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Treatment of Colles Fractures With External Fixation

Robert R. Kaneda, D.O., Harrisburg, PA

ABSTRACT: Despite numerous papers advocating a variety of treatments for Colles fractures, the results have been less than satisfactory. From January of 1982 through March 1985, 49 patients were treated for Colles fractures with the A-O External Fixator. A total of forty-two were available for final review. Utilizing the criteria of Castaing, there were eleven patients with a good result, twenty-seven patients with a satisfactory result, four patients with a fair result and none with a poor result. The surgical technique is reviewed and complications outlined.

Claude Poteau[1] in 1873 described fractures of the distal end of the radius with posterior tilting or displacement of the distal fragment. Abraham Colles, however, has been the one most commonly associated with this fracture. His treatise "On the Fracture of the Carpal Extremity of the Radius" described the lesion without the aid of x-ray. Alfred Armand Velpeau coined the phrase of "Talon de Fourchette" or the silver fork deformity. Following the advent of x-ray, Barton and others have further broken down the fractures of the distal radius and separated the Colles fracture from other fractures of the distal radius.

The treatment of Colles fractures remains controversial. Forms of treatment[2,3,4] vary from closed reduction with long or short arm casting, closed reduction with functional cast bracing, closed reduction with pins and plaster and open reduction. This study seeks to evaluate closed reduction with external fixation utilizing the A-O External Fixator. An ongoing study has been established since January of 1982 through present. This study is limited to fractures of the distal radius covered by the pronator quadratus with posterior tilt of the distal radio-carpal articulation. The initial 49 patients in this ongoing study are presented here.

MATERIALS AND METHODS

Since January of 1982 through present all displaced Frykman Types III through VIII have been included in this study. Although the study is ongoing, no cases have been included after March of 1985 in order to allow a minimum of six months follow-up. Physeal fractures were excluded. Only Colles fractures were included. Smith's and Barton's deformities were not included. Type II and III open fractures were excluded. From January of 1982 until March of 1985, 49 patients were treated for Frykman Type III through VIII fractures of the distal radius. Seven of these were lost to follow-up. There were no bilateral fractures. Forty-two patients were available for review.

Initial data gathered at the time of injury included the patient's age, hand dominance, date of injury, date of surgery and injured extremity. The Frykman classification was then determined, and x-ray measurements (Fig. 1) taken, including palmar tilt, radial inclination and radial shortening. Radial shortening was measured from the tip of the radial styloid to the distal ulnar base excluding the ulnar styloid.

At the time of followup, x-rays were again obtained and the above mentioned measurements were repeated. (Table 1) the distal radio-carpal and distal radio-ulnar articulations were also evaluated for post-traumatic changes. Ranges of motion of the wrist were recorded for both extremities, as well as, pronation and supination of the forearm. (Table 3) A Jaymar Dynamometer was utilized at the time of follow-up testing both the fractured and non-fractured wrists.

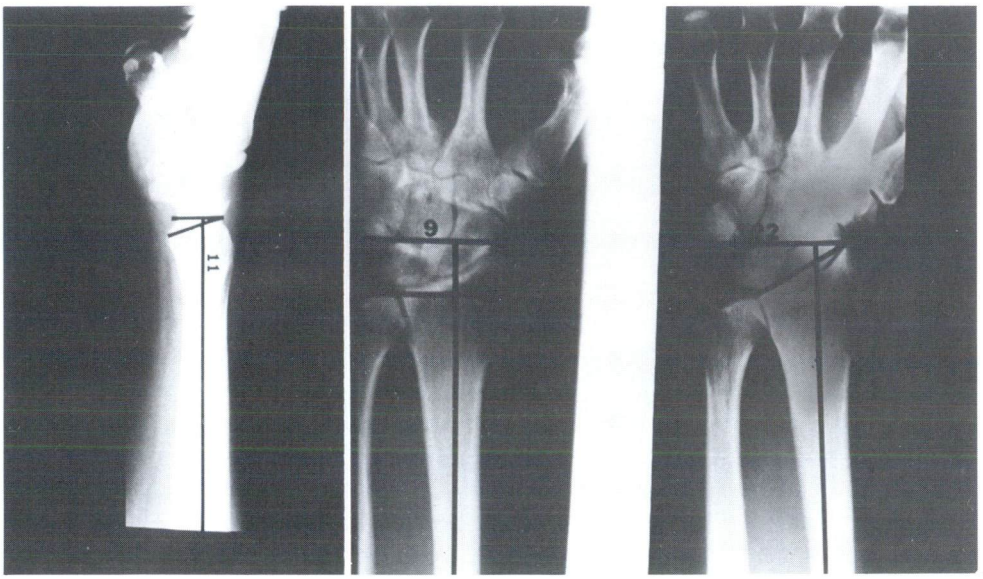


Fig. 1: X-Ray measurements utilized.

Fig. 1A: Volar tilt. **Fig. 1B: Radial length.** **Fig. 1C: Radial inclination.**

TECHNIQUE

The procedure is divided into two main stages. (Fig. 2 and 3) The initial stage is sterile with placement of the four pins. There will be two pins placed in the second metacarpal metaphyses and the two radial pins will be placed in the shaft of the radius proximal to the fracture site.

The arm is prepped in the usual fashion. Utilizing an image intensifier, the first pin is placed in the second metacarpal at the level of the distal metaphysis. The pin is angled 20-30 degrees from the perpendicular and 15 degrees dorsal to the coronal plane. The second pin is placed in the proximal metaphysis facing in a complementary orientation. A second pair of pins is placed in a similar orientation in the radius proximal to the fracture site. The pins are drilled percutaneously with release incisions if there is any tenting of the skin. Care must be exercised in placement of the proximal pin at the base of the second metacarpal. The drilling must be initiated dorsally enough to avoid the radial artery. When placing the radial pins, palpate the radius and find the area which is subcutaneous and be sure to avoid the sensory branch of the radial nerve.

After the release incisions are made, the pin puncture sites are dressed. If

TABLE I

Comparison of Pre-Operative and Final Follow-Up X-Ray Measurements

Palmar Tilt			
Pre-Op	**Range (Degrees)**	**– 15 to – 50**	**Average – 29**
Post-Op	**Range (Degrees)**	**+ 10 to – 15**	**Average + 0.5**
Degrees change pre-op vs. post-op range 10-58			
Radial Inclination			
Pre-Op	**Range (Degrees)**	**– 11 to + 20**	**Average 11**
Post-Op	**Range (Degrees)**	**+ 15 to + 40**	**Average 26**
Degrees change pre-op vs. post-op range 10-30			
Radial Length			
Pre-Op	**Range (MM) 0-7**		**Average 3**
Post-Op	**Range (MM) 9-15**		**Average 11**
Millimeters changes pre-op vs. post-op range 2-10			

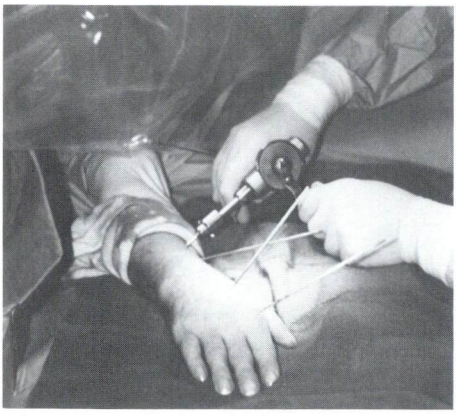


Fig. 2: Surgical technique.

Fig. 2A: Insertion of A-O pins percutaneously with image intensifier.

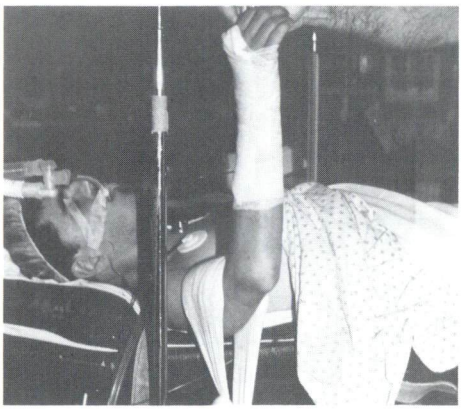


Fig. 2B: Arm is suspended by a thumb trap and weights applied for counter traction.

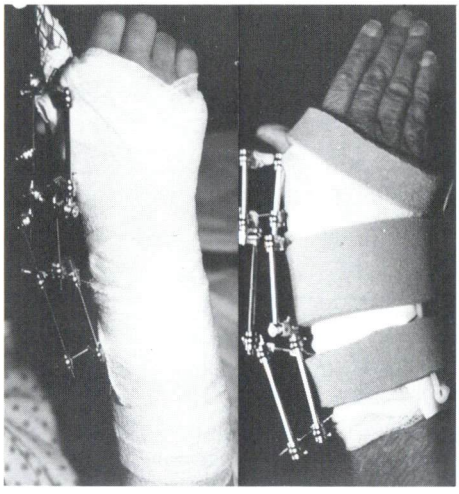


Fig. 2C: Reduction performed and external fixator applied.

Fig. 2D: Completion of procedure with external fixator and volar orthoplast splint.

percutaneous pins are not being used, the second stage of this procedure need not be performed in a sterile fashion. The external fixator is then ready to be constructed. The arm is suspended in finger traps with 15-20 lbs. of counter traction placed from a sling suspended from the brachium. Traction is then applied for 5 to 10 minutes to disimpact the fracture fragments. During the period of traction, the initial portion of the fixator is applied. After the traction has been applied, the wrist is brought into volar flexion to reduce the dorsal tilt. The connecting bars are then placed and the reduction checked with image intensification. The traction is discontinued and final x-rays are obtained.

A volar resting forearm splint is applied to strengthen the fixator in the bending mode. This is later converted to an orthoplast splint at the time of the initial redressing.

Post-operatively the hand is elevated for at least 24 hours. The pin sites are redressed three times weekly by cleansing with peroxide and application of Neosporin ointment. Active range of motion exercises of the hand, elbow and shoulder are initiated as soon as tolerated. The frame is maintained for six to eight weeks. When discontinued, the volar resting splint is continued for an additional two weeks. When the splint is discontinued, active range of motion exercises are started with progression to strengthening exercises.

TABLE II

Distribution of Fractures with Frykman Classification

Classification	#Patients	Classification	# Patients
III	1	IV	2
V	6	VI	3
VII	3	VIII	27

TABLE III			
Comparison of Ranges of Motion at Final Followup			
Wrist Flexion			
Fractured	Range (Degrees)	35-70	Average 53
Non-Fractured	Range (Degrees)	44-70	Average 59
Average loss of wrist flexion 6 degrees			
Wrist Extension			
Fractured	Range (Degrees)	15-65	Average 46
Non-Fractured	Range (Degrees)	50-70	Average 56
Average loss of wrist flexion 10 degrees			
Wrist Radial Deviation			
Fractured	Range (Degrees)	5-30	Average 21
Non-Fractured	Range (Degrees)	17-30	Average 24
Wrist Ulnar Deviation			
Fractured	Range (Degrees)	20-45	Average 31
Non-Fractured	Range (Degrees)	30-55	Average 41
Average loss of ulnar deviation 7 degrees			
Forearm Pronation			
Fractured	Range (Degrees)	11-90	Average 75
Non-Fractured	Range (Degrees)	71-90	Average 87
Average loss of forearm pronation 13 degrees			
Forearm Supination			
Fractured	Range (Degrees)	11-90	Average 75
Non-Fractured	Range (Degrees)	51-90	Average 80
Average loss of forearm supination 5 degrees			

RESULTS

Forty-nine Colles fractures Frykman Types III through VIII were treated from January, 1982 through March of 1985. (Table 2) Of these forty-nine, seven were lost to followup. This left forty-two fractures in forty-two patients for review. The following parameters were evaluated. The age range was from 27 to 93 years with a mean of 58 years.

DISCUSSION

The literature is replete with accounts of complications of Colles fractures. Although Abraham Colles' description was quite accurate considering its publication prior to the advent of x-ray, one must take issue with his conclusion that the functional prognosis is good despite the deformity.[5] The concensus is that the closer to anatomic the result, the greater the chance of a good result.[6] The goal of treatment of any periarticular fracture is painless motion with good strength. In an attempt to evaluate this treatment, both objective and subjective parameters were utilized. Whenever possible measurements were taken of both wrists for comparison. If not possible, as in the x-rays, accepted norms were used.

External fixation for treatment of intra-articular fractures of the wrist is not new.[7] Many different types of external fixators have been advocated. The A-O External Fixator provides a versatile unit which is easy to apply. It allows construction of two subframe units with reduction and application of the connecting bars with which you can control wrist flexion and ulnar deviation because of the universal joints in the coupling units.

The volar resting splint is applied to assist the external fixator in the bending mode — the weakest link in a single plane fixator. It also seems to evoke greater patient acceptance in regards to the external fixator. This orthoplast splint is continued two weeks after the removal of the external fixator. All external fixators were removed as an office procedure.

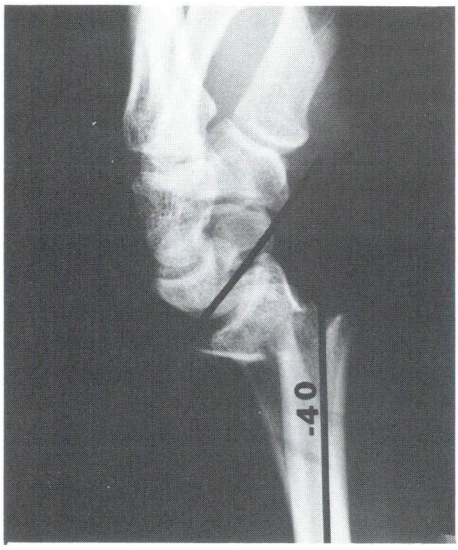


Fig. 3: X-ray case summary of a typical fracture.

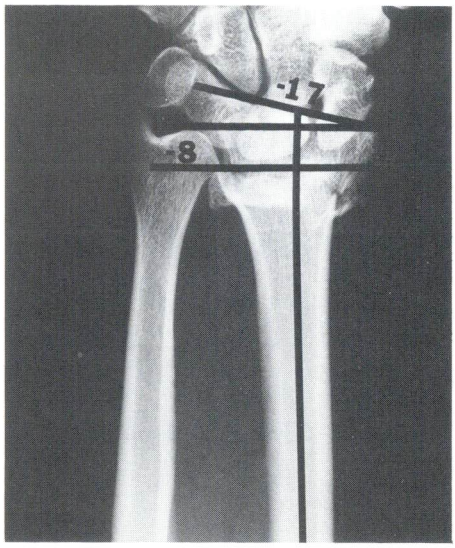


Fig. 3A: AP and lateral views of a typical Colles' fracture.

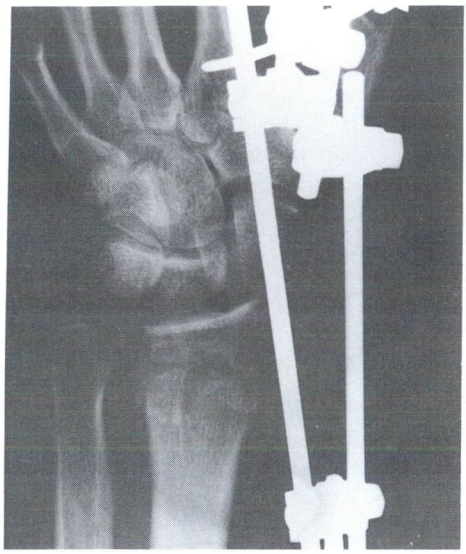
Complications of the external fixator included one broken pin, three pin tract infections, two cases of reflex sympathetic dystrophy and one loss of reduction. The single broken pin was in the proximal pair of pins and A-O now offers a pin of 15 mms. for the proximal pins. The three pin tract infections cleared with removal of the pins and treatment with oral cephalosporins. Cultures were obtained on one pin tract and Staph aureus was the organism isolated. Follow-up x-rays did not show osseous involvement. Reflex sympathetic dystrophy was seen in two patients. In one patient, early in the series, wrist flexion was too acute and may have been the initiating factor. Both responded to intense physical therapy, but both resulted in decrease finger and wrist motion. The single loss of reduction was secondary to inadequate initial reduction. Osteoporosis was universally seen without regard to age, but in all cases was reversible.

Treatment with the external fixator does not require circumferential enclosure of the fractured wrist as treatment with pins and plaster and plaster cast alone. This greatly reduces the amount of digital swelling. This intense digital swelling often requires bivalving of the cast with greater risk of loss of reduction. With less digital swelling, it is easier to start the rehabilitation program of active range of motion exercises of the hand, elbow and shoulder.

The external fixator is more labor intensive than other conventional forms of treatment. It requires constant cleaning of the pin sites, although with improvements in home nursing and compliant family members, the pin care can be handled in the home environment. If these support measures are not available, or if the patient is not compliant, then alternative forms of treatment should be considered.

Taleisnik and Watson[8] gave the following normals for x-ray measurements: Palmar tilt +11 degrees, radial inclination or angulation +22 degrees and radial length 9 mms. Radial length was measured from the tip of the radius to the base of the distal ulna excluding the ulnar styloid.

Palmar tilt pre-operatively measured an average of −29 degrees with a post-operative average improvement to +0.5 degrees. The average improvement when comparing pre and post-operative measurements was 28 degrees. Although this represents a considerable improvement, this parameter was the most under-corrected of the x-ray parameters. Correction to essentially 0 degrees was compatible with a



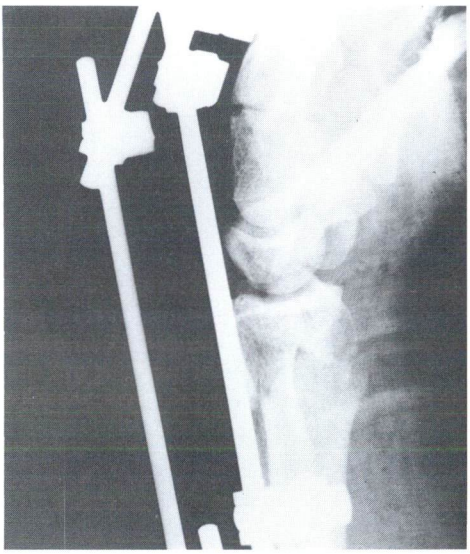


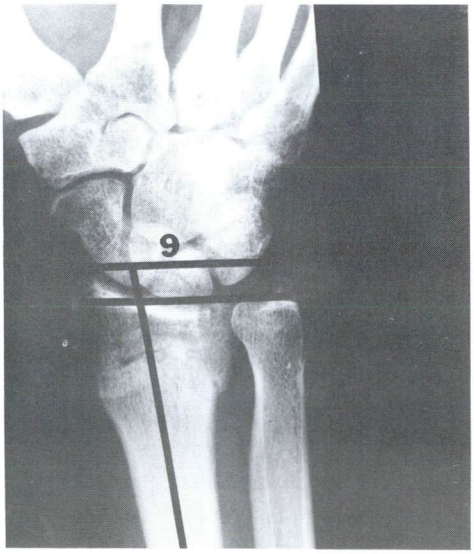
Fig. 3B: AP and lateral views of the fracture after reduction.

satisfactory range of motion and grip strength.

The normal radial inclination is 22 degrees with a range from 12 to 30 degrees. The average radial inclination pre-operatively was 11 degrees. This improved to an average of 26 degrees post-operatively. This yielded a net average improvement of 16 degrees. It appears that the radial inclination was restored with the external fixator.

The normal radial length was given as 9 mms. The average pre-operative radial length was 3 mms. The average post-operative radial length was 11 mms. with an average improvement of 7.7 mms. The radial length is adequately restored with the external fixator.

Comparison of the ranges of motion between the fractured vs. the unfractured indicates excellent restoration of



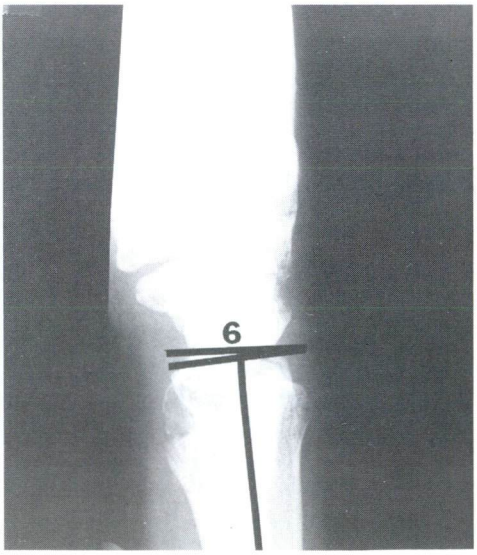


Fig. 3C: AP and lateral views of the fracture at the final x-rays showing restoration of the radial length, inclination and improvement in volar tilt.

TABLE IV

	Castaing's Parameters (From Ricciardi and Diquigiovanni)	# of Patients
Good	**No pain. Normal articularity Maintained muscular strength**	**11**
Satisfactory	**Occasional pain, not limiting function Flexion-extension between 25-40° Abduction-adduction between 15-30° Pronation-supination between 90-150° Normal muscular strength**	**27**
Fair	**Pain with any limitation of motion Flexion-extension between 15-25° Abduction-adduction between 0-15° Pronation-supination between 0-90° Poor muscular strength**	**4**
Poor	**Incapacitating pain Flexion-extension between 0-15° Heavily limited abduction-adduction, and pronation-supination Insufficient muscular strength**	**0**

range of motion. Mean wrist flexion was 89% of the unfractured side. Mean wrist extension was 82% of the unfractured side. Mean wrist radial deviation was 87% of the unfractured side. Mean wrist ulnar deviation was 75% of the unfractured side. Mean pronation was 62% and supination 93% of the unfractured side.

In Table 1 Castaing's parameters[9] were applied to the patient population. Eleven patients were deemed as good and 27 as satisfactory. In that group of 27 patients, nine would have been in the good category, except that there was a minimal joint incongruity present on the x-rays. All other conditions were met otherwise.

Grip strengths were evaluated at the time of clinical review. This was done by comparing the grip strengths of the injured and non-injured wrists. A factor of ten percent was utilized to accommodate hand dominance. A range of grip strength from 12 kgs. to 44 kgs. was obtained with an average decrease in grip strength of only 0.8 kgs. when comparing injured to non-injured wrists. This would appear to indicate that residual weakness was not a problem in the injured wrists.

CONCLUSIONS

1. The A-O External Fixator offers a reasonable alternative form of treatment for Frykman Type III-VIII fractures of the distal radius and ulna.
2. With reasonable care, the complications inherent in treatment of distal radial fractures in general and with external fixators specifically can be minimized.
3. Radial inclinations and length can be adequately restored. Palmar tilt can be improved, but not restored but the amount of correction obtained is enough for good results. Grip strength is also restored.
4. Range of motion in the fractured wrist was adequately restored with use of the A-O External Fixator.
5. The external fixator obviates the need for circumferential immobilization giving the added bonus of reduced edema and more rapid rehabilitation.
6. The external fixator should not be used in stable fractures of the distal radius. Care must be taken in patient selection in order to avoid

complications in the care of the external fixator.

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Marmor Modular Unicompartmental Arthroplasty of the Knee A Two to Eleven Year Follow-up

Jeffrey Gorosh, D.O., John Swienckowski, D.O., B.J. Page, II, D.O., Farmington Hills, MI

ABSTRACT: A retrospective review on the use of the Marmor unicompartmental arthroplasty at this institution was performed. 118 underwent this procedure between 1975 and 1987. In 41 patients (49 knees) the follow-up has been greater than 2 years, forming the basis of this report. The patients were interviewed and examined both clinically and radiographically. The results were analyzed utilizing 3 knee-rating systems:

the Hospital for Special Surgery,
the Cleveland Clinic modified by Slocum and Larson and
the knee rating system described by Marmor.

Satisfactory results were found in 96% of the patients reported here and the results are consistent with most other authors reporting on the procedure.

INTRODUCTION

Unicompartmental replacement arthroplasty of the osteoarthritic knee has been in clinical use for the past 14 years, however, its efficacy and rationale for its use remains somewhat controversial. The Marmor knee replacement is an unconstrained prosthesis designed to allow normal rotation of the knee joint. The rationale for its use involves the fact that only the abnormal articular surfaces are removed, minimal bone is sacrificed and the procedure is readily revisable should this become necessary.

Unicompartmental arthroplasty for single compartment joint disease is an attractive alternative procedure to high tibial osteotomy. The majority of authors have reported favorable short and long term results and advocate its use within specific indications,[1-12] however, other authors have criticized its use because of poor results.[13-16]

By 1983, the reported cases found in the orthopedic literature exceeded 1000 cases and the overall results were favorable with an average of 79% good to excellent results.[17]

Marmor first reported his technique and satisfactory results in 79% of cases using single and bicompartmental prostheses in 1973.[23] He reported similar success rates with unicompartmental arthroplasties of the lateral compartment in 1983 (11/14 excellent results (79%). In 1976 Marmor reported on 126 cases with a minimum follow-up of 2 years, finding good to excellent results in 88% of cases.[11]

More recently, Marmor reported on a total of 87 unicompartmental arthroplasties performed between 1972 and 1981 with a minimum follow-up of 5 years. This review revealed a 75% success rate for single compartment arthroplasties and a similar success rate for bicompartmental arthroplasty.[1]

Other authors have reported a significant number of cases with an equal or greater success. Englebrecht reported 85% satisfactory results on 169 cases.[24] Scott reported 92% satisfactory results in 100 cases[18]; and Jones reported on 207 cases, finding satisfactory results in 89% of the cases. Numerous other studies revealed similar encouraging results.[3, 4, 5, 8, 10, 18, 19, 20, 21]

It is, however, significant to note that experience with unicompartmental modular arthroplasty has not been uniformly reported favorably. In 1976 Insall reported only a 65% satisfactory results and 17% failure rate suggesting that there was no role for unicompartmental replacement athroplasty in the treatment of osteoarthritis.[15] Laskin in 1978 reported a similar failure rate in 37 cases.[14] Mallory in 1983 also

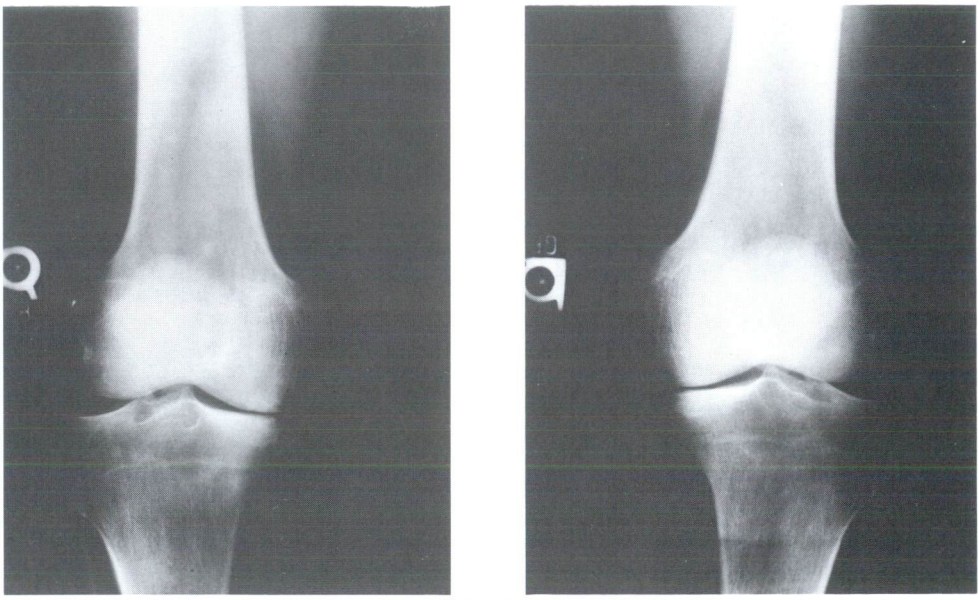
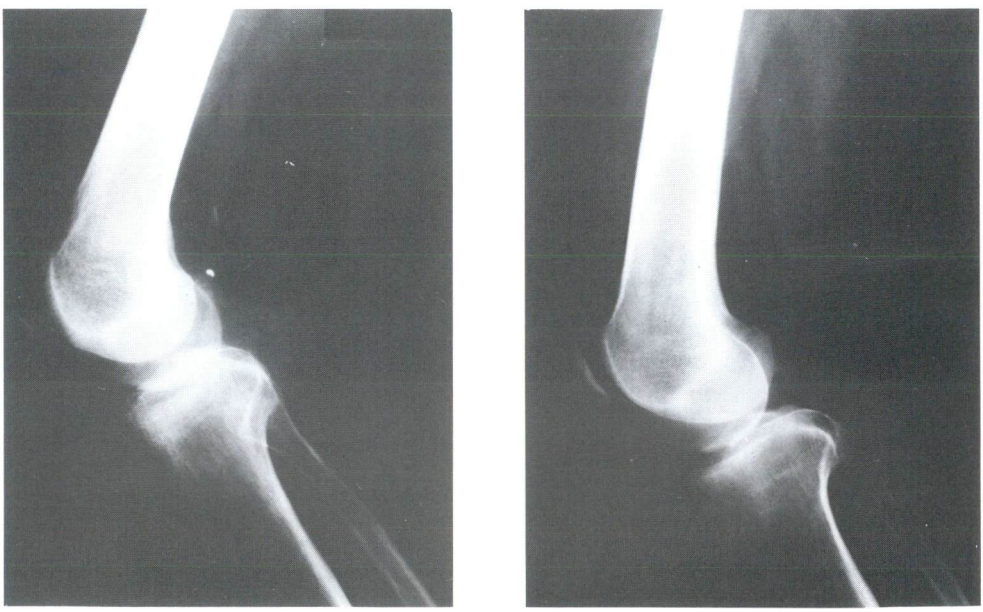


FIGURE 1.
Pre-Operative X-Rays: Bilateral standing AIP and lateral radiographs of a 1/9 Y.O. male with sclerosis. Degenerating arthritis primarily involving both medial compartments.

reported on 65% satisfactory results in a series of 21 patients.[22] In addition, in 1981 Cameron reported 70% unacceptable results in a review of 83 cases of unicompartmental arthroplasty.[13] He has since, however, expressed improved surgical results with the subsequent cases he himself has performed in properly selected patients.[17]

MATERIALS AND METHODS

All Marmor unicompartmental modular arthroplasties performed by two orthopedic surgeons at Botsford General Hospital were reviewed. The purpose of this study was to analyze the results of our experience utilizing this particular unicompartmental arthroplasty. 118 consecutive patients



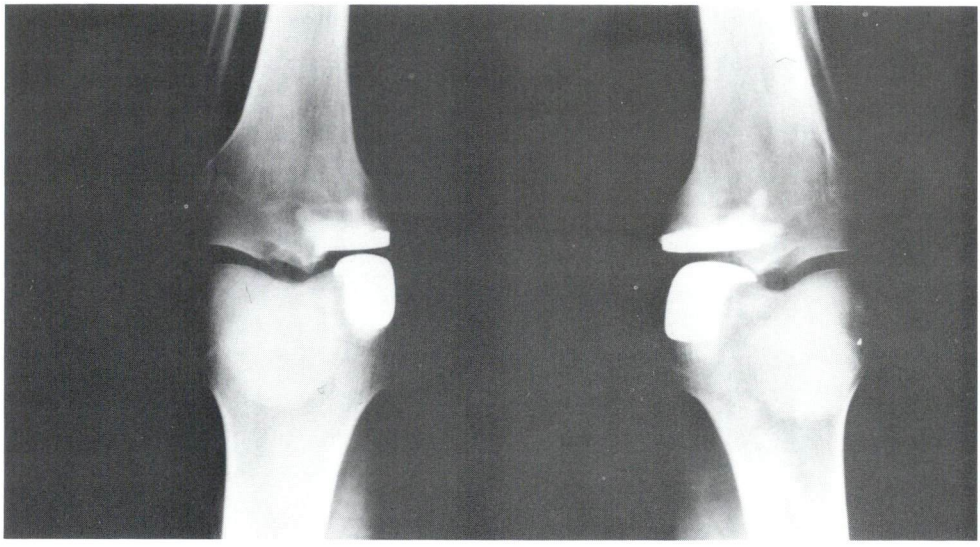


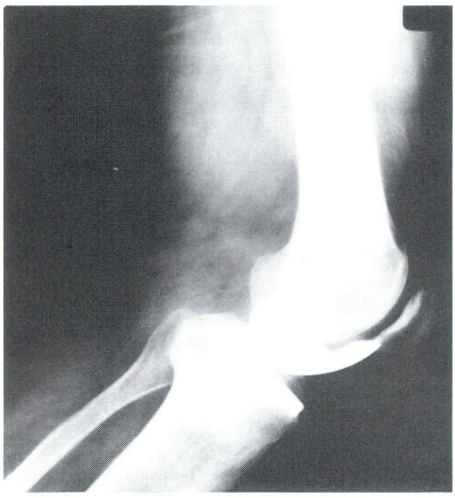
FIGURE 2.

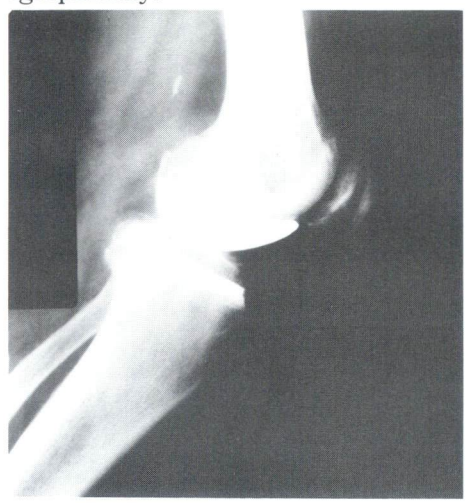
Bilateral Standing AIP lateral radiographs obtained at a 36 months post-operative examination, revealing satisfactory alignment of both the femoral and tibial components. No advancement of degenerative changes in the uninvolved compartments, and no evidence of component loosening.

underwent single compartment replacement arthoplasties of the Marmor modular knee type between 1975 and 1987. The average follow-up was 37.9 months, (range was 24 to 110 months.) In 49 patients the follow-up period has been greater than two years.

Two patients died in the follow-up period due to causes unrelated to their surgery. Four patients were lost to follow-up and two patients refused to return for re-examination and interview. 49 knees in 41 patients were analyzed with a follow-up of greater than two years.

The average age at the time of surgery was 69.5 years (range was 52 to 85 years). There were 17 males and 24 females. All 49 procedures were medial compartment arthroplasties. There were 27 left knees and 22 right knees. A thin, 6 mm tibial component was used in only one knee. The thicker 9 mm to 18 mm components were used in the remaining cases (9 mm — 22; 12 mm — 16; 15 mm — 5; and 18 mm — 1.) Thickness of the component was not recorded in 4 knees, however, all appeared to be thicker components (greater than or equal to 9 mm) radiographically.





MARMOR RESULTS

Table I

Excellent	**No Pain**	**>90° Flexion**
Good	**No Pain**	**<90° or Mild Pain >90°**
Fair	**Moderate Pain**	**>90° Flexion**
Poor	**Severe Pain**	**Less flexion than after surgery**

In all patients, the procedure was performed for incapacitating pain from osteoarthritis that was presumed to primarily involve the medial femorotibial compartment. Preoperatively there was no clinical evidence of degeneration of the patellofemoral or lateral femorotibial compartments. If gross findings contradicted this, intraoperatively, total knee arthroplasty was performed. Indications for single compartment arthroplasty as described by Marmor were followed in all cases.[1]

The pre-operative range of motion (R.O.M.) was not uniformly recorded in all patients. Postoperative ROM and any varus or valgus deformity was recorded in all patients. Radiographs were available on all patients, both pre- and postoperatively; standing A-P and laterial radiographs were analyzed for evidence of component loosening or deformity, malalignment, or advancement of degenerative arthritis of the uninvolved compartment.

TABLE II

KNEE RATING SCALE

PAIN (30 points)	
No pain at any time	**30**
Mild pain on walking	**10**
Moderate pain on walking	**5**
Severe pain on walking	**0**
No pain at rest	**15**
Mild pain at rest	**10**
Moderate pain at rest	**5**
Severe pain at rest	**0**
FUNCTION (22 points)	
Walking and standing unlimited	**12**
Walking distance of 5-10 blocks and standing ability intermittent > ½ hour	**10**
Walking less than 1 block	**4**
Cannot walk	**0**
Climbing stairs	**5**
Climbing stairs with support	**2**
Transfer activity	**5**
Transfer activity with support	**2**
RANGE OF MOTION (22 points)	
1 point for each 8° of arc of motion to a maximum of 18 points	**18**
MUSCLE STRENGTH (10 points)	
Excellent: cannot break the quadriceps power.	**10**
Good: can break the quadriceps power	**8**
Fair: moves through the arc of motion power	**4**
Poor: cannot move through arc of motion	**0**
FLEXION DEFORMITY (10 points)	
No deformity	**10**
Less than 5°	**8**
5-10°	**5**
More than 10°	**0**
INSTABILITY (10 points)	
None	**10**
Mild	**8**
Moderate: 5-15°	**5**
Severe: more than 15°	**0**
SUBTRACTION:	
One cane	**1**
One crutch	**2**
Two crutches	**3**
Extention lag of 5°	**2**
Extension lag of 10°	**3**
Extension lag of 15°	**5**
Each 5° of varus	**1**
Each 5° of valgus	**1**

RESULTS

Forty-nine knees are reported in forty-one patients who underwent modular unicompartmental arthroplasty of the medial compartment of the knee. The results were recorded as outlined below. The first knee rating utilized is the least complex and involves using pain and range of motion as described by Marmor (Table I).

The second knee evaluation system utilized is the Cleveland Clinic System modified by Slocum and Carson.[11] A total of 100 points was possible based on function (35 points), pain (35 points), gait (10 points), range of motion (10 points), and absence of deformity or instability (10 points.) (Table II)

The third knee rating system utilized was that from the Hospital for Special Surgery (H.S.S.). Again, a total of 100 points was possible based on pain (30 points), function (22 points), R.O.M. (18 points), muscle strength (10 points), ligamentous instability (10 points), and flexion deformity (10 points.) (Table III)

The above rating systems were utilized in each case where available and applicable (39 out of 41 patients).

Based on the Marmor knee rating system there were 31 excellent and 14 good results (satisfactory result in 45 of 49 knees — 92%). There were 3 fair results and only one failure. Evaluation by the Cleveland Clinic and Hospital for Special Surgery ratings revealed similar success rates. The H.S.S. rating system revealed 33 excellent, 11 good, 1 fair and 1 poor results (satisfactory results in 44/46 knees — 96%). Two patients (3 knees) were unavailable for detailed interview and examination necessary for application of the H.S.S. and the C.C. rating systems. The C.C. rating system also produced similar results: 34 excellent, 10 good, 1 fair and 1 poor result (satisfactory results in 44/46 knees — 96%).

The patient considered a fair result underwent above-the-knee-amputation of the leg 59 months after undergoing unicompartmental arthroplasty. Physical examination and interview were performed one month prior (at 58 months follow-up) revealing a ROM of 0-90°; the patient, although he admitted to having mild intermittent knee pain, complained of severe bilateral leg pain secondary to advanced atherosclerotic vascular disease. This patient was graded as fair by the Marmor grading system. There was no evidence of advanced vascular disease noted at the time of initial surgery.

TABLE III

KNEE EVALUATION SHEET

FUNCTION: Fill in each block	
Does most of the housework or job which requires moving about	**5**
Walks enough to be independent	**5**
Dresses unaided (includes tying shoes and putting on socks)	**5**
Sits without difficulty at table or toilet, including sitting down or getting up (reduce if additional aid is necessary)	**4**
Picks up objects from floor by squatting or kneeling	**3**
Bathes without help	**3**
Negotiates stairs foot over foot	**3**
Carries objects comparable to suitcase	**2**
Gets into car or public conveyance unaided and rides comfortably	**2**
Drives a car	**1**
FREEDOM FROM PAIN: (Max. 35 points) (Fill in one only)	
(1) No pain	**35**
(1) Mild pain with fatigue	**30**
(1) Mild pain with weight-bearing	**20**
(2) Moderate pain with weight-bearing	**15**
(3) Severe pain with weight-bearing, mild or moderate at rest	**10**
(4) Severe continuous pain	**0**
RANGE OF MOTION (10 points)	
Extension_____ Flexion_____	
Total range of motion (Normal 150°)	
ABSENCE OF DEFORMITY OR INSTABILITY (Maximum 10 points)	
No flexion deformity over 10° with weight-bearing	**2**
No flexion deformity over 20° with weight-bearing	**1**
No varus or valgus deformity over 10° with weight-bearing	**2**
No varus or valgus deformity over 20° with weight-bearing	**1**
No ligamentous instability	**2**
No heat	**2**
No heat over 1+	**1**
No swelling	**2**
No swelling over +1	**1**
COMMENTS:	
TOTAL SCORE: (Out of 100)	

Another patient considered a failure, underwent modular arthroplasty for medial compartment arthritis with the insertion of 9 mm tibial component. Postoperatively, this patient complained of severe pain on ambulation and radiographs revealed obvious

loosening and subsidence of the tibial component. This patient underwent revision surgery approximately 15 months later with the insertion of an 18 mm component. Follow-up examination 33 months later revealed total motion arc of 8° to 110° and the patient ambulated pain-free without assistive device. The initial procedure was rated a failure, however, the revised knee was graded excellent by all 3 rating systems.

The patients followed in this study all had severe pain with weight bearing preoperatively and this was the primary indication for surgery. Relief of pain was considered excellent if the patient had no pain with activities of daily living as well as at rest. Good pain relief was defined as only mild aching with activity. 26 of 41 patients (33 knees) interviewed reported complete relief of pain postoperatively. 14 patients (15 knees) reported only mild pain with activity. Only one patient (1 knee) complained of severe pain postoperatively, and as discussed above, this patient subsequently underwent revision surgery which was successful.

The average range of motion preoperatively was not uniformly recorded. The average flexion postoperatively was 116° (range 70° to 140°). Flexion contractures were found in 11 of 49 knees examined (range 5° - 15°). There were no cases of residual varus or valgus deformity or ligamentous instability found at re-examination.

There was no radiographic evidence noted regarding advancement of degenerative arthritis in the lateral femorotibial compartment. Excluding the tibial component failure previously mentioned, there were no cases noted of significant radiolucency below the tibial component at the cementbone interface. No infections or delayed wound healing problems were encountered in this series. Prophylactic perioperative antibiotics were used in all cases and surgeries were performed with laminar air-flow.

There were no major neurologic complications encountered and no documented cases of thrombophlebitis or deep vein thrombosis. Pulmonary embolus prophylaxis was utilized in each case (p.o. aspirin — 5 gr. bid, or subcutaneous Heparin 5000 u bid.) Cases performed from 1983 to present were placed in a C.P.M. (Continuous passive motion) machine 1- 2 days postoperatively. Patients were ambulated full weight-bearing to tolerance 1-3 days postoperatively.

Only one 6 mm tibial component was used in a patient with a follow-up of 44 months — there was no radiographic or clinical evidence of loosening in this patient.

DISCUSSION

Unicompartmental replacement arthroplasty is emerging as an acceptable alternative to high tibial osteotomy for the treatment of a single compartment osteoarthrosis of the knee in the properly selected surgical patient.

For unicompartmental arthroplasty the generally accepted criteria have been clearly defined and are fairly strict. Adherence to these criteria is a critical factor in the success of the procedure. Major boney deformity and rheumatoid arthritis are contraindications to the procedure. Lateral compartment disease, though not addressed in this study, has been shown to be effectively treated by the modular arthroplasty. Occupational responsibility, activity level, age, and weight are strong considerations in determining the treatment of choice for unicompartmental osteoarthritis.

Advantages of single compartment modular replacement include the preservation of normal joint surfaces, the rapid recovery, early ambulation, and the almost uniformly reported paucity of significant complications.[25]

Long term follow-up is necessary, as in any study, to fully evaluate the incidence of late loosening, infection, and changes involving the non-operative compartment; however, in patients who are poor candidates for proximal tibial osteotomy and who have truly unicompartmental disease, modular unicompartmental replacement arthroplasty provides an important alternative in treatment.

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Analysis of Continuous Passive Motion as a Modality of Deep Vein Thrombosis Prophylaxis and Rehabilitation in Total Knee Arthroplasty

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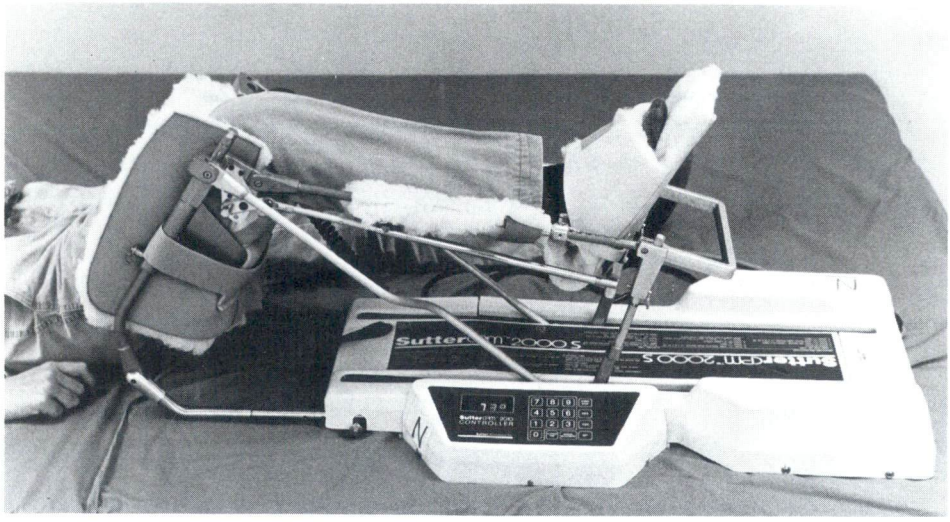
ABSTRACT: In 84 patients 90 total knee arthroplasties were reviewed. 70 had CPM post-operatively and 20 did not. No statistical difference was found in ambulation time between the two groups, however, there was a statistically significant increase in the arc of motion, and a shorter hospital rehabilitation time in those receiving CPM. Of the 90 knees 40 had post-operative dopplers and 4 DVT's were detected. No statistical significance was found between those receiving CPM and the incidence of DVT. Small sample size restricts conclusions of risk factors and prophylactic measures for DVT. A high incidence of patella dislocation and subluxation was found in knees receiving CPM.

INTRODUCTION

This study is a retrospective analysis of the population of total knee arthroplasties in our institution over the last four years. Its purpose is to identify risk categories amongst this population, review the means of prophylaxsis for deep vein thrombosis, the methods of detection, and its incidence. Its main objective is to analyze the effect of continuous passive motion, (CPM), as a means of accelerating rehabilitation in terms of obtaining an improved arc of motion of the knee, faster graduation to independent ambulation, decreasing hospital days, and as a means of prophylaxis for deep vein thrombosis, (DVT).

MATERIALS AND METHODS

During the period of January, 1982 to April, 1986, eighty-four patients underwent ninety total knee arthroplasties. Three of these underwent bilateral simultaneous total knee arthroplasties and four had revisions. The average age in this study was 64.8 with a range from 43 to 88 years of age. Fifty-two right knees and thirty-eight left knees were operated, eighty-four for degenerative arthritic deformities, three for rheumatoid arthritic deformities, and three for component revision. Thirteen knees had surgery and four had fractures of the knee prior to arthroplasty. Sixty-five RMC, thirteen Townley, eight Tricon, three PCA, and



one Guepar prosthesis was employed for total joint arthroplasty. Continuous passive motion was employed on seventy knees post operatively. The number of days implemented was dependent on the patient's ambulatory status, and the discretion of the attending physician. The patient was placed in the CPM device immediately post operatively in the Recovery Room. An arc of 0 to 40 degrees was initially employed and decreased, if not well tolerated, within twenty-four hours. After forty-eight hours, the CPM arc was increased by ten degrees per day unless not tolerated by the patient. The maximum arc obtainable was one hundred and ten degrees of flexion. Patients were encouraged to remain in the machine at all times while supine in bed.

The arc of motion of the knee preoperatively and on the day of discharge was recorded for each patient by goniometer evaluation by physical therapy. In those cases where this analysis was not recorded, the values were obtained from either the resident's or attending's daily notes. The total number of hospital days from the day of surgery to the day of discharge were recorded, as well as the number of days it took the patient to ambulate twenty-five feet with minimal assistance.

To calculate risk factors and prophylactic measures for DVT, the original population of ninety knees had to be sorted by Doppler evaluation. Only those having postoperative Dopplers were utilized. Doppler and plethysmography studies in our facility were instituted in 1982. Plethysmography was initially utilized in some evaluations but was not popular.

Twenty cases had preoperative Dopplers and eight had preoperative plethysmography, each involving one bilateral simultaneous arthroplasty. Thirty-eight cases had postoperative Dopplers with two cases involving bilateral knee arthroplasty, and five cases had postoperative plethysmography. Thirteen cases had both a pre and postoperative Doppler analysis for DVT.

Three cases had ventilation-perfusion scans and three had postoperative venography after a suspicious Doppler study.

Five different modalities of prophylaxis for DVT were employed. These were prescribed to patients on the basis of their medical status and risk factors as determined by the internal medicine consults and the discretion of the attending or resident managing the case. No specific protocol was adopted by the hospital on prophylaxis administration.

Eight knees were prophylaxed utilizing low molecular weight dextran, (LMD), three of which also received five grains of aspirin BID. Seven knees had sequential compression device hose, (SCD's), five of which also had five grains of aspirin administered on a BID regimen, and one was prophylaxed with subcutaneous Heparin, 5,000 units BID. Two aspirin regimens were utilized. Fifty-six knees received five grains of aspirin on a BID regimen and nineteen knees received ten grains of aspirin on a BID regimen. Seven cases received no means of prophylaxis. Twenty-one cases received their means of prophylaxis on the same day of surgery and fifty-two on the day prior to surgery. In the sorted sample of those with postoperative Dopplers, four had no means of prophylaxis, three had SCD's, all with concurrent aspirin therapy, five had LMD, twenty-four had aspirin, five grains BID, six had ten grains BID, and one had subcutaneous Heparin, 5,000 units BID. Of these, twenty-five were placed in TED hose postsurgically. Of these forty, twenty-seven had prophylaxis starting one day prior to surgery and ten the day of surgery.

At risk categories could only be applied to the subpopulation of forty knees. Risk factors investigated were GI disease, because of the restriction of prophylaxis, previous DVT, obesity, hypertension, heart disease, diabetes, venous insufficiency as diagnosed by Doppler, and tourniquet time. Other factors also investigated were preoperative medications such as long term aspirin or Coumadin therapy and use of non-steroidal antianflammatories.

Post operative complications and the necessity for manipulations under anesthesia of the knees for poor range of motion were noted as a matter of record.

RESULTS

The first series of analyses involved dividing the population of ninety knees into those receiving continuous passive motion and those that did not. CPM was employed on seventy of the knees. The average number of days instituted for treatment was eight days with a range from two to fifteen. The average number of days for ambulation of twenty-five feet with minimal physical therapy assistance and then with an assistive walking device with CPM was 5.6 days and 6.3 days without. No statistical significance utilizing the T test could be attributed to the use of CPM as a means of faster progression of ambulation, (T greater than .05). Hospital days measured from the day of surgery to discharge averaged 10.8 with CPM and 13.0 without. This difference in hospital days was demonstrated to be statistically significant according to the T test, (T less than .05).

The average initiating arc of the CPM machine post surgery was 0 to 40 degrees of flexion. The end arc at the time of termination of CPM was 2.5 degrees to 81.1 degrees. The average arcs of motion of both groups were analyzed prior to surgery and at the time of discharge. For non-CPM knees, ten had pre and postoperative evaluations with the average presurgical having 97.5 degrees of motion and postsurgical 69.4 degrees of motion. For CPM knees, forty-six had pre and postsurgical evaluations with the average presurgical knee having 101.5 degrees of motion and the postsurgical with 76.6 degrees of motion. There was no statistical significance between the initiating arcs, however, the T test was significant, (T less than .01), for the postsurgical arcs, indicating CPM did statistically increase the total arc of motion.

The sample of forty knees with postoperative Dopplers was used for evaluation of the incidence of DVT with CPM and potential risk factors. The initial postoperative Doppler was performed on an average of 5.8 days after surgery on forty knees. Second postoperative Dopplers were performed on sixteen knees on an average of 12.2 days after surgery, and one knee had a third postoperative Doppler.

Of this sample of thirty-three knees with CPM, two developed a DVT, (six per cent), one with posterior tibial and common femoral involvement, and the other with common popliteal involvement, both of the surgerized leg. Seven did not have CPM, two (29 percent) of which developed a DVT, one involving the common popliteal and the other the superficial femoral, both of the surgerized leg. A significant relationship, (P less than 0.135) between the incidence of DVT and CPM utilization was not observed using Fishers exact T test, however, it should be noted that the size of the DVT sample was very small.

Only two of the four cases received anticoagulation therapy involving five to seven days of intravenous Heparin followed by oral Coumadin.

In evaluating risk factors and prophylactic regimens, the sample size of DVT was small which made the statistical evaluation utilizing Chi square analysis hazardous. The only statistically significant risk factor found was in individuals having a history of ulcer disease. Three of the four individuals with DVT also had a history of ulcer disease. Of these three individuals one received aspirin, five grains BID, one LMD and one no means of prophylaxis.

Tourniquet time for each arthroplasty was evaluated for potential DVT risk. For the thirty-six knees not developing a DVT, the average tourniquet time was 1.7 hours and in those that developed a DVT, 1.9 hours of which there was no statistical significance. Other correlations of risk factors and prophylactic measures are noted in table I.

In analyzing the results of Doppler evaluations, nine postoperative Dopplers were initially reported as suspi-

cious or positive. Of these, four were found negative for DVT when repeated, two of which were documented as consistent with edema. One knee had a positive pre and postoperative Doppler for DVT, the postoperative Doppler varying from the initial, indicating a potentially new DVT. One knee had a positive post Doppler study, which venography confirmed as the result of an old clot. Two cases had positive post operative venograms and Dopplers consistent with DVT. One case was diagnosed as being positive for DVT based on one positive postoperative Doppler study.

Because venography was not performed on all suspicious Doppler reports, a true sensitivity specificity could not be obtained. However, three out of the five positive final Doppler studies were confirmed by venogram.

Of ninety total knee arthroplasties, twenty-one, (twenty-three per cent), developed postoperative complications. Five cases had problems with wound healing and effusion and five developed other organ complications. There was one case of fracturing of the femur during surgery. Eight total knees developed a subluxing or dislocating patella, which resulted in a secondary surgery to correct the problem, and two cases progressed to above knee amputations. Three cases required a manipulation under anesthesia, two of which did not receive CPM.

DISCUSSION

The literature on DVT as a consequensive of total knee arthroplasty has been very limited.[42] Concern has arisen as total knee arthroplasty has become more common. With the incidence of thromboembolic disease as a common complication of elective orthopedic surgery, particularly hip surgery, and the incidence of fatal pulmonary emboli occurring in two per cent of the cases[15] and constituting ten to fifty per cent of all orthopedic mortalities[29], the need for DVT investigation in total knee arthroplasty is warranted.

In our study, the incidence of DVT was ten per cent, all of which were associated with above calf involvement. Three of the four cases had received prophylaxis, with low dose aspirin, five grains BID and one received LMD on the day of surgery and second postoperative day. This ten per cent is consistent with data by Stulberg[42], who using venography found an overall DVT incidence of fifty-seven per cent of which eleven per cent had popliteal and thigh involvement. It also corresponds with those results by Lotke with 3.4 per cent thigh involvement. Other studies have demonstrat-

TABLE I

Sample — 40 knees

Risk Factors	# Involved	# DVT with risk Factor	Statistical Significance
Sex	29 females 11 males	1 female 3 males	—
Venous Insufficiency	11	2	—
Hypertension	20	3	—
Diabetes Mellitus	3	1	—
Ulcer Disease	6	3	+
No Prophylaxis	4	1	—
Prophylactic Modalities	**# Involved**	**# DVT with Prophylaxis**	**Statistical Significance**
Nonsteroidal Anti-inflammatory agent	21	3	—
TED hose	25	1	—
ASA v grains Bid	27	3	—
ASA x grains Bid	6	0	—
SCD hose	0	0	—
LMD	6	1	—

ed an overall rate of about forty to seventy per cent occurrence of DVT in the calf, popliteal and thigh regions with varying prophylactic measures.[5,22,26] The high incidence of DVT with bilateral simultaneous knee arthroplasty[42] and those with no prophylaxis[22,42] was not found in this study, however, our sample size was only two and four respectively.

Three of the four cases of DVT had ventilation-perfusion scans, all with negative results, which was consistent with the very low incidence of pulmonary emboli found in other studies.[5,26,42]

One of the original intentions of this study was to see if CPM provided a significant means of prophylaxis against DVT. The potential as a means of prophylaxis was first proposed by Coutts,[7] who noted a consistent venous surge within the femoral vein with an associated rise in compartmental pressure above the level of venous pressure in the calf. He believed that CPM may duplicate the prophylactic effect of SCD hose.

Despite this assumption, the study failed to show a statistical significance between non-CPM and CPM treatment in the incidence of DVT. However, one must consider the small DVT sample size, being very small with four DVTs. Coutts also evaluated the arc of motion in eighty-two patients, fifty-two placed on CPM postsurgical and thirty with no CPM as a control. Those on CPM obtained a statistically significant greater arc of motion earlier and one year postoperatively. This study showed that there was a statistically significant increase in the arc of motion on those receiving CPM at the time of discharge, but no difference in the time to initiate ambulation. A statistically significant value was obtained for the length of hospital stay in regards to CPM and non-CPM patients. Hospital stays were noted to be shorter which may be attributed to the overall improved rehabilitation of the CPM patient. Also mentioned in his study was the "virtual absence" of postoperative edema and effusion. Studies utilizing CPM on rabbit legs also supported quick effusion clearance.[34] In postoperative wound analysis three of the five cases with complications had CPM, reflecting no decreased incidence. Of note is the recording of eight incidences of subluxing or dislocating patella, requiring a corrective procedure. Seven of these knees received CPM. One must therefore question whether CPM prevents the proper healing of the capsule after arthrotomy or stresses the suture repair. CPM may be too excessive and oppose the beneficial properties claimed of having collagen fibers laid down along lines of stress with motion.[7]

The method of DVT determination was based on Doppler analysis. Clinical presentation has been proven to be grossly inaccurate as a means of detection for DVT with total knee arthroplasty,[5,26,29,42] and was thus not employed. Plethysmography, although present at our facility, is used very infrequently to be a dependent means of detection. Although venography is available, it has only been employed in those cases where DVT was highly suspected or only after positive Doppler studies. According to Salzman[36] and others[13,14,35,37,38,42] venography provided the most accurate means of detection of DVT in the orthopedic patient. Comparison studies of venography and Doppler analysis show a range of seventy-one per cent to ninety-three per cent concordance of Doppler analysis to venography.[33,37,38,41] The most accuracy lies in the detection of DVT in iliofemoral and femoral popliteal venous segments. Studies by Sumner[43] analyzed Doppler studies and found the specificity to be ninety-four and sensitivity ninety per cent above the knee and ninety-one per cent and eighty-four per cent respectively below the knee.[43] There are several limitations to this modality. False negatives represent the most serious problem with Doppler analysis and are most apt to occur in evaluation of the calf.[14,41] A proximal high grade obstruction must be present for the test to be positive. There is no means of

differentiating thrombotic from non-thrombotic occlusions.[35] Error may arise from improper positioning of the extremity or any compressive dressing.[40] Overall, Doppler analysis has a high specificity however its sensitivity ranges from seventy-five to ninety per cent.[10-40] Despite the limitations of Doppler analysis, it is found to be cost efficient, non-invasive and technically easy to perform.[7,9,14] It provides evaluation of venous insufficiency.[13]

Studies using fibrinogen uptake and venography for DVT, indicate a very high incidence of DVT occurrence in the calf with a remote incidence of propagation or dangerous sequelae.[8,42] For these reasons Doppler analysis is an adequate initial screening modality for determination of normal blood flow and non-significant clots. Supplemented with venography for suspicious studies, the incidence of detection is vastly improved.

In evaluating risk factors and prophylactic measures, our statistical comparison using Chi squares is hazardous because of our sample size. Only tentative assumptions can be concluded. While there are no clear statistical differences between means of prophylaxis, one can suggest that no arthroplasty should be performed without a regimen of prophylaxis, and that the higher dose of aspirin therapy be utilized rather than the lower one.

RECOMMENDATIONS

The following recommendations are proposed to allow for a subsequent prospective study of total knee arthroplasty in regards to the effect of CPM, for range of motion and as a modality of prophylaxis. In the preoperative workup of the total knee arthroplasty candidate, it is essential a consistent means of prophylaxis for DVT be employed. The most published studies on total knee arthroplasty have employed a minimum of six hundred and fifty milligrams of aspirin on a BID regimen,[5,22,26,28,42] and have noticed a decreased incidence when compared to no prophylaxis. No study has clearly evaluated all of the options and has found results that are statistically significant. Recent attention has been towards the utilization of SCD hose. McKenna has shown a statistical significant reduction in embolic phenomenon utilizing high dose aspirin, 1,300 mg TID and SCD hose.

It is suggested that as a means of DVT and PE prophylaxis, either LMD initiated intraoperatively and then on the second postoperative day, or SCD hose combined with high dose aspirin therapy starting the day prior to surgery, be utilized. CPM should be initiated in the Recovery Room at an arc of 0 to 40 degrees and increased by 10 degrees after the first postoperative day. It should be maintained until the time of discharge. All involved legs should receive a Doppler screening analysis preoperatively and on the fifth post operative day and prior to discharge. Any suspicious Doppler should be repeated and followed by venographic analysis. If venography is consistent with a clot at or above the knee, a ventilation-perfusion should be performed, and anticoagulation therapy utilizing IV Heparin initiated. Those individuals with DVT of the calf should be monitored closely for any signs of pulmonary emboli. The patient should be discharged on 650 mg of aspirin BID if their recovery was unremarkable and if there are no medical contraindications.

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Comparison of Computerized Tomographic Scanning and Myelograms

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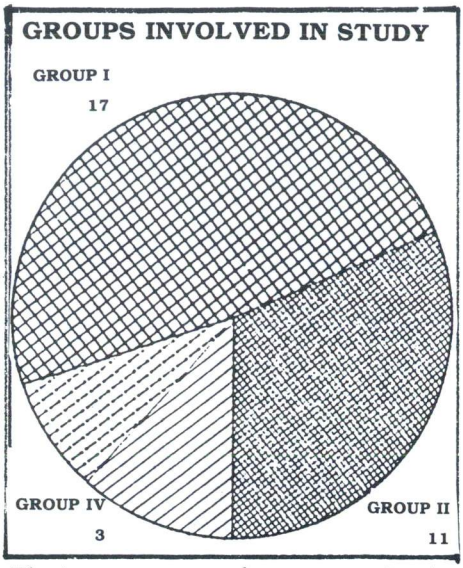
ABSTRACT: Computerized tomographic scanning (C.T. scanning) of the fourth and fifth lumbar disc space and the fifth lumbar and first sacral disc space was performed on 35 patients. Clinical data was obtained and used in this study; these patients were compared to their myelographic findings. A radiologist was presented case histories and the computerized tomographic scan. The report of his findings was presented. The objective was to see how well the computerized tomographic scanning and myelography correlated; to see how well the computerized tomogram correlated with symptomatology and, to propose a method of investigating the "low back patient" in an economical yet productive testing manner. Eighty percent correlated with the two diagnostic tests. Of the remaining 20 percent 4 patients had positive C.T. scan with negative myelography, and 3 patients had positive myelography with negative C.T. scans. Historically C.T. scanning was not considered as accurate as myelography in detecting herniated nucleus pulposus. However, with clinical correlation, an experienced radiologist and proper technique, computerized axial tomography provides a means of augmenting and confirming a diagnosis of a ruptured nucleus pulposus.[1; 3, 5] A strict criterion has not been established for utilization of the C.T. scanner in the "low back" patient. The C.T. scanner should not be a screening test for patients with back pain. Myelography, in our institution, had the best concordance rate with the surgical disc level.

MATERIALS AND METHODS

C.T. scanning was performed before the myelogram as a screening test, or for confirmation following the metrizamide injection. During the period from 1983 to 1985 myelography and C.T. scanning with or without contrast were performed on 35 patients. Ages ranged from 19 to 61, and a ratio of 22 females to 14 males. All patients presented with back and/or leg pain. Eighteen percent were worker's compensation, 25 percent stated that they had significant trauma, including heavy lifting or sudden turning, twisting or falling. Fifteen percent of those studied stated they had subjective weakness of their legs. There was one person who had a positive history of metastatic bone disease. Two patients had cauda equina syndrome and experienced bowel and bladder symptoms. Two patients had a diagnosis of spinal stenosis. A significant amount of patients had subjective parasthesis down one leg. A total of 6 surgeries were performed and 11 chymopapain injections. The rest were treated in a conservative manner.

RESULTS

Thirty-five patients were divided into four categories. Group I was positive C.T. scans and positive myelograms. Group II was negative C.T. scans and negative myelograms. Group III was positive C.T. scans and negative myelograms and Group IV was negative C.T. scans and positive myelograms (these are the groups representative of the attached graphs). Groups I and II were considered good correlation between the tests. Groups III and IV had poor correlation. The breakdown of patient populace was as follows: Category I involved 17 patients or 45 percent of those studied. Group II had 11 patients.

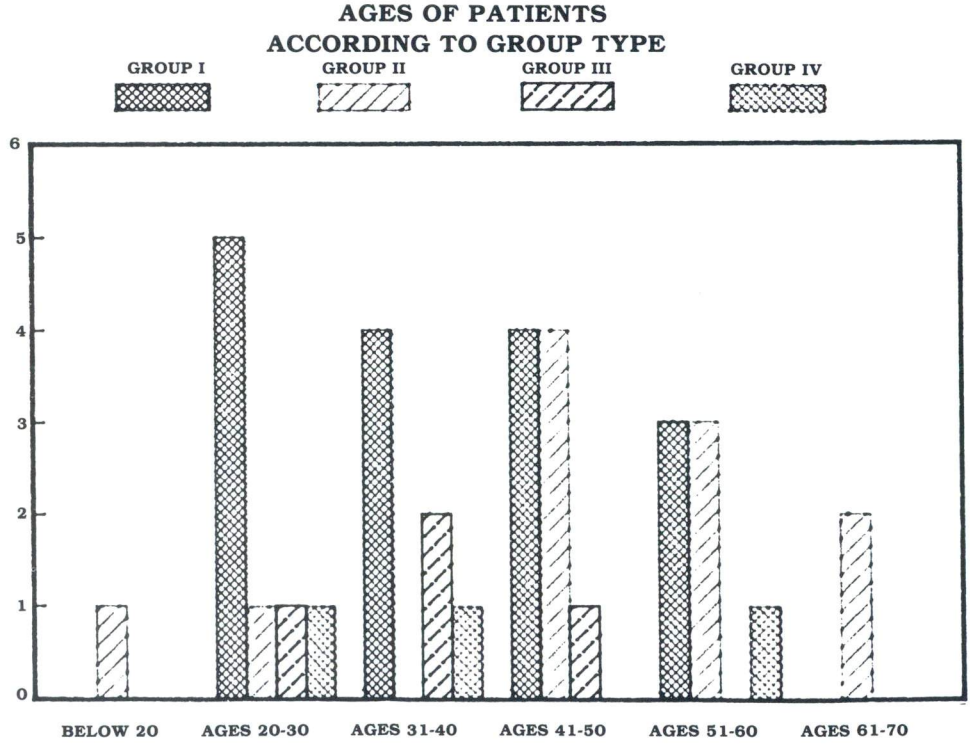


The two groups made up approximately 72 percent of the total patients. Groups III and IV totalled 9 percent and 8 percent respectively.

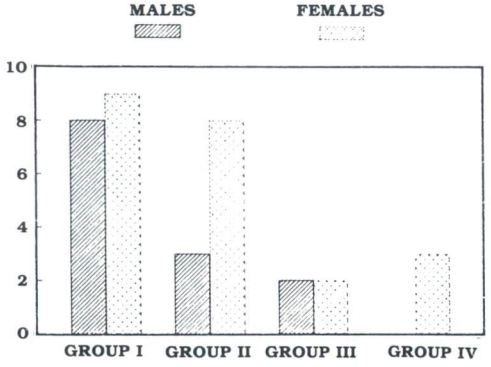
Group I had positive findings at the levels of C.T. and myelograms. This group had an average and median age of 39. Group I also had the following findings: There were 22 patients at the L-4, 5 levels and 6 patients at the L-5, S-1 levels. Average spinal fluid protein was 51. One patient had cauda equina syndrome. Fourteen patients had a herniated nucleus pulposus either on the right or the left side or central bulging. Two patients went to surgery and 10 patients, or 65 percent had chymopapain injections. Nine of the injections were performed on the L-4, 5 level and 1 patient had an L-5, S-1 injection. There were 7 patients who had enhancement of the C.T. scanning. Significant trauma only occurred in 3 patients. Objective clinical evidence of reflex loss or sciatic lists or motion deficits occurred in 90 percent of the group I patients. Three of these patients had a central herniated disc. Two of these had chymopapain injections with good results. According to Williams, a bulging disc, per C.T. scan, is not an indication for surgery.[11; 407]

Critera have been established for differentiating the protrusion from a bulge. Williams demonstrated an anatomical normal nucleus pulposus may show generalized extension of the disc margin beyond the vertebral body. It is difficult to make this distinction with C.T. scanning alone.

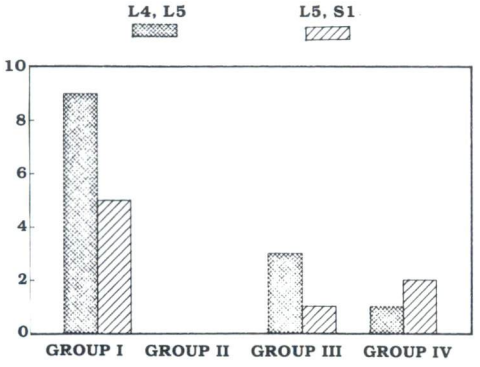
Concordance rate on Group II (negative C.T. scan and negative myelogram) occurred in 11 patients. One



BREAKDOWN OF THE GENDER IN THE STUDY



POSITION OF TRAUMA IN THE PATIENTS STUDIED



person in this group had breast carcinoma with was metastesis to the lumber vertebrae. No surgery was performed in any of the patients. The average age was 43. Median age was 51. Seventy-three percent were females. Average age in the female populace was 46 and the median age was 54. Most of these patients were experiencing back pain with gluteal pain without a radicular pattern.

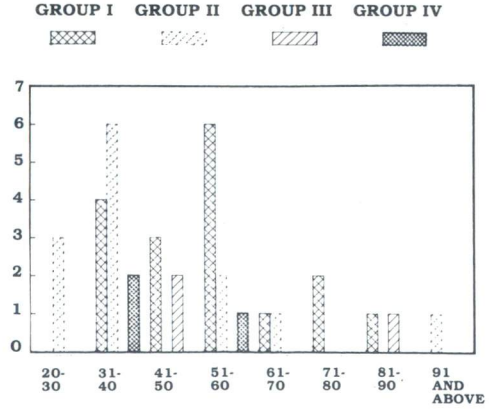
Groups III and IV had a combined total of 7 patients. Three of these had positive myelography with negative C.T. scans. All of these patients underwent surgical intervention demonstrating the lesion. All had focal neurological deficits and 1 demonstrated cauda equina syndrome. The remaining 4 patients demonstrated a positive C.T. scan with a negative myelography. The other three patients did not warrent surgery based on clinical examination. The symptoms resolved, with time. One patient gave us a positive impression of an inferior protruding disc not readily apparent on the amipaque myelography. A retrospective careful evaluation of the myelography revealed a slight elevation of the L-5 nerve sleeve. The C.T. readily demonstrated this elevation where the myelography did not. One female had an L-3, L-4 level on the C.T. scan, but an L-4, L-5 level on myelography. She had no neurological deficit.

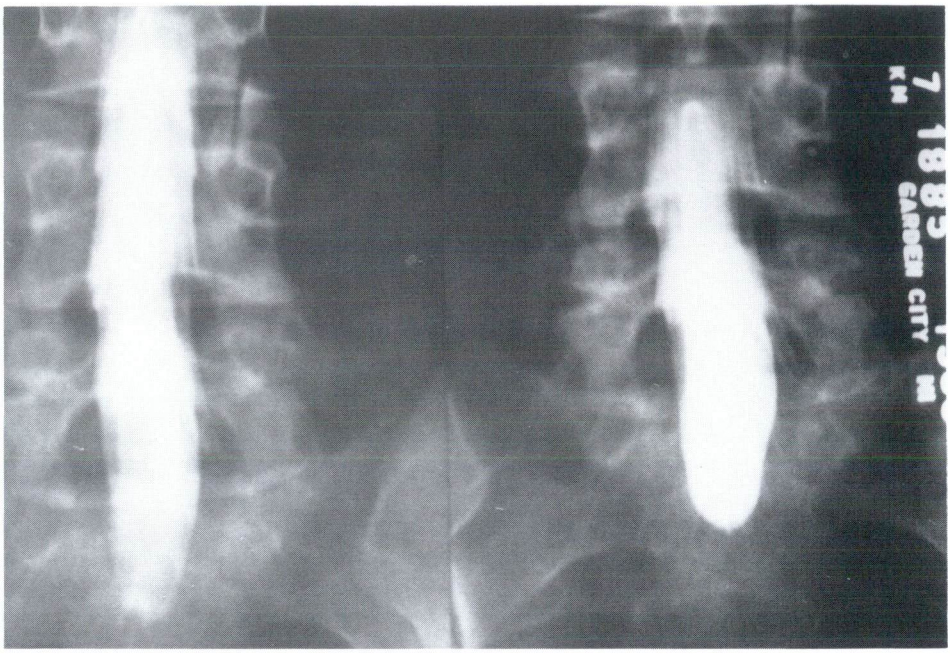
DISCUSSION

The value of lumbar myelography is well known in the diagnosis of the "low back patient." It involves little risk per informational gain. At our institution this test requires two days of hospitalization, totalling a cost of about $520. Computerized axial tomography is another diagnostic means for lumbar disc disease. The Phillips 3/10 high resolution scanner is employed: 4.5 contiguous slices are cut. Most of the cuts are angled to the disc tangentially.

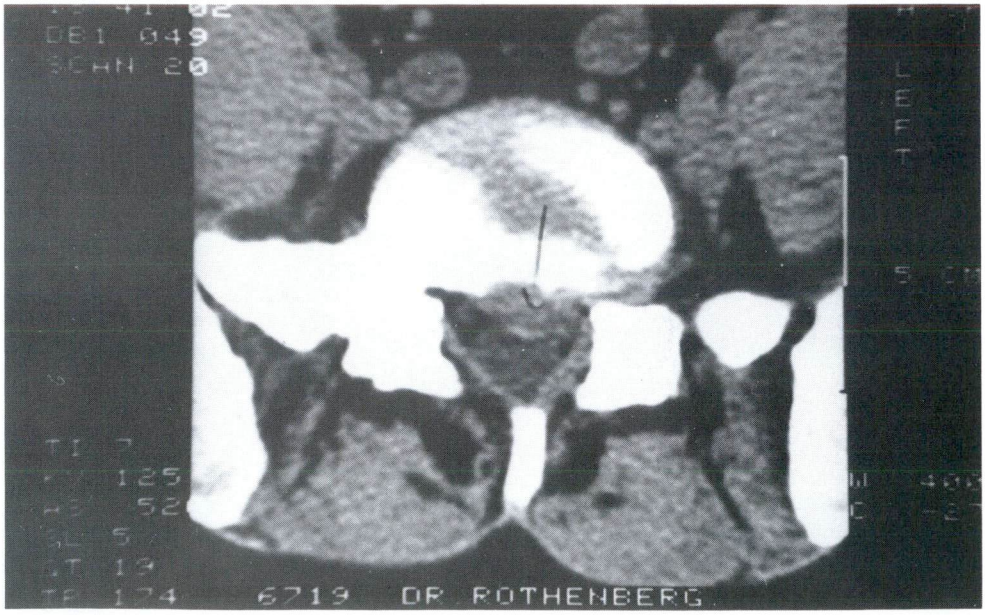
At our suburban institution some physicians use the C.T. scanner as diagnostic test. If this is positive, then the physician refers him or her to the appropriate specialist. Other physicians have little faith in the C.T. scanner as a diagnostic tool. (Too often a radiologist or physician not skilled in the reading of the scanner will report a false impression.) Based on clinical data and the nature of the clinical signs and symptomatology, a myelogram will be

AMOUNT OF SPINAL FUND PROTEIN FOUND IN EACH GROUP



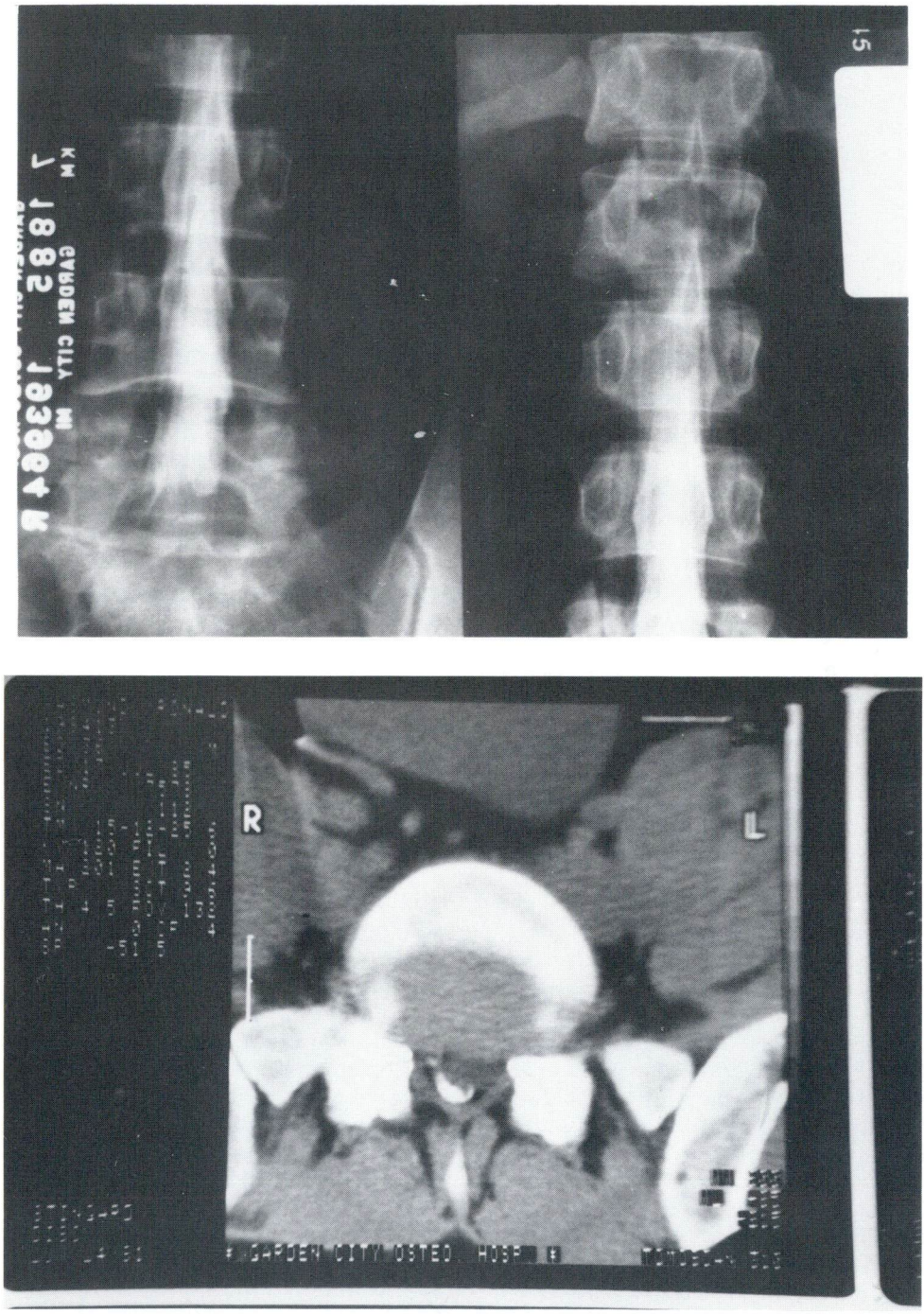


Example of a 32 year-old male complaining of generalized weakness in both lower extremities. He described global parasthesia on his abdomen, with difficulty having erection. He had severe back pain, but no focal neurological changes. CT demonstrates a central disc. Myelography shows no L5 nerve root, Surgery demonstrated a mass of venous plexus adjacent to, and attached at the L5 dural sleeve.



performed. Occasionally this is followed by an enhanced C.T. image for confirmation. The cost of a C.T. scanning on the lumber disc at the L-4, L-5 and S-1 levels is about $450. It was the purpose of this paper to compare these results and recommend a protocol for the diagnosis and treatment of the low back patient.

Our studies showed that 80 percent of the C.T. scans correlated with the myelogram. Significant data on physical examination had an extremely close correlation rate. Physical signs in-



Example of a good correlation between C.T. and Myelography. This patient was taken to surgery for removal of a large disc. He correlated well, on clinical examination.

cluded sciatic lists, reflex changes and moderate functional deficits. The study found little benefit with the enhanced myelography. However, one particular case had an inferior protruding disc which this helped clarify. Enhanced myelography may also be confusing. In many instances there has been asym-

metrical filling of the nerve sleeve. This may give a false interpretation. The exact timing when to perform the C.T. scan is inconsistent. If the concentration of amipaque is too great, scatter is present. In many instances the patient is exposed to two C.T. scans generated by a doubtful radiologist; a screening C.T. scan with equivocal findings followed by a confirmational one with contrast. Midline bulging discs or an anulus at the floor of the canal on C.T. scan proved a difficult situation. Without physical signs of disc disease, we feel this represents a normal variant.

Bosacco et al, *Clinical Orthopedics*, scanned the 4th and 5th disc space of 134 patients. There was an overall concordance rate of 85 percent between C.T. and myleography. He found there were no false positive C.T. scans and 94 percent concordance rate between myelography and surgery C.T. scanning and surgery produced a 92 percent agreement. His conclusions from this magnificent study reserved the role of myelography to equivocal cases.

At the Annual American Academy of Orthopedic Surgeon's meeting in 1982 six surgical teams reported good to excellent results with C.T. imaging. A New Orleans team concluded that "C.T. scanning is as accurate as metrizamide myelogram."[7: 41-49] Dr. Thomas Whitecloud III operated on 80 patients and produced a 92 percent accuracy rate in both procedures when performed. They found myelography slightly more advantageous when only one test was performed. At the Ullevel Hospital in Norway C.T. scanning demonstrated lumbar disc disease as effectively as myelography. This study consisted of 52 patients. Cross negative diagnoses were made twice on myelography and once on C.T. There were 8 false positive C.T. diagnoses of protruding discs. Conclusions drawn were that "substituting C.T. for myelography will reduce the morbidity and cost of evaluating the low back patient without reducing the diagnostic accuracy."[7]

C.T. scanning offers a benefit of 1) non-invasiveness; 2) assessing the vertebral bodies, pedicles and other osseous structures and lateral recess; 3) cost effectiveness. This may be performed on an outpatient basis; 4) a method of seeing the soft tissue structures and ligamentous hypertrophy surrounding the osseous structures; and, 5) a relatively innocuous test. Major disadvantage include the amount of radiation the patient must be exposed to. Values of patient dosage from clinically used C.T. scan technique range from 2-10 rads per study. This is surface radiation. Generally 500 millirad to 1 rad is the surface radiation one would get from a lumbosacral spine series using routine x-rays. No complete study has been performed to determine the exact effect deep radiation may have on the reproductive organs using C.T. scanning. C.T. scanning is not a screening test and "should be administered only when clinically warranted." "Nominal C.T. surface dosages are on the order of 2 to 5 rads per study for the area scanned."[5]

Differentiating fibrous tissue from the disc may be difficult. Myelography offers accurate visualization of the dural sac, cut off signs are more severe and midline defects are more obvious. Disadvantages included invasiveness. Postop complications are few, but include headaches, nausea, seizures, CNS manifestations and anaphylactoid-type reaction following allergy to contract material. If two cut off lesions are present, myelography may only demonstrate that defect most proximal to the needle insertion. Therefore, the limited surgical decompression may be adequate. A CT scan, in addition, may be of benefit, especially with cuts distal to the myelographic cut off. Hospitalization at this institution is required for minimum of 24 hours prior to testing. "In certain situations there are advantages of myelography over C.T. (C.T. scanning) may not be diagnostic due to technical inadequacies, operative errors or excessive patient size." Also, scoliotic patients prove poor candidates and complete lumbar blocks, as in Cauda Equina Syndrome, or tumors may not show.[2: 886]

The C.T. scanner should not be used as a simple screening test. In 1960 Lanche wrote 5 indications for myelography. He stated that not every patient who has low back pain with or without scanning should have a myelogram. His statement may also be included for the C.T. scanning. I leave the reader with this thought "in general . . . should be considered for the patients who have clinical diagnosis of lumbar disc lesion which have been made after a careful history, complete physical examination, necessary laboratory studies and a complete set of lumbosacral roentgenograms and who have disabling symptoms which have failed to respond to adequate trial of conservative treatment."

A retrospective evaluation of 100 Laminectomies — Discectomies performed at Garden City Osteopathic Hospital by a co-author (L.M.) revealed a 96 percent concordance between myelography and the surgical level. One of the reasons for this excellent correlation was proper indication and utilization of myelography. A strict criterion has not been established for C.T. scan use for the "low back" patient.

Diagnosis is obviously increased when the two tests are used together. Confidence may be placed on using the C.T. scanner as a diagnostic means for radiculitis from herniated nucleus pulposus only when meticulous and thorough technique are practiced. Myelography, in our hands, offers a more consistent diagnostic finding. Clinical evidence must be relied upon, when diagnosing from a C.T. scanner.[3, 107]

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Intraosseous Ganglion of the Lunate

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ABSTRACT: Intraosseous ganglions are benign cystic lesions that are histologically identical to those ganglions found in soft tissues. They can be quite painful and are important considerations in the work up of wrist pain. Tomography is useful in exacting the location of these lesions and to help in planning the surgical approach. Curettage and bone grafting is usually curative.

INTRODUCTION

Cystic lesions of the carpal bones are quite common, occurring in over 50% of the 600 cadaver wrists studied by Bugnion.[5] An increasing awareness of intraosseous ganglions as a cause of these lesions has led to reports of twenty-six cases since 1967,[5, 7, 13, 14, 16, 18, 22] with seven intraosseous ganglions being reported in the lunate.[7, 16, 18] Intraosseous ganglions may be symptomatic, and must be suspected when cystic lesions accompany wrist pain. Although plain radiographs will usually visualize the lesion, polytomography is useful in determining the exact location of an intraosseous ganglion and in planning the surgical approach.

The purpose of this paper is to describe the work-up of an intraosseous ganglion of a lunate as a cause of obscure wrist pain. The natural history of this entity and the usefulness of additional diagnostic testing are also discussed.

CASE REPORT

A 42 year old right-handed manager of a manufacturing company noted the insidious onset of a dull aching pain over the mid-dorsal aspect of his left wrist which had been present for 18 months prior to examination. The pain became progressively more constant and annoying over the next six month period until he sought medical attention with a local orthopedist. He denied any history of trauma. Pain became more frequent with usage of his left wrist, especially while playing golf. He was forced to give up golf because of the pain, and was referred to a hand surgeon. The initial x-ray revealed a radiolucent lesion in the carpal lunate (Figure 1). Examination was that of a normal wrist. There was neither swelling nor significant tenderness over the wrist. The neurovascular exam was also normal, and he had a normal range of motion in his wrist.

Bone scan was then obtained which revealed an area of increased uptake in the region of the left scapho-lunate joint (Figure 2). A wrist arthrogram was performed to rule out a ligamentous tear as the cause of pain (Figure 3). The study demonstrated the leakage of dye through the triangular fibrocartilage, but the intraosseous ligaments remained intact. Lateral tomograms were obtained to more precisely locate the lesion, demonstrating it in the volar half of the lunate (Figure 4).

Because of the chronicity of the patients symptons, surgical treatment was recommended. Based upon anatomic considerations the left lunate was approached through a dorsal incision. A small cortical window was made on the dorsal side of the lunate. An intraosseous ganglion was encountered. The contents of the lesion consisted of a gelantinous material normally found in ganglions. The wall of the cyst was lined by a friable membrane. The lesion was curetted and packed with cancellous bone which was harvested from the distal radius.

DISCUSSION

Intraosseous ganglions are well defined cystic lesions located in the subchondral bone adjacent to a joint.[21]

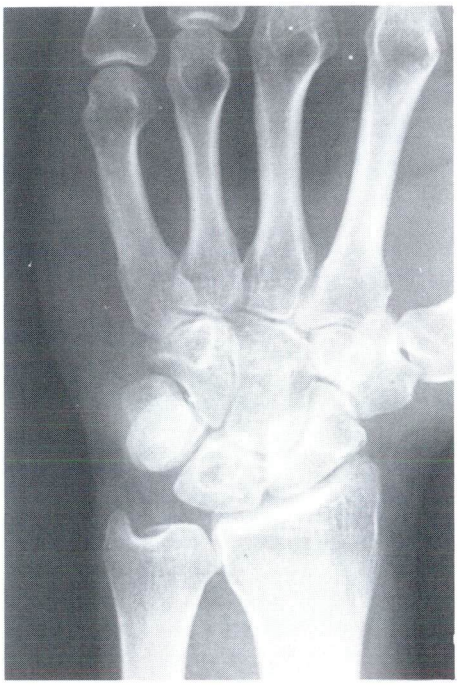

Fig. 1: AP x-ray of the left wrist demonstrates a cystic lesion within the lunate. This lesion has a sclerotic border and is seated within the substance of the lunate.

They are not associated with degenerative joint disease, as changes in the articular surface are usually not present.[24] Their characteristic sclerotic border serves to distinguish them from the chondromatous and giant cell tumors.[7]

Clinically, these lesions present as pain related to a joint.[13, 22, 23] Trauma is not an accompanying factor and swelling is infrequent.[3, 13, 23] Acute trauma may lead to an incidental finding of the lesion but probably does not contribute to its cause.[16]

Typically, the age at presentation is in the mid-forties,[13, 22] although reported cases range from fourteen[22] to eighty-six.[24] There is a slight male to female preponderance of about 3:2.[13, 22]

The etiology of intraosseous ganglions is uncertain, as reflected by the variety of terms used to describe the lesion, including necrobiotic pseudo cyst,[2] synovial cyst,[7, 12] subchondral cyst,[26] and juxta-articular bone cyst.[3, 22] Four main theories have been proposed; a) synovial herniation and proliferation,[7, 13, 17] b) focal area of bone necrosis followed by mucoid degeneration,[22] c) mucoid degeneration of intramedullary connective tissue,[9, 11, 13] and d) primary intramedullary metaplasia, where mesenchymal cells differentiate into synovial-like cells with secretion of mucin-like substance.[4, 12, 19] This last theory assumes an active metabolic process versus a degenerative problem.

Histologically the intraosseous ganglion is identical to those found in soft tissue.[7, 13, 16, 22, 24] The cystic cavity contains gelatinous mucoid material and is surrounded by fibrous connective tissue. Much of the uncertainty in the etiology stems from the disagreement as to the absence[9, 12, 22] or presence[4, 7, 12] of synovial cells lining the inside capsule. There is also controversy as to whether the cysts do communicate with the joint[1, 17, 19] or not.[13, 22]

The absence of giant cells, new bone formation, inflammatory response and pigment or fat deposition[7] helps to histologically differentiate the intraosseous ganglion from other cystic lesions.

Treatment of this lesion consist of curettage and bonegrafting. An adequate graft can easily be taken from the

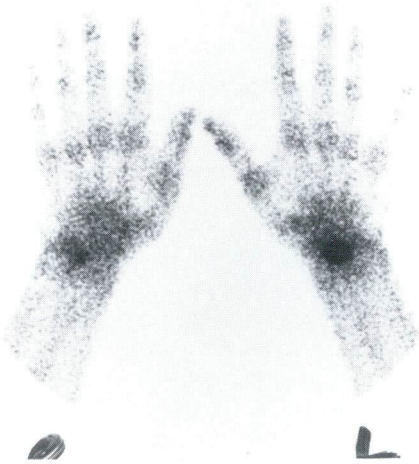

Fig. 2: This bone scan demostrates increased uptake in the region of the scapho-lunate joint.

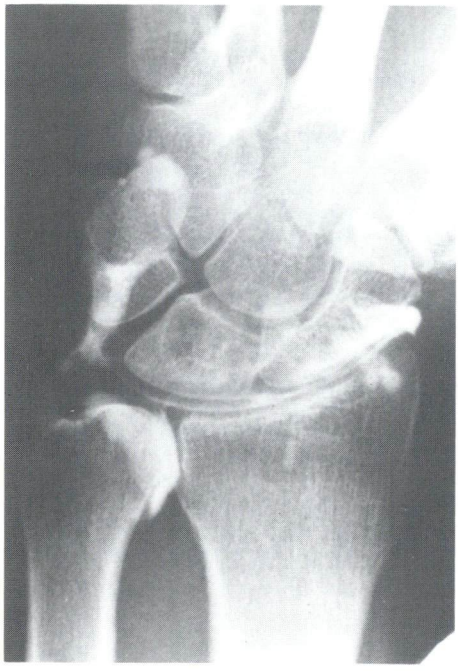

Fig. 3: A wrist arthogram was performed in an attempt to rule-out a ligamentous tear as cause for the wrist pain. This study demonstrates the leakage of dye through the triangular fibrocartilage. The interosseous ligament remain intact.

distal radius. Polytomography is a useful tool to pinpoint the location of the lesion and plan the surgical approach.

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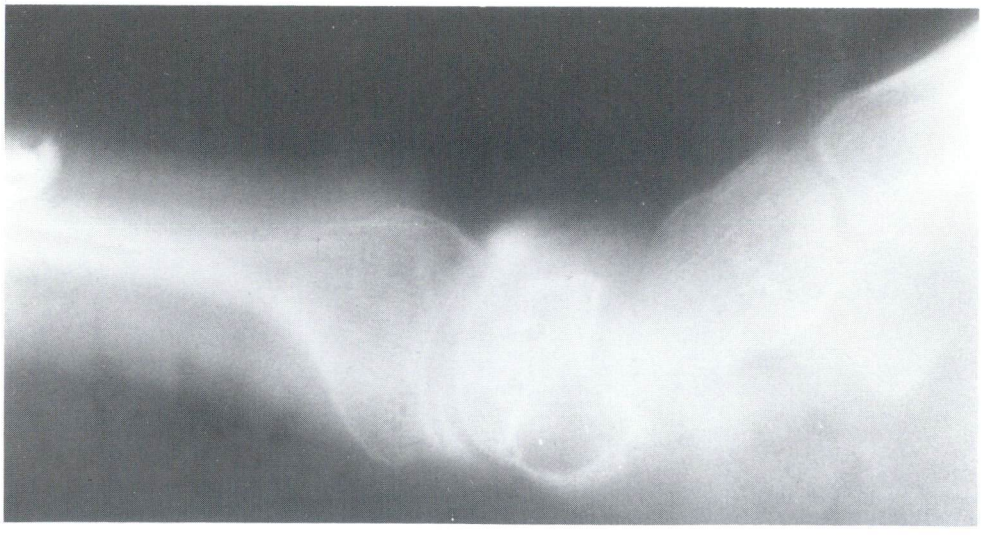

Fig. 4: Lateral tomograms demonstrated the cyst to be in the volar half of the lunate.

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Snapping Sartorius Tendon: An Unusual Complication of Arthroscopic Knee Surgery

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ABSTRACT: Arthroscopic knee surgery is a commonly performed procedure. An unusual complication, the development of a "snapping" sartorius tendon following arthroscopic meniscectomy, is presented. An extensive search of the current English literature failed to reveal mention of this or similar syndromes following arthroscopic knee surgery. **KEY WORDS** Arthroscopic knee surgery, "snapping" sartorius tendon.

Snapping tendon syndromes are often times difficult both to diagnose and to treat. They may be seen after trauma,[1-6, 10-13, 19, 20] following surgery,[9] or may appear without any apparent explanation.[8, 14] Frequently the response to both nonoperative and surgical measures is less than satisfactory for both the patient and his surgeon. The most commonly involved tendons are the peroneal tendons in the ankle[1, 3, 6, 7, 10-12, 17, 21-23] and the biceps tendon in the shoulder.[13] Those seen less often include the iliopsoas and obturator internus at the hip,[18] the triceps at the elbow,[5] the biceps femoris at the ischial tuberosity[15] and the iliotibial band at the knee.[16] Others have also been reported.[2, 8] A review of the curent English literature on this topic did not contain reference to involvement of the Sartorius tendon in a snapping tendon syndrome. Also, no mention of the development of a snapping tendon syndrome at the knee following arthroscopic procedures was found.

CASE REPORT

A twenty eight year old caucasian male was seen for complaints of pain, clicking and popping in the left knee of two years duration. He had undergone an extensive physical therapy program prior to this exam which had provided no relief of his symptoms. Arthroscopy was recommended and subsequently performed. A partial medial meniscectomy for treatment of a posterior flap tear was done in forty five minutes without use of a leg holder or inflation of a tourniquet.

Following the outpatient arthroscopic surgery the patient had no further pain at the joint line and no clicking or popping in the knee joint itself. He did note a "snapping, popping" sensation on the medial aspect of the knee. He denied any similar problems prior to the arthroscopic surgery.

On physical examination there was tenderness on palpation of the Sartorius tendon at the point of its passage over the medial femoral condyle of the left knee. On flexion and extension of the knee the tendon of the Sartorius muscle was noted to sublux or "snap" into and out of place when brought into the 30-45° of flexion range.

Initial treatment consisted of phenylbutazone, ace wrap, and suspension of the knee rehabilitation program except for quadriceps and hamstring setting and straight leg raising exercises. This provided no relief of the tenderness and the snapping persisted. The next step consisted of injection of the subtendonus bursa with methylpredisolone and immobilization with a knee immobilizer for ten days. The symptoms were still present at the end of this time, therefore, his left leg was placed in a cylinder cast for four weeks. The tenderness and snapping of the Sartorius tendon was as intense as before the cast was applied.

At operation the Sartorius tendon was observed to markedly sublux over the medial femoral condyle with flexion and extension of the knee. No tear of the retinaculum was visualized. Attempted suture tenodesis of the Sar-

torius tendon to the tendon of the gracilis at the level of the pes anserinus was not effective in eliminating the subluxation. The Sartorius tendon was, therefore, detached at the pes anserinus and a suture tenodesis to the tendon of the semitendinosus more posteriorly was performed. The subluxation was completely eliminated.

Following a layered wound closure the knee was immobilized in a knee immobilizer for a six week period. The patient was kept nonweight-bearing on the leg for four weeks, then partial weight-bearing for two more weeks. The quadriceps and hamstring and straight leg raising exercise program was continued for the six week period. No further subluxation of or pain from the Sartorius tendon was experienced postoperatively. After a vigorous knee rehabilitation program the patient was able to resume his prior lifestyle and activities.

DISCUSSION

Development of a subluxing or "snapping" Sartorius tendon syndrome following arthroscopic knee surgery is a heretofore unreported complication of this commonly performed outpatient procedure. Although a "snapping tendon" at the knee is seen with iliotibial band syndrome[16] in runners it has not been reported following arthroscopic surgery. Current English literature also contains no mention of other cases of subluxating tendon syndromes about the knee after arthroscopic procedures.

Subluxing or "snapping" tendon syndromes are often times difficult to diagnose since they are infrequently seen and the patient's presenting complaints are often vague thus delaying immobilization or other nonoperative treatment. Early diagnosis is extremely important if nonsurgical methods are to be successful. The reported case was recognized early postoperatively, however, immobilization was not instituted immediately.

Surgery was ultimately required to correct the subluxation. Simple suturing of the Sartorius tendon to the adjacent gracilis tendon would not correct subluxation. Transfer of the Sartorius tendon more posteriorly with tenodesis to the semitendinosus tendon was necessary to eliminate the "snap". Following rehabilitation of the knee, no weakness, instability, or other functional problems were observed.

The exact etiology of the tendon subluxation following arthroscopy was not determined. Careful examination preoperatively had not revealed this finding. The patient also denied the "snapping" symptoms prior to his arthroscopic surgery. The procedure had not been lengthy (45 minutes). Excessive valgus stress was not applied to the knee (no leg holder was utilized). A lesser degree of force may, however, have resulted in the development of the "snapping" Sartorius tendon after the arthroscopic partial meniscectomy. Evaluation for this problem immediately post-operatively with early immobilization being instituted may have averted the need for surgery. If surgery is required posterior transfer with simple suture tenodesis to the semitendinosus tendon appears to yield satisfactory results without residual problems in the knee.

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Volar Dislocation of the Proximal Interphalangeal Joint Treated by Silastic Implant Arthroplasty

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Volar dislocation of the proximal interphalangeal joint has been reported as a rare entity compared to its dorsal counterpart.[1, 5, 6, 9, 10, 12, 14, 15] Most cases have been reported as isolated cases,[1, 3, 5, 9, 14, 15] except for a series of 15 cases presented by Peimer et al., seven chronic cases by Posner et al., five cases by Spinner et al., a series of four cases by Kilgore et al., and two reports of two cases by Murakami and Neviaser. Controversy exists among the many authors over closed vs. open therapy. This case report presents a chronic volar proximal interphalangeal joint dislocation treated by a different modality — ie., silastic interposition implant arthroplasty.

CASE HISTORY

A 65 year old female sustained an injury to her right middle finger approximately four months prior to being referred to a hand specialist. The patient was assaulted and did not recall the mechanism of injury to her middle finger. There was no history of a prior injury to the involved digit. She was initially treated for approximately three weeks in a dorsal splint. After the splint was removed, she continued to have pain, swelling, and loss of motion at the proximal interphalangeal joint of the right middle finger.

Physical examination revealed a right hand dominant female with a grossly swollen proximal interphalangeal joint of the middle finger. (Fig. 1) The finger was radially deviated and supinated over the dorsum of the index finger. (Fig. 2) The circumference of the proximal interphalangeal joint measured 82 mm, compared to 62 mm on the left middle finger. Motion of the joint was 0/50 degrees of flexion compared with 0/60 degrees on the proximal interphalangeal joint of the left middle finger. The distal interphalangeal joint had no active flexion. Radiographs revealed an old complete volar dislocation of the proximal interphalangeal joint. (Fig. 3) Calcification along the extensor hood and erosion of the dorsal surface of the middle phalanx were also identified on the lateral view. (Fig. 4)

The patient elected to have operative intervention due to the disability she was having with routine activities. A longitudinal dorsal incision was made over the proximal interphalangeal joint of the right middle finger through the remains of the central slip. The central slip was ruptured and a pseudotendon formed at the original insertion site. Marked fibrosus at the volarly dislocated joint was dissected free. The condylar head of the proximal phalanx was eroded over the entire surface. The joint was reduced, but a very tight joint surface resulted. The decision to perform the silastic implant arthroplasty was made at this time due to the scarred and degenerative articular surfaces. The collateral ligament structures and contracted volar plate were incised and the usual procedure of implantation according to Swanson[13] was performed. The extensor slip was sutured to the middle phalanx with the rent in the central slip closed. An oblique K-wire was inserted to hold the joint in extension. (Fig. 5)

Post-operatively, superficial incisional erythema cleared with oral antimicrobial therapy. The K-wire was removed at four weeks, and at the three month post-operative office visit the proximal interphalangeal joint flexion increased to 0/95 degrees. Distal interphalangeal joint motion has 0/70 degrees of flexion. Post-operative radiographs (Figs. 6 and 7) taken at two months show adequate position of the prosthesis. The patient is pain-free with

residual swelling much less than the amount pre-operatively.

DISCUSSION

Volar dislocations of the proximal interphalangeal joint are often irreducible because of entrapment of dorsal soft tissue structures.[5, 6, 7, 11, 12] With acute localized soft tissue swelling, the joint is mistakenedly diagnosed as the more common dorsal dislocation and is treated by a closed reduction. A dorsal splint is applied with the affected joint placed in slight flexion. After weeks of splintage, the swelling, pain, and loss of motion persists.[8, 12] Even though closed reduction has been advocated in

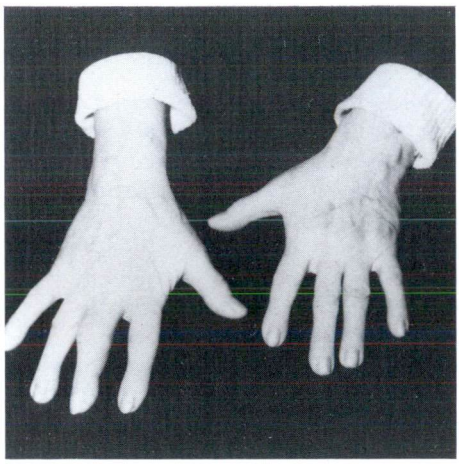

Fig. 1: Antero-posterior view demonstrating swollen proximal interphalangeal joint of the right middle finger.

the acute dislocations,[2, 8] open reduction with appropriate reconstructive procedures has been the most agreeable approach in the acute and chronic dislocations.[1, 3, 5, 6, 7, 9-12, 14, 15]

The case presented represents one of the older patients with this injury at the age of 65. Peimer et al., reported the little finger being the most commonly affected in his series of fifteen. He was able to determine the exact mechanism of injury through the patient's history. Our patient was dealing with an assailant and could not remember if her finger was jammed, twisted, or hyperextended. The mechanism of injury has been identified through a controlled study of thirty fresh cadaver fingers.[12] It is a combination of a varus or valgus stress and an anteriorly

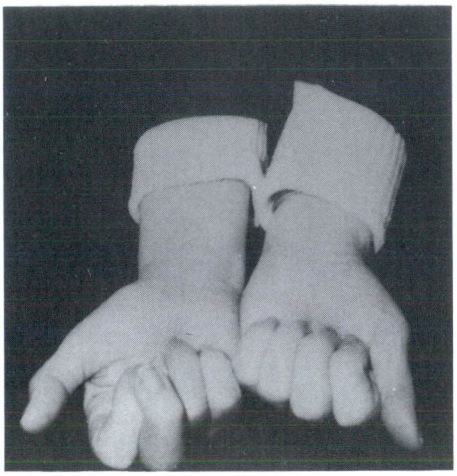

Fig. 2: Flexion view of the fingers demonstrating the radially deviated right middle finger.

directed force on the base of the middle phlanx. The varus or valgus stress ruptures one collateral ligament and/or volar plate and the anteriorly directed force disrupts the central slip.

At the time of open reduction via the longitudinal dorsal incision of the proximal interphalangeal joint, the central slip was ruptured and because of the delay in therapy, a pseudotendon had begun to form. Adequate identification of the collateral ligament and volar plate integrity could not be made due to the extensive fibrotic tissue sur-

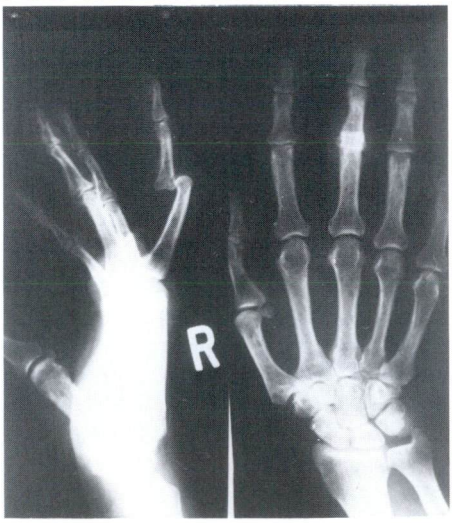

Fig. 3: Iateral and antero-posterior radiographs of complete volar dislocated proximal interphalangeal joint of the right middle finger.

rounding the joint. Erosive degenerative changes were identified at the proximal interphalangeal joint. A silastic arthroplasty appeared to be a reasonable alternative for treatment. The collateral ligamentous complex was excised, not thinned as advocated by Skinner et al., nor lengthened as suggested by Peimer el al. The middle extensor tendon (central slip) was repaired to the lateral extensor tendon (lateral band) after the implant was placed in the joint.

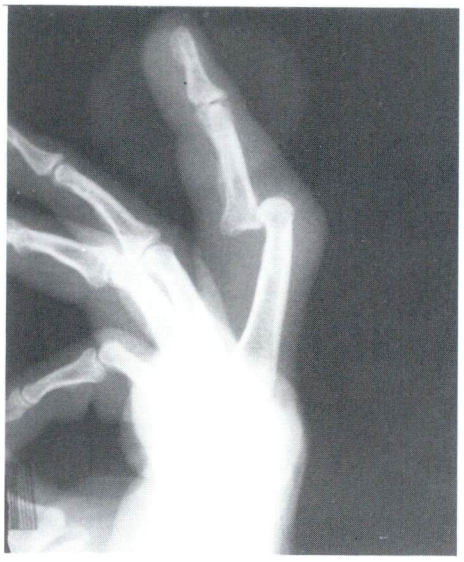

Fig. 4: Magnified lateral radiograph of the right middle finger demonstrating the ligamentous calcification on the dorsal aspect of the proximal interphalangeal joint.

A typical boutonniere deformity[2] was not present in our patient because there was no hyperextension of the distal interphalangeal joint. No active flexion of the distal interphalangeal joint could be performed, which was probably due to the extensive scarring of the lateral extensor tendons at the capsular portion of the proximal interphalangeal joint. The patient's middle finger did deviate in a radial direction which confirms the presence of a ruptured collateral ligament in the initial injury.[12]

Initial radiographs were unobtainable, therefore the status of the proximal interphlangeal joint could not be assessed at the time of injury. It is in this situation with a swollen, painful proximal interphalangeal joint that Spinner et al., recommends varus and valgus stress roentgenograms, especially one with any characteristics of a boutonniere deformity. Close scrutiny of the radiographs taken at four months post injury showed the ligamentous calcification on the dorsal aspect of the proximal interphalangeal joint. (Fig. 4) This could have been secondary to the central slip rupture or an accompanying fracture from the middle phalanx with the volar dislocation.

Fig. 5: Immediate post-operative lateral radiograph of the silastic arthroplasty of the proximal interphalangeal joint of the right middle finger with K-wire fixation.

No reported cases of silastic implant arthroplasty as the initial operative therapy for chronic volar dislocation of the proximal interphalangeal joint has been reported. Spinner et al., suggested silastic implant arthroplasty if the joint surface was destroyed as it was in this case. Posner[10] felt open reduction with extensor mechanism reconstruction was the preferable treatment versus an arthrodesis in selected patients, but did not address arthroplasty as a treatment modality. The implant arthroplasty gave a theoretical advantage of earlier post-operative motion of the involved joint. This was found with this patient. At the patient's three month

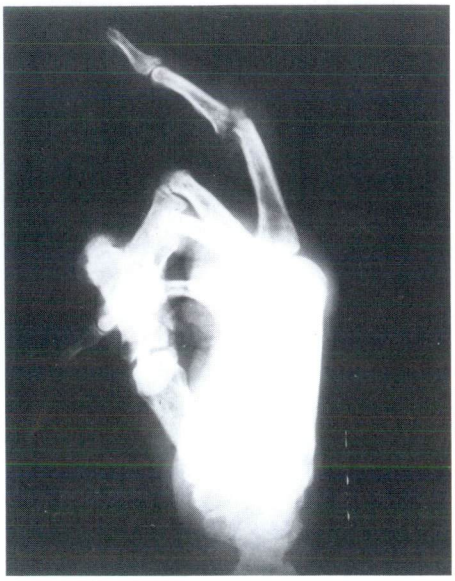

Fig. 6: Two month post-operative lateral radiograph demonstrating adequate position of the silastic interpositional arthroplasty of the proximal interphalangeal joint, right middle finger.

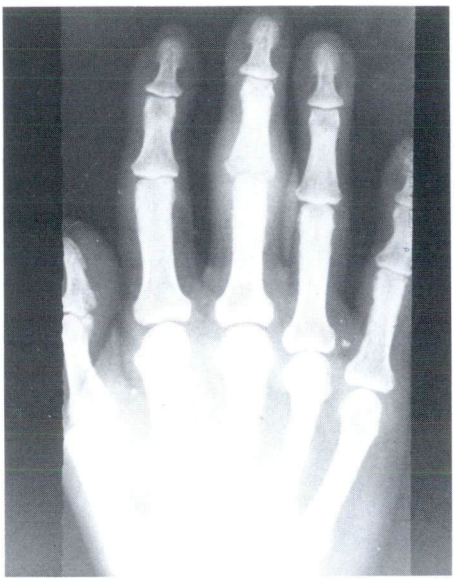

Fig. 7: Two month post-operative antero-posterior radiograph demonstrating the adequate position of the silastic interpositional arthroplasty of the proximal interphalangeal joint of the right middle finger.

post-operative office visit, she gained 95 degrees of painless active flexion of the proximal interphalangeal joint. The distal interphalangeal joint had normal function. The patient had minimal functional limitation.

This patient's short term result is consistent with the literature,[3, 8, 10] with respect to function and range of motion, but the patient requires further follow-up before this procedure can be recommended as a reasonable treatment alternative.

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Dupuytren's Contracture In a Black Male: A Case Report

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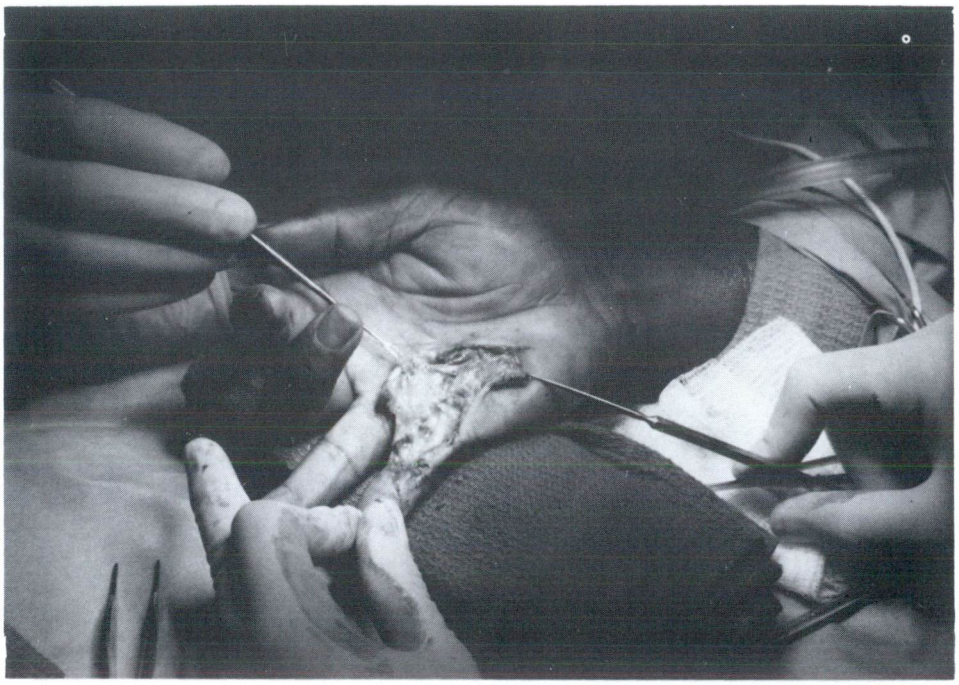
ABSTRACT: Dupuytren's contracture is extremely rare in blacks. This is a case report confirmed grossly and histologically.

Dupuytren's contracture has been written about in the Medical Literature for over 150 years but it still remains an enigma. It was in 1832 when Baron Guillaume Dupuytren published his results of an open palmar fasciotomy for this condition. Although we are able to treat Dupuytren's contracture rather well surgically the pathophysiology is still unclear. The etiology of this disease process is unknown but can be associated with some conditions and groups. It is most common in white males of Northern European ancestory. The male to female ratio is approximately 10 to 1. There have been several reported cases in the literature of Blacks and Orientals with Dupuytren's contractures.[ref. 1, 2, 3] This patient represents another case of Dupuytren's Contrature in a Black.

Grossly Dupuytren's Contracture starts as a fiberous band or nodule in the hand, usually to the ulna border. It can progress across the joints resulting in a flexion contracture of the digits. The rate of progression is extremely variable. There is an association with alcoholism, epilepsy and chronic pulmonary disease. It quite often effects both hands.

My patient, J. N. presented to my office first on December 20, 1983, with a complaint of progressive flexion contractures to both hands over the previous few years. His right hand was worse. He was a 56 year-old Black male. He denied any history of trauma. He had a history of hypertension and alcohol use but denies seizures or chronic pulmonary disease. He was unaware of any white intermarriage and he knew of no other family members with a similar condition.

Examination of the right hand revealed a flexion contracture at the



proximal interphalangeal joint of the middle and little fingers to 90 degrees.(Fig. 1) Fiberous cords and bands were present in the palm, especially about the little finger. Neurovascular status was intact. The left hand had a band from the palm to the little finger with a beginning flexion contracture. The use of the right hand was compromised and surgery was carried out.

A palmar fasciectomy was carried out to the right hand including the little and middle fingers.(Fig. 2) Grossly the resected palmar fasca was consistant with Dupuytren's Contracture tissue. A microscopic pathology report revealed areas of fiberous proliferation extending through the dense fiberous connective tissue. The histologic appearance is consistant with Dupuytren's contracture.

Due to the extensive surgery about the fingers, there was some skin loss which became scarred and developed some contracture about the middle and little fingers. This did not respond to physical therapy and splinting so six months after the initial surgery, a second procedure was carried out. At the second surgery, the scar was excised and a full thickness skin graft was placed over the open wound. He was last seen three weeks after the skin graft to have his sutures removed. At this time all wounds had healed well and there was good extension to the fingers. Since stiffness was present, physical therapy was recommended. He, however was lost to follow-up at this time despite repeated attempts to contact this patient. I do believe that clinically, grossly and pathologically, this represents a case of Dupuytren's Contracture in a black male.

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MR Imaging of a Ruptured Distal Tendon

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ABSTRACT: Rupture of the distal tendon of the biceps brachii is and has been, a clinical diagnosis primarily because of lack of appropriate radiologic methods for confirming the diagnosis. This report describes a case in which Magnetic Resonant Imaging is demonstrated to provide exquisite definition of this injury.

INTRODUCTION

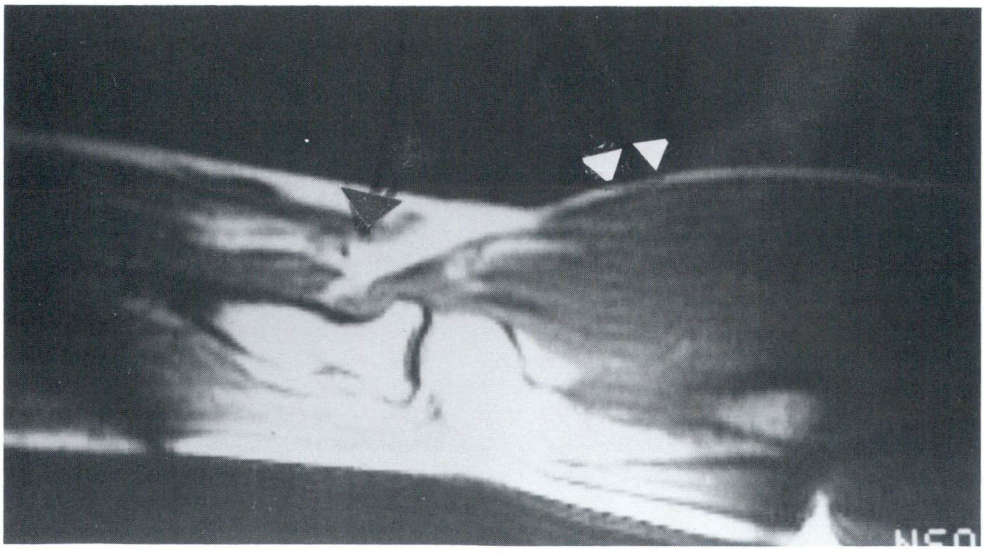
The following case report indicates the first known use of Magnetic Resonant Imaging to aid in the diagnosis of a rupture of the distal attachment of the biceps brachii tendon at the radius. Presently this diagnosis can only be made by clinical means and sometime, only by inference. Clinical findings to aid in the diagnosis may include pain at the site of rupture, local ecchymosis, loss of prominence of the palpable portion of the biceps brachii tendon at the elbow or mild weakness. Frequently this diagnosis may not be all that apparent however, particularly in muscular individuals or large, obese patients who manage full range of motion in flexion and extension, without significant demonstrated weakness.

Magnetic Resonant Imaging techniques have provided the clinician with an accurate, prompt, non-invasive assessment of the distal biceps brachii tendon and its appropriate insertions both into its muscular origins and at the insertion site into the proximal radius. This information may be quite helpful to the operating surgeon to arrive at the correct diagnosis prior to surgical intervention which is generally required for appropriate repair.

CASE REPORT

A 42 yr old male was initially evaluated in the Emergency Room of a local hospital, as a result of injuries sustained to the left arm while climbing onto a roof and slipping off a ladder. Apparently the patient grabbed the ladder with his left arm and felt a sudden

FIGURE 1a: Depicts MRI of the normal unaffected right elbow. Solid single arrow points to normal distal biceps and tendon insertion. Double arrow points to normal full well rounded biceps muscle.



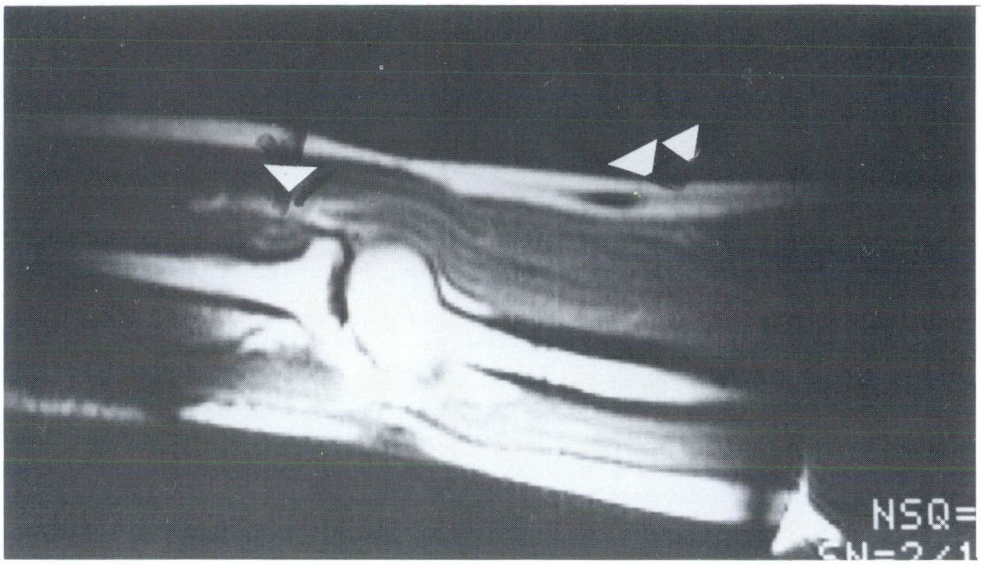


FIGURE 1b: Depicts disrupted biceps tendon of left elbow showing distal tendon insertion coiled upon itself (single arrow). Double arrow points to flaccid left biceps muscle.

tearing and stretching in the left elbow region. Because of severe pain and discomfort the patient was initially seen at the Emergency Room at a local hospital and was referred for orthopedic consultation. Examination of this patient revealed local ecchymosis, pain and tenderness as well as swelling in the region of the distal left biceps. There was some softness of the left biceps musculature and absence of the normal prominence of the biceps tendon at the elbow. The patient was able to flex and extend his elbow, but it was slightly weaker than the normal unaffected side. Xrays were taken and interpreted as completely within normal limits. A probable diagnosis was made of a rupture of the distal portion of the left biceps brachii tendon and the patient was referred for Magnetic Resonant Imaging of the left elbow, which confirmed the loss of continuity of the tendon. This study revealed disruption of the tendon distally at the insertion in the proximal radius. The patient was subsequently admitted to the hospital for surgical exploration of the elbow and tenodesis of the left biceps tendon to the radial tuberosity, utilizing the method of[1] Boyd-Anderson. The gross findings at surgery revealed flatness of the left elbow, with local ecchymosis. The end of the tendon was ragged and retracted approximately 5-6cm proximally. Following the surgery the patient was placed in the posterior fiberglass splint and sling and discharged from the hospital to be followed in the office. The patient was followed on several occasions in the office after approximately one month of immobilization, and started with active range of motion. The patient continued to improve clinically with increased motion of his elbow and was referred back for follow-up M.R.I., the results of which showed complete restoration and continuity of the tendon and the patient was able to return to work a short time after this. At the time of the patient's return to work he had minimal restriction of supernation with good strength in the left forearm and full flexion and extension and range of motion of his elbow. At this time, approximately one year after the surgical intervention, the patient has no restrictions of motion and excellent strength.

DISCUSSION

Magnetic Resonant Imaging technique, offers the opportunity to study normal anatomy in multiple plains with high contrast and high special

resolution. This technique is totally non-invasive and well tolerated by most patients. Appropriate resolution in the elbow can be achieved by the use of surface coils. The selection of imaging plains is important when imaging both normal anatomy and pathologic conditions. By selecting the appropriate imaging plain, optimal information can be obtained while keeping the imaging time within acceptable limits. The sagittal-plain is optimal for displaying the biceps brachii tendon, and articular surfaces of the elbow joint including the humeral radial articulation.

The MR imaging was performed utilizing a 0.6 supraconductive Technicare instrument. The signal to noise ratio was increased by using an anatomically shaped surface coil appropriate for the elbow region. 5mm thick sections in the sagittal plain were obtained with an image matrix of 256 × 256 and resolution of 4-1mm. The spin-echo technique was utilized. The repetition time was determined by the number of section and was 500 milliseconds with echo times of 30 milliseconds and 1000 - 1500 milliseconds with echo times of 50 milliseconds.

The signal intensity of bone marrow with this relatively long T-2 and short T-1 relaxation, has a high signal intensity on the T-1 and T-2 wave images. Bone marrow of the humerus, radius and ulna can be easily identified. Cortical bone on the other hand, shows a low signal intensity, independent of pulse sequence as a result of low spin density and short T-2 relaxation time of compact bone. The articular surfaces of the humerus and radius are covered with hyaline cartilage which has a high signal intensity on the T-1 and T-2 wave images. The biceps tendon has a low signal intensity helping to differentiate it from the other surrounding structures. Subcutaneous fat and fat between the separate muscle groups around the elbow, have high signal intensity. Muscle fibers converging into a tendon can be indirectly observed because of the high signal intensity of fat surrounding the tendons.

The distal tendon of the biceps brachii is easily identified. The other muscle groups of the elbow and several intramuscular and intermuscular septa and compartments, as well as neurovascular bundles, can be appreciated as separate and distinct structures.

In the case cited above, the MRI demonstrated disruption of the distal tendon at the radial tuberosity. The tendon was found to be completely detached and retracted and coiled upon itself in the MR study. (Fig. 1a & 1b) Several weeks after surgery a repeat MRI demonstrated the complete restoration of continuity of the ruptured distal tendon at the level of the radial tuberosity.

CONCLUSION

It is essential that the correct diagnosis is made in evaluating a rupture of the distal tendon of the biceps brachii since most surgeons agree that surgical repair is necessary for rupture of distal tendon of the biceps.[1, 2, 3, 4, 5]

Avulsion of the attachments of the biceps brachii tendon are relatively uncommon according to Gilcreest,[6] the distal tendon being involved in only approximately 3% of all cases of rupture of a portion of the biceps brachii. This relative infrequency and sometimes difficult diagnosis, and the need to make the correct diagnosis so that appropriate surgical intervention can take place in a timely fashion, point to the need of additional modalities to assist the surgeon in arriving at the appropriate diagnosis.

The case report above clearly demonstrates the usefulness of Magnetic Resonant Imaging as a reliable tool to assist the clinician in arriving at the correct diagnosis of a disruption at the distal biceps brachii tendon. It provides in clear and precise detail the area of involvement as well as an objective way of evaluating the results of anatomic restoration after a surgical tenodesis.

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Peroneal Nerve Palsy: A Review Article

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ABSTRACT: A review of etiologic causes resulting in peroneal nerve palsy is presented. Factors influencing treatment with particular attention to decision making and indications for nerve exploration are offered. Results after partial injury and complete nerve transection as well as neuropraxic lesions are compared.
KEY WORDS: Peroneal neuropraxia, peroneal palsy, common peroneal nerve palsy.

Since Gerhardt[22] in 1923 first described peroneal nerve palsy in a man who had fallen asleep with his legs crossed, many other causes have been recorded. Etiologic factors in peroneal nerve palsies usually fall into one of these categories listed in Table I.

The common peroneal nerve becomes vulnerable to injury due to its unique anatomic course. Of the two terminal branches of the sciatic nerve, the tibial is the better protected and more deeply placed in the popliteal fossa. The fate of the common peroneal nerve's final path is embryologically determined. During hind limb development, marked limb rotation forces the peroneal nerve lateral and ventrad over the head and neck of the fibula. Its course over the periosteum of the proximal fibula is covered only by skin and subcutaneous tissue. From here it passes beneath an arcade of fibrous tissue comprising the most proximal origin of the peroneus longus muscle. Just before the nerve enters the peroneus longus, it is held apposed to the bone and muscle via attachments of deep fascia. Thus, not only is the nerve fixed at this site, but it is also angulated where it has acutely turned laterally before being flattened between the two heads of the peroneus longus.

Clinically, common peroneal nerve palsy leads to paralysis of foot dorsiflexors and evertors with recognizable foot drop deformity. The foot becomes plantarflexed and inverted, being unable to dorsiflex against gravity in complete nerve lesions. Sensory deficits over the anterolateral aspect of the leg and dorsum of the foot is the rule. Compression neuropathies in general tend to impair motor to a greater degree than sensory function.[26] Carney[9] described a "dimple sign" over the fibular neck caused by pressure from the contralateral patella in the crossed-leg position. Rose[2] et al found that in all twenty-three patients in his series, motor fibers of the tibialis anterior and extensor hallucis longus were affected, while eighty-seven percent of the patients had sensory dificits in the first toe web space.

Seddon[12] has classified traumatic nerve lesions into three degrees of injury. First degree injuries, or neuropraxic lesions, are mild traction and compressive lesions without axonal degeneration. Axonotmesis, or second degree injury, infers disruptive axons in their myelin sheath but with intact endoneural tubes to guide axon regeneration to their peripheral innervations. Severe injury, termed neurotmesis, is reserved for nerves severed completely or crushed so extensively that regeneration is not possible.

Peroneal Nerve Palsy Associated with Fractures and Dislocations

Injury to the common peroneal nerve ranks third in frequency (behind radial and ulnar) of all neuropathies caused by fractures.[16] Palsies associated with fractures may be due to spurs, bony fragments, or interposition between bone ends after attempts at reduction.

Traction or stretch injuries secondary to dislocation cause nerve damage more frequently than seen after fractures. Neuropathies related to a dislocated joint are suspect due to fascial envelopes that hold the nerve close to the bone near joints. Dislocations thus cause stretching of the nerve with a

TABLE I

KNOWN CAUSES OF PERONEAL NERVE PALSIES

PRESSURE-RELATED
- Crossed legs[22]
- Animal bites
- Bandages, casts[15]
- Obstetrical[25]
- Hematoma[14]
- Knee hemarthrosis[2, 3]
- Anticoagulant therapy[27]
- Ganglion cysts[5]
- Tubor fibular neck[28]
- Post-cerebrovascular accident[8]
- Patient's position on operating table[7, 10, 11]
- Gunshot wounds[12]

DIMINISHED SOFT TISSUE OVER NERVE
- Nutritionally depleted
- Elderly

ISCHEMIC CAUSES
- Occlusion femoral/popliteal arteries[26]
- Thrombosis vasa nervosum

SYSTEMIC DISEASES
- Diabetes
- Hemophilia
- Rheumatoid arthritis
- Gout
- Leprosy
- Guillian-Barre
- Hypothyroidism
- Hypothermia[10]

STRETCH OR TRACTION INJURIES
- Ankle inversion injury[6, 13, 14]
- Fracture, dislocations knee[16, 18]
- Superior dislocation, proximal fibula[1]
- Motor vehicle accidents
- Prolonged squatting (occupational)[4]
- Post-total knee arthroplasty[2]
- Adduction injuries knee[19, 20, 23]

resultant axonotmesis lesion. Kennedy[17] reports eighteen percent neuropathies following knee dislocations.

Peroneal Nerve Palsy in Missile Wounds

High velocity missile wounds travel greater than 2,000 to 2,500 feet per second at impact. Pressure disruption of the tissues often causes neuropathies without transection of nerve fibers. Low velocity missile wounds, i.e. those from shotguns and civilian hand guns, usually disperse a smaller shock wave and less cavitation. Omer, based on analysis of 595 gunshot wounds from the Vietnam War, found that spontaneous recovery of clinical function is the same (sixty-nine percent) from low and high velocity missile wounds.[31] The exception is gunshot wounds, which carry a spontaneous recovery rate of only forty-five percent.[32]

Peroneal Nerve Palsy and Severe Stretch Injuries

Severe stretch injuries to the peroneal nerve are usually related to trauma about the knee. Hyslop[13] has reported cases of neuropathies following ankle inversion injuries. Nobel[14] with cadaveric dissection, showed that a strenuous inversion force at the ankle caused ten to twenty-five millimeters of excursion of the common peroneal nerve. He hypothesized that this stretch injury may disrupt nutrient vessels leading to hemorrhage into the nerve sheath, resulting in delayed symptoms after hematoma formation.

Factors Influencing Treatment

The latent period between nerve injury and the onset of spontaneous recovery is worth emphasizing. This feature of the nerve regeneration cycle implies that considerable delay may occur without adversely affecting the recovery course and end result. Clinically, return of voluntary contraction in paralyzed muscles or the appearance of Tinel's sign (after a complete lesion) is accepted as marking the onset of recovery of nerve function.

Sunderland[24] has provided guidelines for latency periods in each degree of peroneal nerve injury. Neuropraxic

lesions have latent periods from one to five months. In axonotmesis injuries, recovery is dependent upon regeneration of axons. Expectant onset of recovery can be: [1] calculated from knowledge of distance to muscle denervated, or [2] obtained from clinical data in large series.

Axon growth rate of the common peroneal nerve is about two millimeters per day at the knee, but only one millimeter per day lower in the leg.[24] Latency periods for common peroneal nerve axonotmesis lesions display wide variability and poor correlation between causative factor and severity of nerve lesion in Sunderland's series.[30] Many cases of nerve compression at the fibular neck incurred delays of fifteen to nineteen weeks, while after gunshot wounds delays as brief as four to five weeks were documented. Berry and Richardson,[33] after reviewing seventy-five cases of common peroneal nerve palsy with electrophysiologic data, noted recovery varying from within two to fifteen months after injury.

Electromyographic analysis should be delayed at least one month after suspected nerve injury to permit Wallerian degeneration to occur.[17] Further evidence of clinical recovery should be followed with monthly electrodiagnostic and clinical examinations.

Decision Making in Peroneal Nerve Palsies

Patients with peroneal nerve palsies fall into two categories: [1] those with evidence of nerve damage due to a previous injury, in whom no improvement in function is seen or deterioration is noted. Nerve exploration without delay is advocated,[24] and [2] those with an acute injury with partial or total loss due to an open or closed wound. Partial loss indicates a lesion in continuity. Repeated clinical assessments and time are needed to portend nerve regeneration. A total neurologic deficit of both deep and superficial peroneal nerves could result from: [a] complete transection of the nerve, [b] partial severance with prospects of nerve recovery in those fibers in continuity, and [c] a lesion in continuity that will recover spontaneously.

Distinction of these two major categories in patients who present with peroneal nerve palsies becomes easy if the nerve is visible in an open wound but more difficult if hidden in an open wound or a closed injury. Under these latter conditions, one cannot determine the nature of nerve injury from a single physical examination, nor is it possible to decide whether the lesion will spontaneously recover or require surgical repair. Mild stretch and compressive lesions are best treated by removal of the offending cause, i.e. avoidance of crossed leg sitting, removal of casts or bandages, change from occupations requiring prolonged squatting [farm workers, miners], excision of tumor or hematoma, etc. Most partial lesions of peroneal nerve injury may be expected to recover and should be supported by devices to prevent plantarflexion and the development of equinovarus deformity. Insensate areas of the feet must be well padded.

Indications for Nerve Exploration

1. Severe traction lesions, especially associated with knee dislocations or adduction trauma to the knee, tend to fare poorly. These cases should be explored to assure nerve continuity and to assess prospects of nerve repair.[24, 33] Neuropathies arising after dislocation are less likely to show spontaneous return of function than those injuries associated with fractures.[17]

2. Despite the high incidence of spontaneous recovery of nerve palsies after fracture,[24] exploration is indicated should signs of nerve involvement develop after reduction efforts.

3. Open gunshot wounds with neuropathy demand debridement, irrigation, and exposure of suspected nerve lesions. High velocity gunshot wounds with neuropathies may be watched for nine to ten months since about 70% of these palsies will recover spontaneously within nine months.[17]

4. Lacerations with acute nerve palsy should be followed by neurorrhaphy when indicated.

5. Low velocity gunshot wounds may require a "second look" operation three to four months post-injury if a clinically complete nerve palsy per-

sists.[17] Knee dislocations and comminuted or intra-articular fractures may also benefit from this approach, although others would advocate deferring surgical exploration to six months post-injury.[33]

Kline[21] has found sixty percent of these nerves will have a neuroma-in-continuity and has described a technique to stimulate and record action potentials across the neuroma. Clinical spontaneous recovery has been noted in almost ninety percent of these nerve palsies when an action potential has been present across a neuroma-in-continuity at three months post-injury. Based on this data, decisions regarding resection of a neuroma-in-continuity should be cautioned.

Reports of surgical repair of peroneal stretch and neurotmetic lesions are varied. Highet and Holmes[19] reported eight cases after lateral knee ligament tears. Four showed complete transection and four had gross changes. Only one of six patients having neurorrhaphies recovered any function, with nerve exploration being performed four to eleven months post-injury. White[34] has described six traction injuries to the common peroneal nerve after adduction knee trauma. Two disrupted nerves were sewn, with good functional results, and four with lesions in continuity recovered well, with the author advocating exploration at three months. Berry and Richardson[33] deferred their exploration of five patients to six months post-injury, and four recovered function. Meyers[35] reported fourteen peroneal nerve palsies with only two regaining nerve function.

Most agree upon surgical exploration if a penetrating or lacerating injury produces a recognizable peroneal nerve deficit. Also, cases of absent nerve conduction with no surviving motor units warrant exploration. Grantham[29] concluded from his analysis of end-to-end repairs of peroneal lesions that successful return of function was dependent upon: [1] a critical gap distance, and [2] undue tension at the suture line. Grantham felt that the maximum defect in the common peroneal nerve which can be repaired by end-to-end suturing was 8.1 centimeters for lesions between the distal one-third of the thigh and the popliteal region. The critical gap distances for superficial and deep peroneal nerves are 2.5 centimeters and 1.5 centimeters respectively for neurotmetic lesions distal to the fibular neck.

Factors providing optimal chances for recovery after surgical nerve repair are: [1] more distal lesions, [2] minimal soft tissue injury, [3] microsurgical techniques, [4] avoidance of tension at the suture line, and [5] autografts for large nerve gaps.

Berry and Richardson[33] noted moderate recovery in four of nine patients with complete peroneal nerve palsies. This contrasts with one-third of the patients in Seddon's series.[36] Thus, foot support devices will be required if no recovery is evident and remedial surgical treatment is that of tendon transfer with or without triple arthrodesis.

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