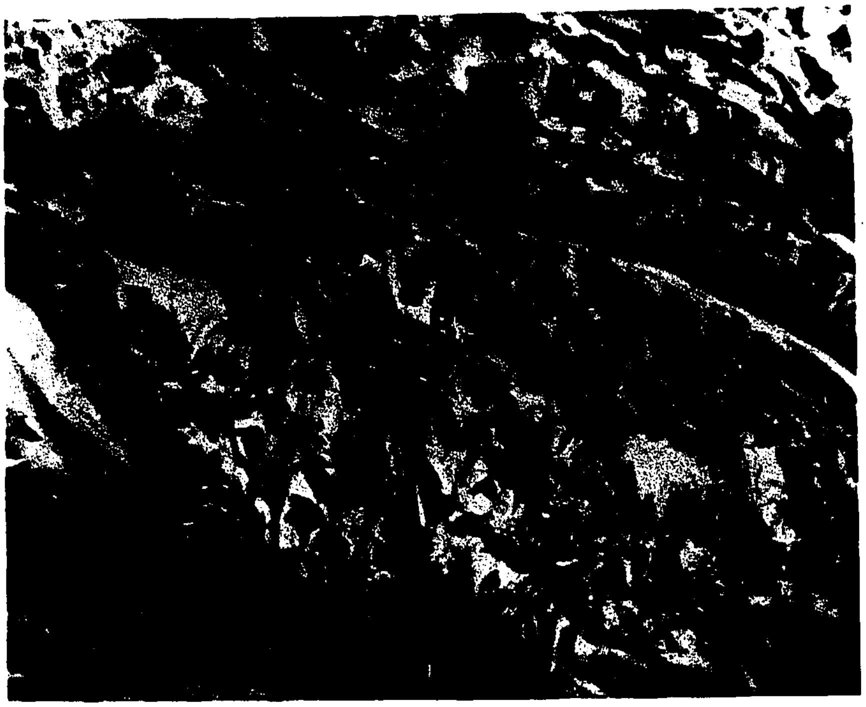

A

Figure 39. An area of increased activity of the cambium layer of the periosteum one week following teflon implant surgery in L-1021. Note the large, round periosteal cells. Hematoxylin and eosin. X 400.

A. Fibrous layer of periosteum
B. Cambium layer of periosteum
C. Cortex of bone

Figure 40. A focal area of osteoclasis from the teflon implant area in L-1023 one week following surgery. Osteoclasts were present in the area of bone resorption. Hematoxylin and eosin. X 160.

A. Osteoclast
B. Area of bone resorption



femurs had osteoclasis (Figure 40). This reaction was probably caused by excessive pressure of the teflon implant on the involved periosteum. The tissue change was characterized by the presence of osteoclasts, hyperchromic osteocytes and bone resorption. Bone dust, causing a foreign body reaction, was also seen in the periosteal tissues.

The bone cortex from the teflon implant areas appeared free of microscopic lesions, except in the region which had contained the stainless steel wires. The cortex wire passages were lined by excessive numbers of neutrophils, macrophages, lymphocytes and a few plasma cells and fibroblasts.

Osteomyelitis was found in the bone marrow of one case surrounding the stainless steel wire. This inflammation was characterized by an excessive increase in neutrophils together with a few macrophages and lymphocytes.

The synovial membranes from the teflon implant areas had focal areas of acute inflammation as a result of the surgery. These membranes were infiltrated with excessive numbers of neutrophils, macrophages, lymphocytes and a few plasma cells. Edema and active hyperemia were both present. All of the articular surfaces from the femurs which had been operated upon appeared free of gross lesions and as a consequence tissue sections were not made from these articular areas.

Two-week dogs Muscles, tendons, connective tissue implant capsules, bones and synovial tissues from the surgical areas of three dogs were studied microscopically. Less edema and active hyperemia than seen in the one-week dogs occurred in the synovial membranes lining the quadriceps femoris muscles in the teflon implant areas. There was an increase in subsynovial connective tissue, macrophages, lymphocytes and plasma cells, but a decrease in the relative number of neutrophils, compared to the one-week cases (Figure 41).

Two weeks following surgery the muscle tissues from the surgical areas had very little edema and hyperemia, but fatty degeneration and connective tissue infiltration had occurred. A few cross sections of synthetic sutures were located in the muscle and tendon tissues. The suture material was surrounded by fibroblasts, macrophages, plasma cells and a few neutrophils.

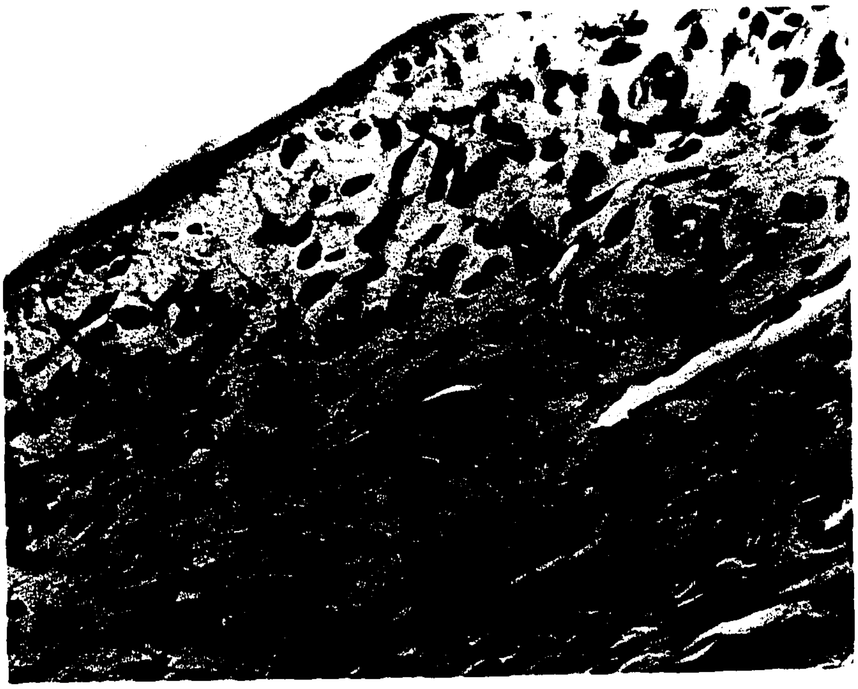
The teflon implants were encapsulated by connective tissue capsules. These capsules consisted of young fibroblasts adjacent to the teflon implant and more mature connective tissue cells near the periphery. The entire capsule was only a few cells thick.

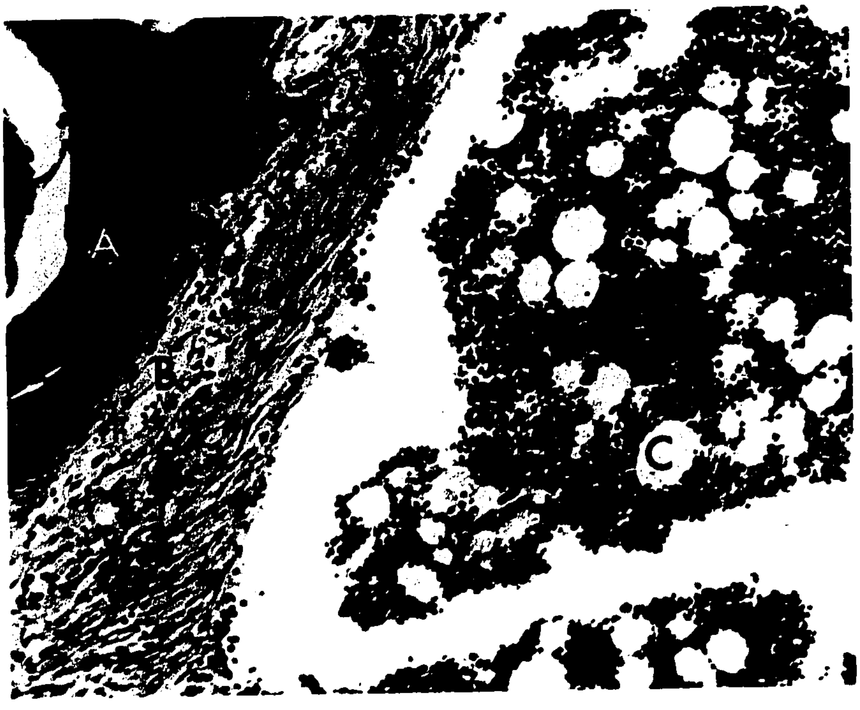
The periostea from the teflon implant regions had focal areas of increased activity in both the fibrous and cambium layers. As in the one-week dogs, the periosteal cells were

Figure 41. An area of synovial membrane from R-9321 two weeks following teflon implant surgery. There was an increase in subsynovial connective tissue, macrophages, lymphocytes and plasma cells. Hematoxylin and eosin. X 400.

Figure 42. Reaction of the femur to the stainless steel wire in R-9321 two weeks following implantation surgery. Hematoxylin and eosin. X 160.

A. Area of bone necrosis
B. Trabeculae of connective tissue
C. Bone marrow cells

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large and round and the osteoblasts were forming new periosteal bone. Very little edema or active hyperemia was present in the involved periostea.

Osteoclasis was present in a few focal zones of periosteum from the surgical areas. This was again characterized by the presence of osteoclasts, hyperchromic osteocytes and bone resorption. Excessive teflon implant pressure on the periostea probably accounted for these lesions. Three tissue sections had bone dust surrounded by subacute inflammatory tissue.

Necrosis had taken place in one cortex where the wire had passed through the bone (Figure 42). This bone necrosis caused enlarged lacunae, bone resorption and a loss of osteocytes from the lacunae. The other cortex areas from the involved femurs having wire passages were lined by numerous fibroblasts, macrophages, lymphocytes and a few neutrophils and plasma cells.

The bone marrows in the region of the stainless steel wires had focal areas of osteomyelitis. These inflammations were probably the result of the chemical irritation of the wire. This tissue change was characterized by an infiltration of numerous neutrophils, macrophages, lymphocytes and fibroblasts.

The synovial membranes removed from the teflon implant areas had less edema and hyperemia than those found in the one-week dogs. There was beginning proliferation of the subsynovial connective tissue and extensive mononuclear leucocytic infiltration had occurred (Figure 43). Numerous areas of focal hemorrhages were seen. Since the articular surfaces of the femurs of the stifle joints that had been operated upon appeared normal, no tissue sections were made of these areas.

One-month dogs Tissue sections from the surgical areas in three dogs in this group were studied. Connective tissue infiltrated the areas of inflammation and degeneration in the various tendons and muscles in the surgical areas (Figure 44). One synovial membrane contained excessive numbers of neutrophils and a focal area of peripheral coagulation necrosis. The coagulation necrosis was characterized by the fact that the synovial cells retained their normal outline, but their cellular detail was lost and the tissues appeared hyalinized.

The synthetic sutures in the tendons and muscles were surrounded by a definite white fibrous connective tissue capsule consisting of fibroblasts adjacent to the suture material and more mature connective tissue cells near the periphery. A few macrophages and lymphocytes were also present in the suture material capsule (Figure 45). The connective tissue encapsulation of the teflon implants appeared very similar to the suture material encapsulation

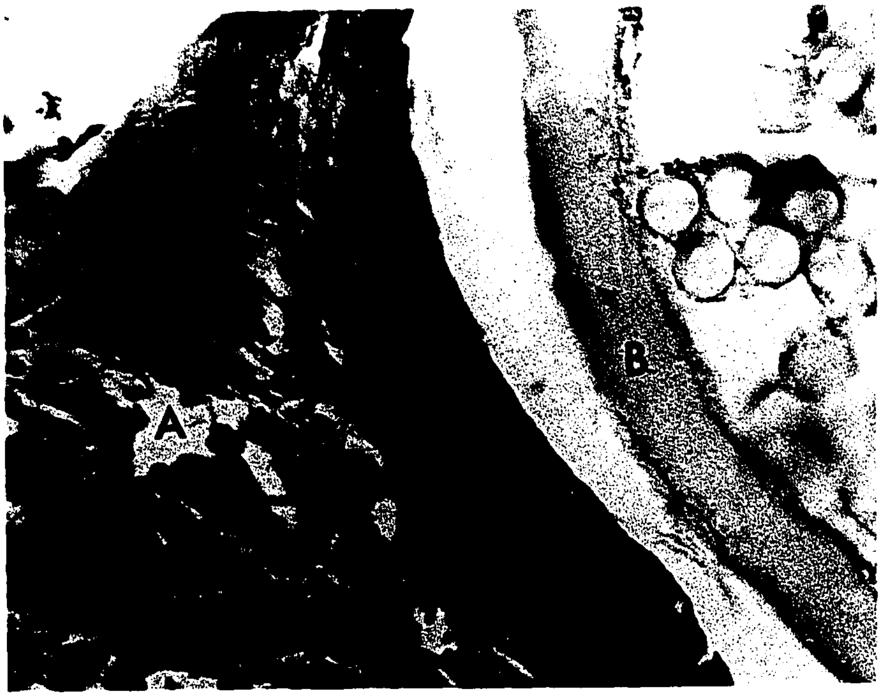
Figure 43. Proliferation of subsynovial connective tissue and mononuclear leucocytic infiltration in the synovial membrane of R-7921 one month following teflon implant surgery. Hematoxylin and eosin. X 160.

Figure 44. A section of synovial membrane from R-7921 which had chronic inflammation one month following implantation surgery. Hematoxylin and eosin. X 400

Figure 45. Tissue reaction to synthetic suture material in the tendon of the quadriceps femoris muscle from R-7921 one month following teflon implant surgery. The suture material was encapsulated by connective tissue. A few macrophages and lymphocytes were also present. Hematoxylin and eosin. X 400.

A. Tissue reaction to synthetic suture material
B. Synthetic suture material

Figure 46. Fibrous connective tissue capsule which had surrounded the teflon implant in R-7922 by one month following the teflon implant surgery. Hematoxylin and eosin. X 400.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(Figure 46).

Some increased activity was present in both the fibrous and cambium layers of the periostea in the surgical areas. Three femurs had marked periosteal cambium stimulation which resulted in numerous osteoblasts forming new periosteal bone (Figure 47). A large number of capillaries was present in this new bone.

A few focal areas of the periostea had osteoclasis. These bone changes were characterized by a presence of excessive numbers of osteoclasts, hyperchromic osteocytes and bone resorption. Bone dust being encapsulated by white fibrous connective tissue was present in one tissue section.

Bone necrosis was seen in one surgical area where the stainless steel wire passed through the involved bone cortex. This lesion was characterized by a loss of osteocytes in the lacunae, enlargement of the adjacent lacunae, bone resorption and the hyalinization of the involved tissues. Thickening of the cortex and right angle alignment of the bone trabeculae with the cortex were present (Figure 48). As stated by Luck (29, p. 37),

> Julius Wolff, in 1870, pointed out that whenever a bone is subjected to a change in function and stresses, the trabeculae align themselves with the new lines of stress.

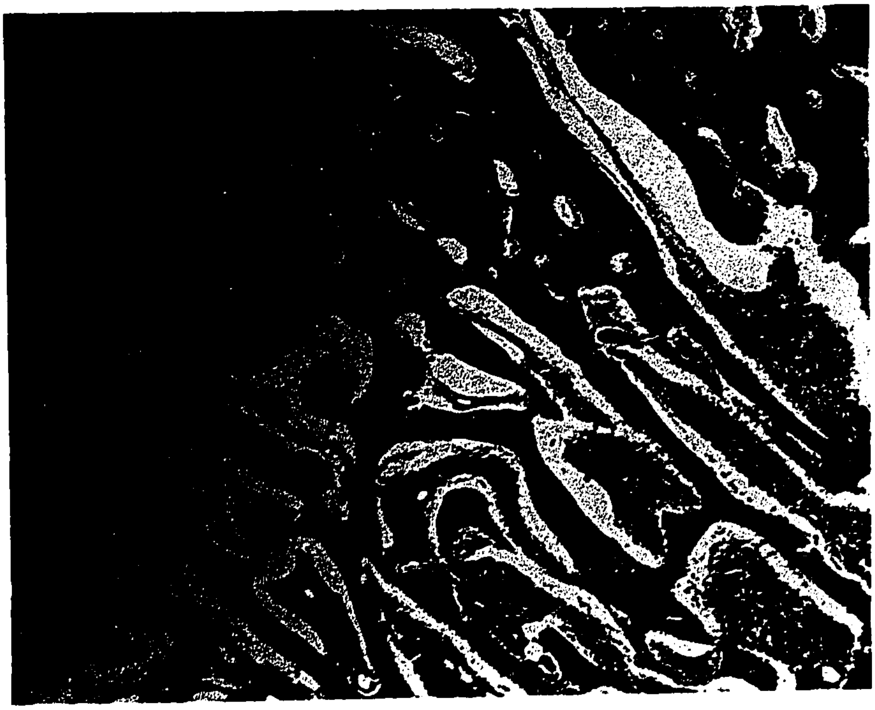
Evidence of a mild local osteomyelitis was seen in the bone marrows in the zones surrounding the stainless steel

Figure 47. New periosteal bone formation in the cambium layer of the periosteum in R-7923 one month following teflon implant surgery. Hematoxylin and eosin. X 60.

A. Fibrous layer of periosteum
B. Cambium layer of periosteum
C. Cortex of femur

Figure 48. Thickening of the cortex of the bone and right angle alignment of the bone trabeculae with the bone cortex in R-7922 one month after implantation surgery. Hematoxylin and eosin. X 36.

A. Cortex of bone
B. Bone trabeculae



wires. These regions appeared similar to those seen in the two-week dogs. Saprophytic bacteria were observed in the marrow cavity of one case.

The synovial membranes appeared to have an increase in the amount of subsynovial connective tissue and an excessive infiltration of macrophages, lymphocytes and neutrophils. Since all of the articular surfaces on the legs which had had surgery appeared normal on gross examination, no tissue sections were made of these areas.

Three-month dogs Tissues taken from muscles, tendons, implant capsules, bones, synovial membranes and articular cartilages from the teflon implant joints in six dogs were studied. Mild chronic connective tissue changes were present in the synovial membranes lining the quadriceps femoris tendons. There were many fibroblasts present with fewer numbers of macrophages, lymphocytes and neutrophils than in those cases previously studied. There appeared to be an increase in the number of blood capillaries present. One synovial membrane had an acute inflammation with many neutrophils and fewer macrophages and lymphocytes. Active hyperemia and edema were also present in this case. Coagulation necrosis of the peripheral margin of the synovial membranes occurred in two surgical cases.

The muscle tissues from the surgical areas had more extensive fibrous connective tissue infiltration and fatty degeneration than those observed in the one-month dogs. The synthetic sutures were surrounded by a connective tissue capsule. The teflon implant capsules appeared the same as those described for the one-month dogs.

With the exception of one case, there was very little increased activity in either the fibrous or cambium layers of the surgical periosteal areas. Most of the cases had various degrees of osteoclasis, characterized by an increase in the number of osteoclasts, hyperchromic osteocytes and bone resorption. Bone dust and its inflammatory reaction were found in several tissue sections.

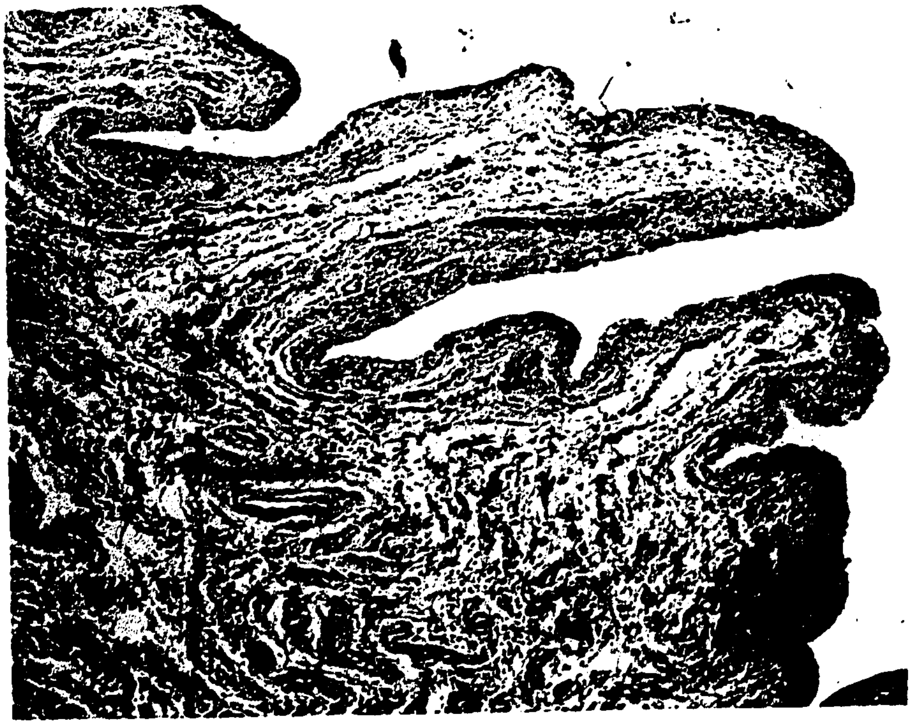
Bone necrosis was present in one surgical area. This necrosis was characterized by enlargement of lacunae, loss of osteocytes in the lacunae and hyalinization of the involved bony tissue. A thickened bone cortex and right angle alignment of the trabeculae with the cortex occurred in two of the surgical areas. The wire passage area in one case had fibrous connective tissue infiltration, bone resorption and bone necrosis (Figure 49). Many neutrophils and fewer macrophages and lymphocytes were present in tissue sections from one animal.

Localized osteomyelitis caused by the stainless steel wires was present in all of the operated femurs. These inflammations were characterized by about equal numbers of neutrophils, macrophages and lymphocytes. Fibrosis of the

Figure 49. Reaction of the cortex of the femur to stainless steel alloy wire in R-3923 three months following implantation surgery. Note the fibrous connective tissue, bone resorption and bone necrosis. Hematoxylin and eosin. X 160.

A. Fibrous connective tissue lining wire passage area in cortex of bone
B. Cortex of bone
C. Periosteum

Figure 50. Extensive villi formation in the synovial membrane from the stifle joint of R-3925 three months following implantation surgery. Hematoxylin and eosin. X 60.



bone marrows in the surgical areas had occurred in two cases.

More extensive villi formations were present in the synovial membranes (Figure 50) and the tissue changes appeared very similar to a condition in the human known as villonodular synovitis. This condition was described by Robbins (45) as a proliferation of subsynovial connective tissue and infiltration by mononuclear leucocytes accompanied by extensive deposition of granular hemosiderin pigments. Lipophages and foreign body giant cells can also be present. This condition was generally considered a reparative granuloma caused by old blood and tissue irritation.

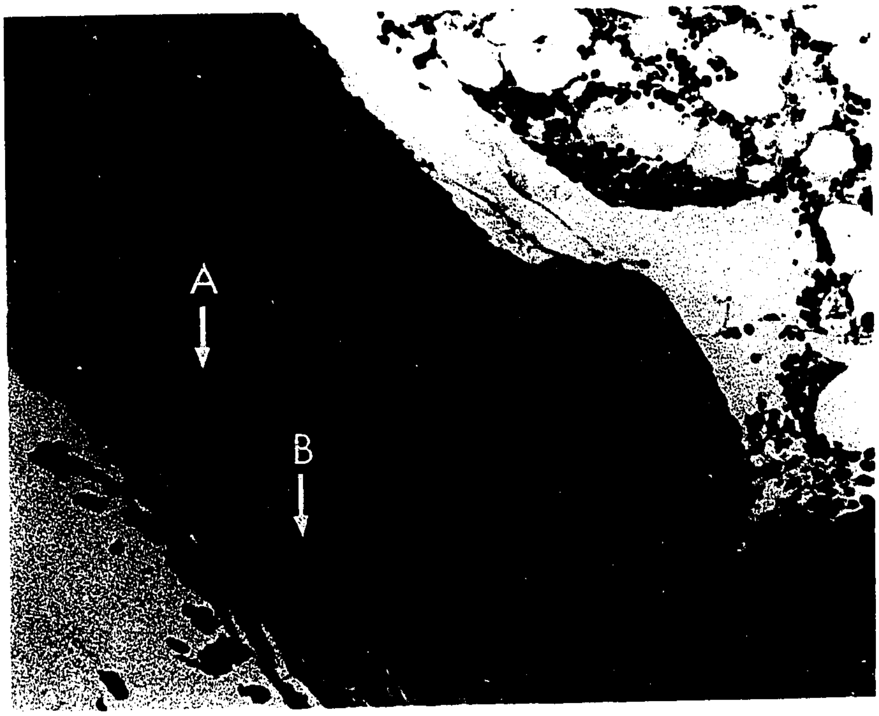
Weichselbaum's lacunae, stated by Luck (29) to be enlarged cartilage lacunae filled by proliferating cartilage cells, were present in the articular cartilages of two of the stifle joints that had undergone surgery (Figure 51). The collagen fibers were very distinct in these joints.

Six-month dogs Tissue sections from the surgical areas of 12 stifle joints in this group were studied. The synovial membranes lining the quadriceps femoris tendons had evidence of chronic inflammation and coagulation necrosis (Figure 52). The chronic inflammation was characterized by many plasma cells and lymphocytes and a smaller number of macrophages, fibroblasts and neutrophils. An increased number of capillaries was noted. The coagulation necrosis was usually located near the periphery of the synovial

Figure 51. Weichselbaum's lacunae and increased prominence of collagen fibers in the articular cartilage of R-3921 three months following teflon implant surgery. Hematoxylin and eosin. X 160.

A. Weichselbaum's lacunae
B. Collagen fibers

Figure 52. Chronic inflammation in the synovial membrane from the tendon of the quadriceps femoris muscle in R-4724 six months following surgery. Note the predominance of plasma cells and lymphocytes along with fibroblasts, enlarged synovial cells and a few neutrophils. Hematoxylin and eosin. X 400.


A
B

membranes.

Various stages of muscle degeneration were noted, with one tissue section having an extensive area of fatty degeneration. There was an increased amount of connective tissue infiltration of the muscles in comparison to the three-month dogs. There appeared to be an increase in the number of capillaries present.

The connective tissue capsules surrounding the teflon implants consisted of fibroblasts on the implant side and mature connective tissue cells near the periphery of the capsules. A few macrophages and lymphocytes were observed in these implant capsules.

Osteoclasis characterized by hyperchromic osteocytes, the presence of osteoclasts and bone resorption occurred in the periostea in the surgical areas. The cambium layers did not appear active in the formation of new bone in most of these surgical areas. A few focal areas of cell infiltration containing mostly macrophages and lymphocytes occurred in the fibrous periosteal layer. Chronic inflammatory reactions had occurred around focal areas of bone dust.

Most of the femurs were thickened in the cortex zone of the surgical areas. The bone trabeculae were arranged at right angles to the cortex to aid in resisting the added stress. One of the tissue sections had a localized area of necrosis characterized by enlarged lacunae, loss of osteocytes from the lacunae and hyalinization of the bony tissues.

Focal areas of chronic inflammation were present in the bone marrow tissues surrounding the stainless steel wires. Many macrophages and lymphocytes were present, with fewer neutrophils. Mild bone marrow fibrosis was beginning in most of the surgical areas.

The synovial membranes located in the areas of the implants had chronic inflammations with proliferation of subsynovial connective tissue, extensive mononuclear leucocytic infiltration and hemosiderin pigment deposition. An increase in the number of capillaries appeared evident in most of these synovial membranes.

A few Weichselbaum's lacunae were located in the articular cartilages in the surgical areas. Further evidence of osteoarthritic changes was not noticed.

One-year dogs The surgical areas in the stifle joints of six dogs were studied microscopically in this group. There was an increase in the subsynovial connective tissue in focal areas of the synovial membranes lining the quadriceps femoris tendons. Peripheral coagulation necrosis was present in the synovial membranes in all the tissue sections and a focal area of ossification was present in one. Focal areas containing about equal numbers of macrophages and lymphocytes and a few plasma cells occurred in one tissue section of synovial membrane from the implant zone.

The muscle tissue from the teflon implant area had various stages of degeneration and necrosis. Calcium had been deposited in one focal area and about one-half of the muscles from the surgical area contained various amounts of coagulation necrosis and fatty degeneration.

The connective tissue encapsulating the teflon implants contained fibroblasts near the implant and more mature connective tissue cells near the periphery.

Changes ranging from new bone formations to osteoclasis occurred in the periostea from the surgical areas. One case had new bone tissue forming from the cambium layer of the periosteum. No adverse periosteal changes were seen in three tissue sections. Two femurs had osteoclasis in the surgical areas. These changes were characterized by the presence of increased numbers of osteoclasts, resorption of bone and hyperchromic osteocytes. Bone dust and focal areas containing macrophages, lymphocytes and an occasional plasma cell were seen. Peripheral coagulation necrosis and calcification occurred in one of the surgically involved periosteal areas.

All of the cortex zones from the teflon implant areas were thickened and the bone trabeculae were at right angles with the bone cortex. Marked bone resorption occurred in R-3952, probably as a result of the *Staphylococcus aureus* that had been previously isolated from this surgical area (Figure 53). This case also had cysts in the cortex of the

Figure 53. Reaction of R-3952, a one-year experimental dog, which was invaded by Staphylococcus aureus following teflon implant surgery. Note the bone resorption and the focal osteomyelitis. Hematoxylin and eosin. X 160.

A. Area of bone resorption
B. Focal area of osteomyelitis

Figure 54. Articular cartilage from R-3951 one year following implantation surgery. Note the breakdown of articular matrix, clumps of single cartilage cells in a lacunae (Weichselbaum's lacunae) and tags of cartilage. Hematoxylin and eosin. X 160.

A
B

bone which contained fibroblasts, macrophages and a few lymphocytes, plasma cells and osteoclasts. The wire passage areas were lined by mature white fibrous connective tissue cells.

Various degrees of localized osteomyelitis were present in all of the bone marrows in the surgical areas. These lesions ranged from focal areas of neutrophils, macrophages and lymphocytes to an almost complete fibrosis of one surgical area. One bone marrow cavity from the teflon implant region had a few giant cells together with the other inflammatory cells.

The synovial membranes from the surgical areas had an increase in subsynovial fibroblasts along with many macrophages, lymphocytes and an occasional plasma cell. Various degrees of coagulation necrosis and hemosiderin pigment deposition were found in all the membranes from the teflon implant areas.

The articular cartilages of the femurs from the surgical areas ranged from four apparently normal surfaces to one having a breakdown of the articular matrix, clumps of single flat cells in the lacunae, tags of cartilage breaking loose and shallow erosions (Figure 54). Evidence of shallow erosions was seen in another surgical articular surface of the femur.

Two-year dogs The tissue sections from the surgical areas in the two-year dogs were studied for evidence of tissue changes and neoplasms. Various degrees of chronic inflammation were present in the synovial membranes that lined the quadriceps femoris tendons in the teflon implant areas (Figure 55). Some of the peripheral margins of these membranes exhibited coagulation necrosis.

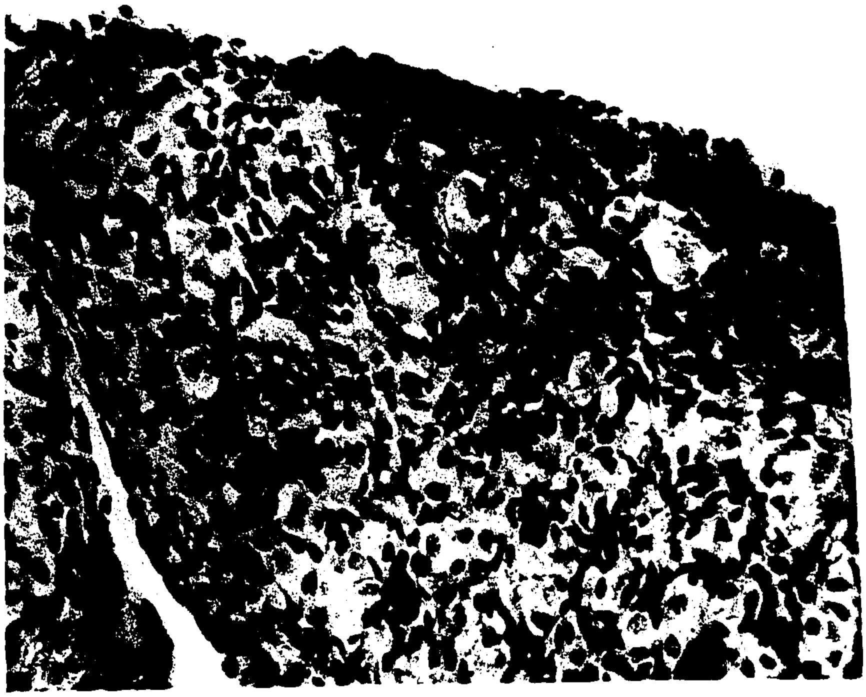
The muscle tissue from the teflon implant areas contained various degrees of fibrous connective tissue infiltration, fatty degeneration and coagulation necrosis. In one tissue section of involved muscle and tendon, focal areas of macrophages, lymphocytes and plasma cells, with a few neutrophils, were seen. The synthetic sutures were walled off with a mature connective tissue capsule together with a few macrophages, lymphocytes and plasma cells (Figure 56).

The teflon implants were encapsulated by white fibrous connective tissue as seen in the one-year dogs, with the exception of one case. In R-360 the teflon capsule was composed of synovial membrane rather than white fibrous connective tissue (Figure 57). This was probably caused by the teflon implant being placed too close to the articular surface and also as a result of insufficient reflection of the synovial membrane from the implant area at the time of surgery.

Figure 55. Chronic inflammation of a synovial membrane from R-460 two years following teflon implant surgery. Hematoxylin and eosin. X 400.

Figure 56. Mature connective tissue, macrophages, lymphocytes and plasma cells surrounding the synthetic suture material in R-660 two years following surgery. Hematoxylin and eosin. X 400.

A. Tissue reaction to suture material
B. Synthetic suture material



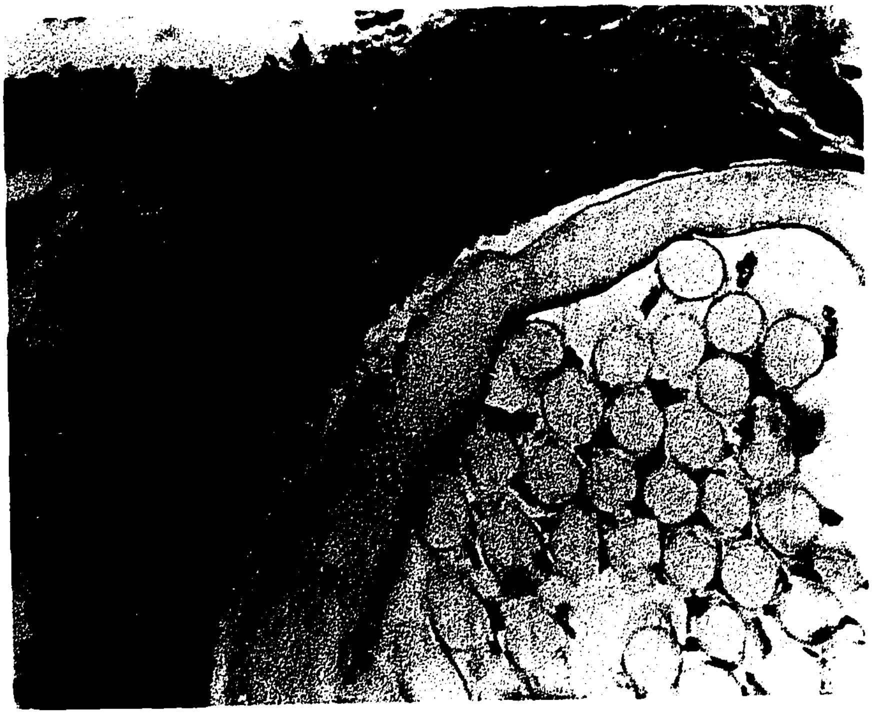


Figure 57. An encapsulation of the teflon implant by the tissue response of the synovial membrane in R-360, a two-year experimental dog. Hematoxylin and eosin. X 400.

Figure 58. Tissue reaction to stainless steel alloy wire in R-660, a two-year experimental case. Hematoxylin and eosin. X 400.

Various stages of osteoclasis were present in the periosteum from the surgical areas. The femurs from this series appeared to have changes similar to the one-year group. Similarly these changes were characterized by the presence of osteoclasts, resorption of bone and hyperchromic osteocytes. Bone dust and peripheral coagulation necrosis were seen in the periosteal tissues from the teflon implant areas.

The cortex areas from the surgical sites were thickened and the trabeculae were at right angles to the teflon implant location. Case #460 had a chronic connective tissue reaction to the stainless steel wire which contained many fibroblasts, macrophages, lymphocytes and plasma cells (Figure 58). The other wire passage areas were lined by mature white fibrous connective tissue.

Localized osteomyelitis was present in the surgical areas, probably as a result of the stainless steel wire irritation. This reaction was characterized by the presence of many macrophages, lymphocytes and neutrophils. Two involved bone marrow cavity areas had localized areas of fibrosis and bone reconstruction.

The synovial membranes involved had various degrees of chronic inflammation. These inflammations resulted in an increase in the subsynovial membrane connective tissue or in mononuclear leucocytes or in both. The involved synovial membrane in R-460 had a marked number of macrophages and lymphocytes present (Figure 59). A few germinal areas for lymphocytes were in the process of formation and marked hemosiderin depositions were present. A few foreign body giant cells were seen in the slides from one case.

The articular surfaces from the femurs in the surgical areas were abnormal in two dogs in this series. Both of these abnormal articular cartilages contained rarefaction of the hyaline matrix, Weichselbaum's lacunae, increased prominence of collagen fibers, disorganization of the cartilage lacunae and flaking of superficial cartilage (Figure 60). As explained in the macroscopic tissue results, most of these osteoarthritic changes were probably caused by the synthetic sutures contacting the articular surfaces of the operated femurs.

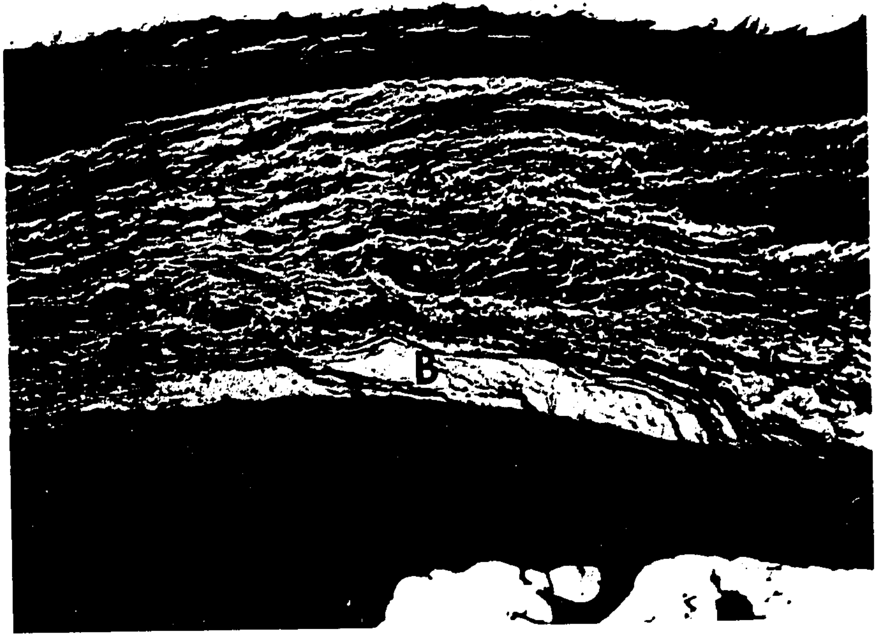
Control dog No microscopic lesions were noted in the tissues studied from the area where the implants would have been placed. The subcutaneous tissues, muscles, tendons, synovial membranes, periostea, cortices, bone marrows and joint surfaces from the involved areas appeared free of tissue changes.

Wire, drilling and teflon control dog Both of the stifle joint areas in this control dog were examined microscopically for tissue changes. The teflon pieces placed in the bellies of the rectus femoris muscles were surrounded by definite white fibrous connective tissue capsules.

Figure 59. Synovial membrane with chronic inflammation in experimental case #R-460 two years following teflon implant surgery. Note the increase in subsynovial connective tissue, macrophages and lymphocytes. Hematoxylin and eosin. X 160.

Figure 60. Articular surface of R-460 two years following implantation surgery. Rarefaction of hyaline matrix, Weichselbaum's lacunae and disorganization of lacunae were present. Hematoxylin and eosin. X 60.

A. Collateral ligament of stifle joint
B. Peripheral margin of articular cartilage
C. Articular cartilage containing Weichselbaum's lacunae


B

The capsule was approximately 12 cells thick in the three-month leg (Figure 61) and about 20 cells thick in the six-month leg. The muscle tissue surrounding the teflon pieces and the connective tissue capsules appeared free of lesions.

The synovial membranes in the areas where the wires were placed had areas of chronic inflammation. This inflammation was characterized by an increase in fibrous connective tissue, and the presence of macrophages, lymphocytes and plasma cells. This reaction was more extensive in the six-month leg.

Osteoclasis characterized by the presence of osteoclasts, hyperchromic osteocytes and bone resorption was present in both surgical areas. Evidence of necrosis occurred in the bone next to the wires. The stainless steel wires were surrounded by mature connective tissue infiltrated by numerous mononuclear leucocytes. These reactions were more extensive in the six-month leg.

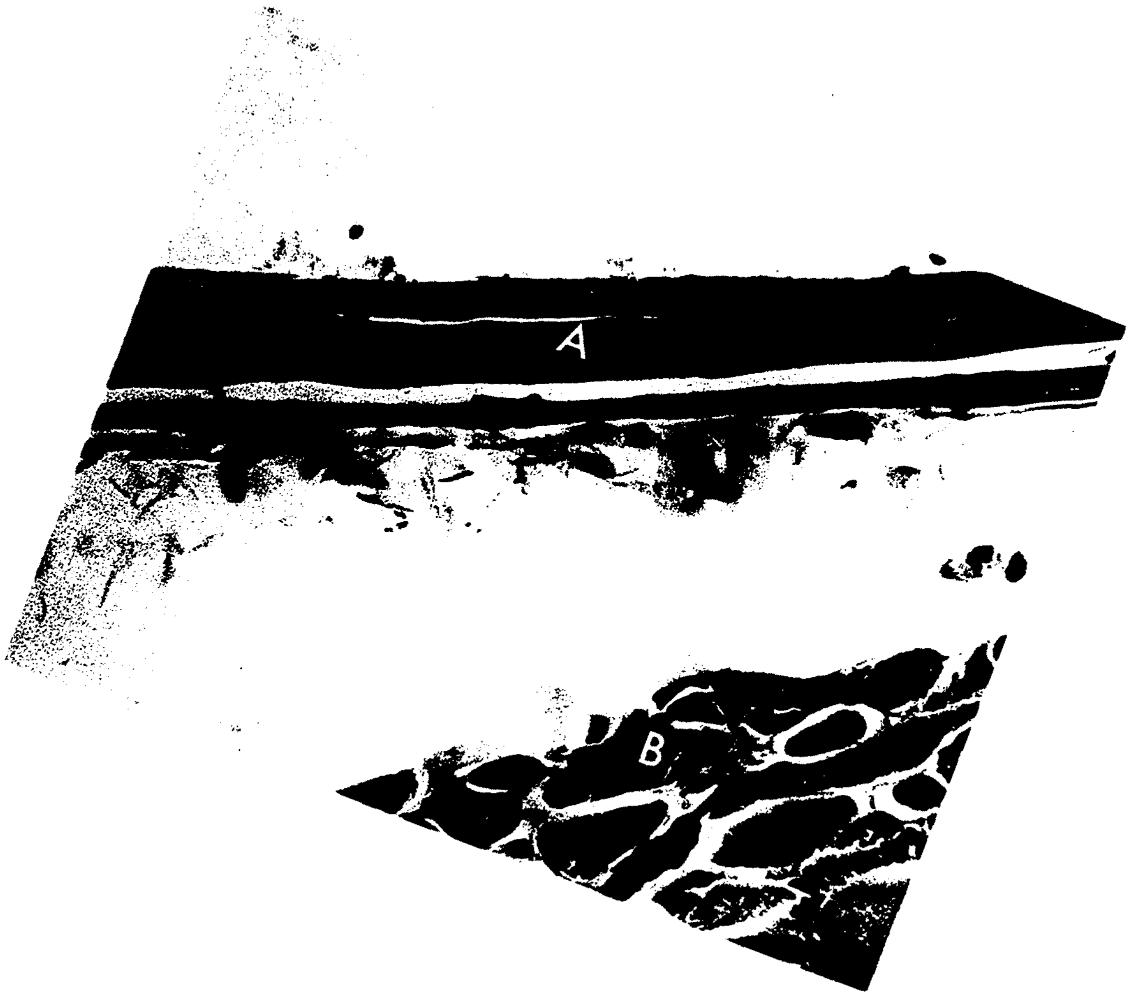
The bone marrows from the stainless steel wire areas had localized osteomyelitis. These areas contained many neutrophils, macrophages and lymphocytes. Some fibrosis of the marrow cavity was taking place in the six-month leg.

Both articular cartilage areas from the control stifles appeared free of osteoarthritic changes. The synovial membranes in this zone were free of lesions.

Areas that could definitely be identified as the bone

Figure 61. Connective tissue encapsulation of the teflon implant which was buried in the belly of the rectus femoris muscle in the three-month control leg. Hematoxylin and eosin. X 400.

A. Connective tissue capsule
B. Muscle fibers of rectus femoris muscle


A
B

drill locations were not located in tissue sections, so no microscopic discussions of these could be given. However, Stark (54) gave a very good description of the microscopic lesions present in drilled bone.

Clinical Cases

Clinical records

Clinical case #101 The first clinical case (Table 2) was a two-year-old, female Pekingese with bilateral medial patellar luxations. Pain appeared to be greater in the left leg. The patient had experienced trouble with walking for over a year, especially during damp weather or pregnancy. Her legs were sore on palpation and she would nip at the client's children when they tried to play with her. A false trochlear ridge had formed on the medial side of the medial condyle in the left stifle joint. The patellar grooves were poorly developed in both hind legs.

Surgery was performed on both legs on November 3, 1960, and teflon implants were placed on both femurs. The patient was discharged two days later and at this time she supported some weight on her hind legs. On November 11, 1960, she was returned for a postoperative check-up. The owner reported that the dog was steadily improving and was walking cautiously at this time.

Table 2. Clinical teflon implant cases

Case number	Breed	Age	Stifle abnormalities	Results[a] Right	Left
C-101	Pekingese	2 y.	R. - shallow patellar groove, mild erosions L. - false medial ridge	++	++
C-102	Pomeranian	7 m.	R. - shallow patellar groove, medial tibial deviation L. - same	+++	+++
C-103	English Bulldog	2 y.	L. - severe osteoarthritis with medial condyle erosion		0
C-104	Schipperke	11 m.	R. - patella fused to medial side of femur, severe osteoarthritis, medial deviation of tibia	+	
C-105	Chihuahua	13 m.	R. - shallow patellar groove, mild osteoarthritis L. - shallow patellar groove	++	++
C-106	Manchester Terrier	1½y.	R. - shallow patellar groove, mild osteoarthritis L. - same	+++	+++

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[a] Walks and runs normally	+++
Satisfactory recovery	++
Some improvement	+
Same as before surgery	0

Table 2. (Continued)

Case number	Breed	Age	Stifle abnormalities	Results[a]	
				Right	Left
C-107	Pekingese	1 y.	R. - mild osteoarthritis, worn medial condyle	+	
C-108	Toy French Poodle	11 m.	R. - shallow patellar groove, mild osteoarthritis L. - same	+++	+++
C-109	Toy French Poodle	9 m.	R. - shallow patellar groove, patella fused to femur	++	
C-110	Chihuahua	3 y.	R. - shallow patellar groove, deviation of tibia, mild osteoarthritis, patella fused to femur L. - same with exception of osteoarthritis	+ (Before euthanasia)	++
C-111	Chihuahua	9 m.	L. - shallow patellar groove, deviation of tibia		++
C-112	Toy French Poodle	9 m.	R. - shallow patellar groove, deviation of tibia, patella fused to femur	+++	
C-113	Boston Terrier	9 m.	R. - shallow patellar groove L. - same	++	++

Table 2. (Continued)

Case number	Breed	Age	Stifle abnormalities	Results[a]	
				Right	Left
C-114	Pug	2½y.	R. - shallow patellar groove, mild osteoarthritis L. - patella fused to femur, severe osteoarthritis	++	++
C-115	Toy French Poodle	5 m.	L. - shallow patellar groove, mild osteoarthritis		++
C-116	Boxer	1 y.	L. - severe erosion of medial condyle, false patellar groove, severe osteoarthritis		+
C-117	Cocker Spaniel	7 y.	R. - complete erosion of medial condyle, mild osteoarthritis	+	
C-118	Chihuahua	6 m.	R. - shallow patellar groove, deviation of tibia, mild osteoarthritis	++	
C-119	Chihuahua	4 y.	R. - shallow patellar groove, mild osteoarthritis L. - same	++	++

On December 5, 1960, the patient was again returned. The left leg had progressed satisfactorily, but the right patella still luxated occasionally. The right leg was again operated on and a larger implant was used. When the patient was discharged one week later, it had partial use of both hind legs.

The client reported at 6 months, 12 months and 21 months following surgery that the dog had good use of its hind legs. On clinical examination neither patella would luxate and pain was not elicited by the animal from either leg. Although the dog's gait was not entirely normal, the owner reported that the dog's attitude was much better than before surgery and that it now was more playful and better natured with the children.

Clinical case #102 This clinical case involved surgery of both stifle joints for medial patellar luxations in a seven-month-old, male Pomeranian. The patellar grooves were very poorly developed and the tibial crests were beginning to deviate medially. On December 14, 1960, teflon implants were placed on both femurs. Thomas-Schroeder splints were applied to both legs for five days to help correct the medial deviation of the tibial crests. The left leg required additional sutures in the joint capsule area on December 21, 1960. The patient was discharged the following day. Although the patient was never seen again, the owner reported that the dog walked fairly well in two weeks and that the medial deviation of the tibial crests corrected itself in the next two to three months. The dog was still showing satisfactory use of the hind legs 20 months following surgery.

Clinical case #103 This clinical case was a two-year-old, male English Bulldog. This dog had a chronic medial patellar luxation of the left hind leg, which had resulted in a smooth medial condyle and severe osteoarthritis, characterized by erosions, exostosis and marginal lipping. On December 18, 1960, a teflon implant was placed on the medial ridge, to compensate for the missing medial condyle. An attempt was also made to remove the exostosis. The patient was discharged from the clinic two weeks following surgery. This dog never regained use of its leg, and the surgery did not seem to help or hinder this stifle joint. Although the patellar luxation was corrected, the existing osteoarthritis prevented the dog from using this limb.

Clinical case #104 A one-year-old, female Schipperke had a history of right hind leg lameness since the time it was a puppy. The femoral condyles were very poorly developed and the patella was adhered to the medial side of the femur. The muscles in this limb were poorly developed and the tibial crest had deviated 90° medially. There was some exostosis and marginal lipping present on both sides of the condyles. On February 3, 1961, a teflon implant was put in place in the manner described before. This dog regained only partial use of the treated leg. The patellar luxation remained corrected, but arthritis and atrophy in the leg interfered with the normal use of this limb.

Clinical case #105 A one-year-old, female Chihuahua had severe medial luxations of both patellae. The right leg was the more severe and the patient held this leg in flexion almost constantly. Osteoarthritis with exostosis was present in the right femur. There was poor development of the patellar ridges in both stifle joints. The teflon implant surgical procedure was used on this patient on January 14, 1961, followed by Thomas-Schroeder splints for one week. The patient was discharged two weeks following surgery. The final report on this patient indicated she had much better, but not complete, use of both hind legs.

Clinical case #106 On March 7, 1961, an 18-month-old, male Manchester Terrier was operated on for bilateral medial patellar luxations. There was a mild osteoarthritis with cartilage hypertrophy and poor condyle development in both stifle joints. Evidence of tibial deviation was not found. The patient started using both legs containing the teflon implants five days following surgery and experienced no trouble until three months later. At this time the patient showed some lameness in the left stifle joint, which subsided after five days of cage rest.

On April 16, 1962, the patient was again admitted to the clinic. This time she was refusing to use her right hind leg. External palpation of the stifle joint revealed a loose teflon implant. An exploratory incision was made into the right stifle joint. The teflon implant, which was partially loose, was causing mild bone resorption of the femur. The patellar groove appeared deeper than at the time of surgery. It was decided to remove the implant, since its main purpose for correcting the luxation was now gone. The surgical area was resutured and the dog now experiences excellent use of both hind legs.

Clinical case #107 A one-year-old, male Pekingese had teflon implant surgery on April 6, 1961, for a medial patellar luxation of the right stifle joint. Osteoarthritis was present with erosion, exostosis and a worn medial condyle. The tibial alignment appeared normal. The patient was discharged three days following surgery. A report from the owner nine days later and a final report both indicated the dog had better use of its treated leg.

Clinical case #108 On August 1, 1961, an 11-month-old Toy French Poodle was operated on in the right stifle joint with the teflon implant procedure for a medial patellar luxation. There was poor condyle development, but the tibial crest was in its normal position and no joint lesions were present. The patient started using its leg in six days and had full use of this leg in three weeks.

On March 29, 1962, the same patient was returned for teflon implant surgery in the left stifle joint. This stifle joint appeared similar to the right joint. The treated leg supported some weight the fourth day after surgery. The patient was walking normally nine days following surgery. The dog had excellent use of both hind legs at the time of the final report.

Clinical case #109 Another clinical patient was a nine-month-old Toy French Poodle. The right patella was fused to the medial side of the femur. Very little evidence of a patellar groove was present and osteoarthritis, especially exostosis, was present in the joint. The pup had been severely lame on this leg since it started to walk. There was about a 90° deviation of the tibial crest. A teflon implant was placed on this femur. The leg was placed in a Thomas-Schroeder splint for nine days. After the splint was removed, the dog placed some weight on the treated leg. The last report available on this patient indicated that it had satisfactory use of this leg and the tibial deviation had been corrected.

Clinical case #110 On September 14, 1961, a three-year-old, male Chihuahua had teflon implant surgery to correct bilateral medial patellar luxations. Before surgery the patient had no use of its right hind leg and limited use of its left hind leg. Both patellae were fused to the medial sides of the femurs. Extensive osteoarthritis characterized by exostosis, erosions and cartilage hypertrophy was present in both stifle joints (Figure 62). Ankylosis was beginning to occur in the right stifle joint. There was about a 90° deviation of the right tibial crest and about a 30° deviation of the left tibial crest. The right leg was placed in a splint for ten days following surgery. The patient gained good use of its left hind leg and some use of its right hind leg.

On November 4, 1961, the patient was returned for a postoperative examination. The dog still had good use of its left hind leg, but only partial use of its right hind leg. The dog was also having trouble with the carpal joints, because of congenital deformities, so the client requested euthanasia for this patient.

Clinical case #111 A nine-month-old, female Chihuahua was brought to the clinic with the history of a persistent medial patellar luxation of the left stifle joint. The leg had been injured several months before, and the left paw was now touching the medial side of the opposite leg. The dog completely refused to use the left leg. The condyles were poorly developed, but no osteoarthritis was present.

Surgery was performed on the joint on September 14, 1961, using the teflon implant procedure. A Thomas-Schroeder splint was placed on the leg and the patient was sent back to the referring veterinarians. The reports on this patient indicate that she has satisfactory use of her treated leg.

Clinical case #112 On October 17, 1961, an eight-month-old, female Toy French Poodle entered the clinic with a persistent medial patellar luxation of the left stifle joint and an intermittent medial luxation of the right patella. The left patellar groove was very shallow and a false groove had formed on the medial side of the femur. There was also about a 20° medial deviation of the left tibial crest. The right patellar groove appeared normal.

A teflon implant and a Thomas-Schroeder splint were utilized on the left hind leg. The lateral patellar ligament was reinforced in the right stifle joint. The splint was removed in five days and the patient placed some weight on both hind legs. In three weeks the dog was walking normally. The final report indicated that the patient had excellent use of both hind legs.

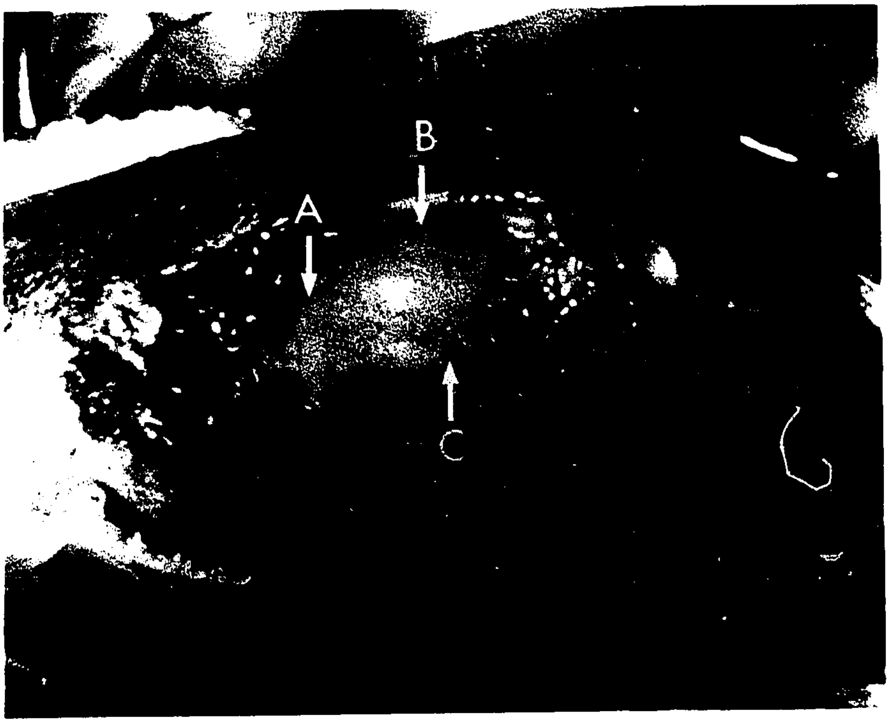
Clinical case #113 Surgery was performed on a nine-month-old, female Boston Terrier on October 27, 1961, for bilateral medial patellar luxations. Since there was very little development of either of the condyles, teflon implants were used. Very little osteoarthritis was present (Figure 63). There was a very mild medial deviation of both tibial crests. Both legs were placed in Thomas-Schroeder splints for one

Figure 62. The distal articular surface of the femur in clinical case #110 had exostosis, cartilage erosion and cartilage hyperplasia.

A. Cartilage hyperplasia
B. Marginal exostosis
C. Erosion of articular cartilage

Figure 63. The condyles of this femur in clinical case #113 were not well-developed, especially the medial condyle.

A. Medial condyle of femur
B. Lateral condyle of femur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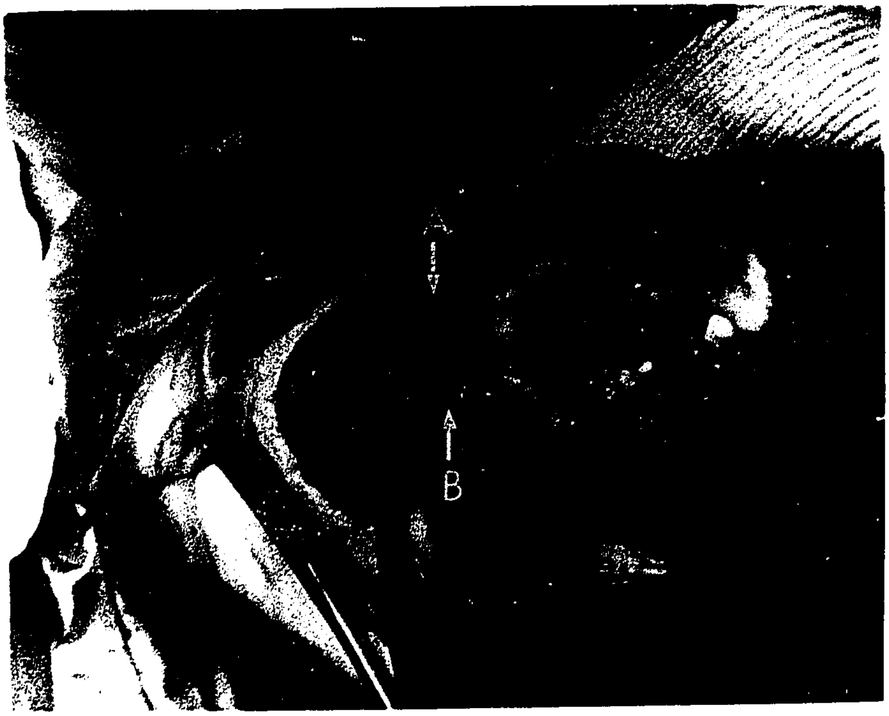
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week following surgery. The dog started walking on the hind legs when the splints were removed, but it still evidenced some pain. The last report from the referring veterinarian indicated that the patient had satisfactory use of both of its hind legs.

Clinical case #114 A two and one half-year-old, male Pug was brought to the clinic on January 13, 1962, for teflon implant surgery to correct bilateral medial patellar luxations. There was a constant medial luxation of the left patella and considerable osteoarthritis, consisting of erosions and exostosis, in this joint. The osteoarthritis in the right stifle joint was not as extensive. There was no deviation of the tibial crests. The dog placed some weight on both legs three days following surgery and was able to walk cautiously in five days. The final report on this patient indicated the dog had regained satisfactory use of both hind legs and was now being used as a show dog.

Clinical case #115 A five-month-old Toy French Poodle was referred to the clinic for patellar luxation surgery of the left hind leg on March 29, 1962. There was mild osteoarthritis consisting of erosions and the condyle development was poor. No tibial crest deviation was noted. A teflon implant was placed on the left femur. The patient supported some weight on the leg in four days and placed full weight on the leg in eight days. The final report indicated that the patient had satisfactory use of its left hind leg.

Clinical case #116 On April 9, 1962, a one-year-old, female Boxer was referred to the clinic for corrective patellar surgery of the left stifle joint. The patella had luxated medially and a false groove had developed. There was extensive osteoarthritis including erosions, cartilage hypertrophy and exostoses. A teflon implant was placed on the left femur and an attempt was made to remove the exostoses. The dog placed some weight on the leg on the third day following surgery and had fair use of the leg on the sixth day. The dog was last reported as having satisfactory use of the leg, although it limped after exercise.

Clinical case #117 A seven-year-old, female Cocker Spaniel was brought to the clinic with a history of severe limping on the right rear leg for two months duration. The patella luxated medially and there was crepitation in the stifle joint. The patellar groove was poorly developed and mild osteoarthritis, characterized by exostoses and marginal lipping, was present. A teflon implant was used to correct this luxation. The patient started putting some weight on her leg in six days and walked with a limp in 14 days. The last report indicated the dog had better use of her right hind leg, but still had a persistent limp.

Clinical case #118 On May 21, 1962, a six-month-old, male Chihuahua was admitted to the clinic with a medial patellar luxation of the right rear leg. The tibial crest had deviated about 90° medially and the femoral condyles were poorly developed. A teflon implant was placed on the femur. Beginning osteoarthritis characterized by marginal lipping was present in the stifle joint. The leg was splinted for ten days. The final report indicated that the tibial deviation was nearly corrected and the dog had satisfactory use of its treated leg.

Clinical case #119 Teflon implant surgery was performed on a four-year-old, male Chihuahua on June 28, 1962, for bilateral medial patellar luxations. Both femurs contained very shallow patellar grooves. Mild osteoarthritis characterized by erosions and exostoses was present on both femurs. The tibial crests appeared normal. This patient started to use its hind legs in five days and the final report 45 days after surgery indicated the dog had satisfactory use of both hind legs.

Clinical discussion From the above clinical cases, it appears that the inherent or congenital patellar luxations must be diagnosed and corrected early in the patient's life in order to prevent joint lesions and to restore satisfactory function to the stifle joint. Once the patient has reached maturity, the chances of restoring normal joint function have decreased.

After joint lesions have occurred, the mental attitude of the patient seems to be one of the most important factors in determining how much joint function can be restored by surgery. There appears to be a higher correlation between the attitude of the patient and its ability to walk, than between the joint lesions present and the ability to walk. Therefore, the attitude of the dog should always be taken into consideration before giving a prognosis on these cases.

Another very important aspect of these cases concerns the possibility of some patellar luxations being inherited. The owner of each clinical case was told of this possibility and was advised against using his dog for breeding purposes. The purpose of this teflon implant surgery was to make the patient's life less painful, not to help perpetuate a condition which might be inherited.

Macroscopic tissue results

On necropsy of clinical case #110, it was found that the skin and subcutaneous tissues were well-healed in both legs. With the exception of expected amounts of scar tissue, there were no gross changes in the muscles or tendons. Both the medial and lateral patellar ligaments were completely healed. The patellae would not luxate in either a medial or lateral direction. Both teflon implants were in place and were covered by a thin connective tissue capsule. Very little, if any, bone resorption was present. The wires were in place and the twisted ends were encapsulated by connective tissue. The joint lesions did not appear to be any more severe than before the surgery.

Microscopic tissue results

The tissues from the operated stifle joints of one clinical case were studied. As a result of the surgery, the quadriceps femoris muscles and the quadriceps femoris tendons from the areas of the teflon implants showed various stages of degeneration and connective tissue infiltration. The synovial membranes lining the quadriceps femoris tendons in the surgical areas had an increase in the subsynovial connective tissue and an excessive infiltration of mononuclear leucocytes.

The connective tissue encapsulation of the teflon implants consisted of fibroblasts lining the teflon implant. The fibroblasts were surrounded by more mature connective tissue cells. Probably as a result of pressure necrosis, focal areas of coagulation necrosis had occurred in the capsule next to the teflon implant.

The periostea studied from the femurs which had been operated on had areas of periosteal cell stimulation and areas of degeneration. Mild pressure from the teflon implant on the periosteum resulted in periosteal stimulation. In the areas where the implant pressure on the femur was excessive, periosteal degeneration had resulted.

Where the stainless steel wire passed through the bone cortex, there was evidence of marginal necrosis. The wire opening was lined by connective tissue containing fibroblasts and mononuclear leucocytes.

Mild localized osteomyelitis was present in the areas of the stainless steel wires in both treated legs. Even though stainless steel wire is a relatively inert metal, it did produce local tissue irritation in the bone marrow of the dog.

Although lesions were present from surgical trauma and tissue repair, no adverse changes were observed which could interfere with the use of these two stifle joints. The lesions produced by the teflon implant appeared to be of little pathological or clinical significance.

SUMMARY AND CONCLUSIONS

1. Medial patellar luxations occur most frequently in the small breeds of dogs, such as the Pekingese, Boston Terrier, Manchester Terrier, Chihuahua and Toy French Poodle.

2. Medial patellar luxations can result from inherent or congenital deformities, traumatic blows or a combination of these factors.

3. The inherent or congenital patellar luxations are the most difficult to correct, especially if there is marked deformity of the distal end of the femur. A number of different surgical treatments have been advocated clinically to correct this condition.

4. A new surgical procedure employing a teflon implant was performed on 66 experimental legs and on 28 clinical legs. This procedure was used in clinical cases where the patellar groove was either very shallow or entirely absent. A medial deviation of the tibial crest was also present in many of these cases. The teflon implant functioned by keeping the quadriceps femoris tendon in proper alignment, which indirectly kept the patella in its proper position on the distal end of the femur. In young growing dogs the teflon implant also tended to return the tibial attachment of the quadriceps femoris tendon to its normal alignment.

5. All of the experimental dogs used in this study were

found to have normal values for hemoglobin, hematocrit reading, erythrocyte count, leucocyte differential count, serum glutamic oxaloacetic transaminase and serum glutamic pyruvic transaminase, both before and after surgery. Most of the experimental dogs' blood pictures did have a decrease of around 3,000 cells/mm.^{3} for 12-18 hours following the surgery. In many of the cases the erythrocyte counts, hemoglobin values and hematocrit readings dropped to a lower level than before surgery for a few hours after the anesthetic was given. Most of these values were still within the normal range, however. The differential leucocyte count frequently had an increase in lymphocytes for a few hours following the surgery. These effects were probably produced by the anesthetic, rather than by the surgical procedure. No abnormal changes were evident in the urine analysis, which included the urine color, specific gravity, reaction, albumin, sugar, methylene blue liver function test and urinary sediment.

6. The first radiographic tissue change noticed was a thickening of the periosteum two weeks following implantation. This change occurred on both the implant and wire sides of the bone. Bone pressure necrosis was diagnosed by radiographs on the 40th day following surgery. This necrosis also occurred on both the implant and wire sides of the femur. Excessive capsule formation, increased bone density, decreased bone density, wire breakage, osteomyelitis and osteoarthritis

were also tentatively diagnosed by means of radiographs.

7. The experimental dogs' stifle joints had the cardinal signs of inflammation for four to five days following the teflon implant surgery. The patients started standing cautiously on their hind legs in two to three days and were walking slowly in three to five days. It required two to three weeks for most of these cases to regain good use of their legs. Two dogs never regained full use of their right hind legs. One case was a two-year dog and the other a one-year dog. Both of these joints were free of any severe gross lesions and both were negative for pathogenic bacteria. Improper surgical implantation was probably responsible for these two failures.

8. The final reports obtained on the clinical cases indicated that 7 stifle joints had excellent postoperative results, 14 legs had satisfactory function of the stifle joints, 4 joints had some improvement, 1 leg had no change and no stifle joints were any more abnormal than before surgery. One clinical case was destroyed because of unsatisfactory clinical response to surgery and coexisting congenital skeletal defects.

9. All of the experimental cases had the expected tissue changes at necropsy, such as inflammatory changes and scar tissue deposition as a result of the teflon implant surgery. Some of the cases also had some undesirable tissue

changes, such as: excessive amounts of connective tissue surrounding some of the teflon implants, pressure resorption of some of the bones as a result of both the implant and the stainless steel alloy wire, osteoarthritis of some of the stifle joints, localized osteomyelitis of several femurs, an excessive volume of joint fluid in a few stifle joints, an occasional case of synovitis, some fibrosis of muscles and tendons and one case of chronic dermatitis with a fistulous tract. Most of the adverse tissue changes were caused by improper implant techniques, stainless steel alloy wire irritations or excessive movements of the implants as a result of a failure of some of the wires to hold properly the teflon implants.

10. The tissue changes studied microscopically varied greatly in these experimental cases, depending mainly on the length of time that had elapsed before examination, following surgery. The microscopic lesions present included various degrees of inflammation, degeneration and necrosis in the surgical areas of the skin, subcutaneous tissues, muscles, tendons, periostea, cortices, synovial membranes, bone marrows and articular surfaces. Connective tissue encapsulation had occurred around synthetic sutures, teflon implants and the stainless steel alloy wires. Most of the excessive tissue changes appeared to be caused by too much pressure of the teflon implants on the femurs, excessive movements of the

implants or stainless steel alloy wire irritations to the tissues. The most severe tissue changes were caused by _Staphylococcus aureus_ in two experimentally treated stifle joints. Evidence of neoplasms were not found, although a longer period of time may be necessary for this type of tissue change to occur.

11. As with all other surgical techniques, this teflon implant procedure has its specific indications and should not be used as a routine method to correct all medial patellar luxations in the canine species. This surgical procedure appears to have its best applications in the repair of severe inherent or congenital medial patellar luxations in young patients with shallow patellar grooves. If the surgery is done properly on an immature patient and the stifle joints show no evidence of osteoarthritis, good clinical results can be expected.

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