Closed Treatment of Subtrochanteric Fractures of the Femur in a Modified Cast-Brace

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ABSTRACT: **We studied a series of fifteen consecutive subtrochanteric fractures treated in a long quadrilateral cast-brace with a pelvic band. Patients with severely comminuted fractures in which stability cannot be obtained by internal fixation, as well as those with open fractures, are considered candidates for such treatment. Treatment with preliminary traction followed by an ambulatory cast-brace with a pelvic band resulted in a shorter period of treatment, an excellent range of motion of the hip and knee, and no non-unions in the fifteen comminuted or open fractures. Shortening, angulation, and rotational deformity were not significant complications. It must be emphasized that this treatment regimen requires exacting attention to detail by the treating physician. The amount of time needed from the physician in this form of treatment is considerably greater than that after open reduction and internal fixation.**

Subtrochanteric fractures have been reported to constitute 7 to 10 per cent of proximal femoral fractures[16], and have the highest incidence of delayed union, non-union, implant failure, and varus and rotational deformities after treatment[6,7,9,14,27,29-31,33]. Because of this, authors recently have concentrated on the improvement of internal fixation devices for the management of subtrochanteric fractures[2,9,18,19,34]. The Zickel intramedullary nail[34], the Samson subtrochanteric nail[19], and the AO condylar blade-plate are examples of recently developed devices that have been reported to obtain good results in the treatment of selected subtrochanteric fractures.

There remains a group of subtrochanteric fractures, however, that are not amenable to open reduction and rigid internal fixation of any type because of severe comminution or because they are severe open injuries[26]. It is this group of patients in which closed treatment, consisting of preliminary traction followed by the application of a long cast-brace with a pelvic band and early ambulation, has proved quite successful.

The closed treatment of proximal femoral fractures in the elderly patient has been abandoned appropriately due to the high rate of formation of decubitus ulcers, pneumonia, urinary tract infection, and subsequent mortality; open reduction and internal fixation has become the recommended treatment in such patients[10,23,28]. Two current textbooks did not even consider the technique of closed treatment of subtrochanteric fractures[29,32]. However, severely comminuted and open subtrochanteric fractures do occur in younger patients, in whom closed treatment can be both acceptable and desirable.

We reviewed the cases of a consecutive group of patients with subtrochanteric fractures. All were treated initially in traction followed by the application of a long quadrilateral cast-brace with a pelvic band. Subtrochanteric fractures are defined in this study as those fractures of the proximal part of the femur in which a portion of the fracture line lies between the lesser trochanter and a horizontal line five centimeters below it[26]. Extension of a fracture into the trochanteric mass did not eliminate it from the subtrochanteric group[9].

The classification of subtrochanteric fractures has been discussed by many authors. Boyd and Griffin included these fractures as a subgroup of intertrochanteric fractures[7]. The classification of Fielding and Magliato[14] is well known but does not take into account comminution or the direction of fracture lines. The fractures in this series were classified according to the scheme proposed by Seinsheimer[26] (Fig. 1).

Materials and Methods

From May 1971 to March 1979, 100 subtrochanteric fractures were treated at the University of Texas Health Science Center in San Antonio. Of these, fifty-six underwent primary open reduction and internal fixation and therefore were excluded from the series. This left a group of forty-four patients whose fractures were treated closed. Nineteen children younger than sixteen years old were excluded. Two patients died from multiple injuries, and two patients with severe head injuries were treated entirely in traction prior to their transfer to nursing homes.

The remaining twenty-one patients were treated initially in traction followed by the application of a long quadrilateral cast-brace with a pelvic band and early ambulation. Fifteen of these twenty-one patients were available for follow-up and form the basis of this study. The average

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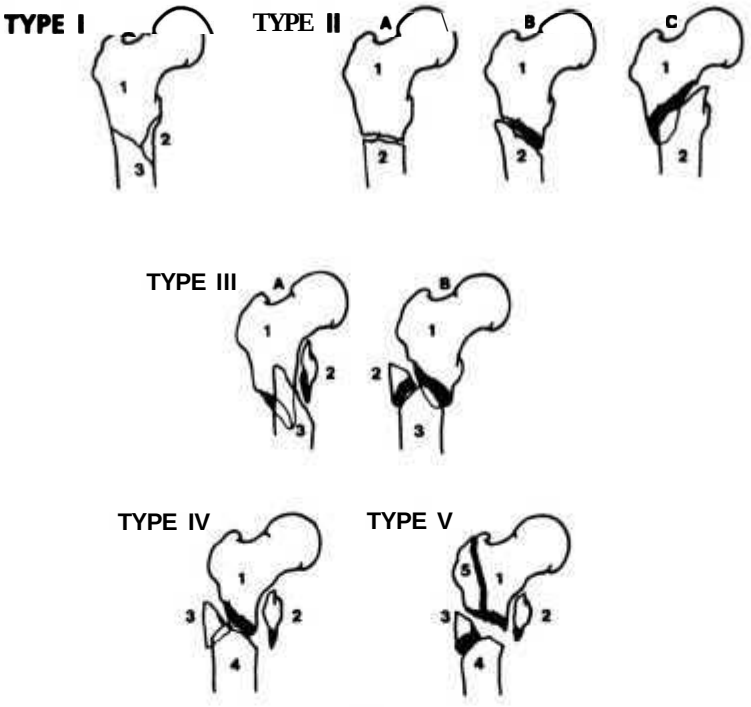

FIG. 1

Seinsheimer's classification of subtrochanteric fractures[26].

follow-up was 38.3 months, with a range of fourteen to 102 months.

The average age of the patients who were treated operatively was 50.5 years, with a range of seventeen to eighty-four years. The average age of the patients who were treated by the closed technique was 27.4 years, with a range of sixteen to sixty-three years. There were two female and thirteen male patients.

In the fifteen patients in our series, the mechanism of injury was a motor-vehicle accident in ten, a motor-vehicle-pedestrian accident in three, a fall in one, and a gunshot wound in one. Associated injuries included one patient each with a fracture of the ipsilateral lateral femoral condyle and an anterior cruciate ligament injury, an acromioclavicular separation, multiple rib fractures, multiple metatarsal and phalangeal fractures in the foot, and a mandibular fracture. Two patients had fractures of the ipsilateral tibia. Other injuries included a concussion and several severe soft-tissue injuries.

Of the fifteen fractures treated conservatively, five were open injuries, including one that was associated with a gunshot wound. The open fractures were treated with thorough débridement in the operating room. Antibiotics were used for three to five days after injury. All wounds initially were left open, closed secondarily, and healed without chronic soft-tissue infection or osteomyelitis.

In nine of the ten closed fractures, closed treatment was elected on the basis of the fracture being too comminuted to obtain stable internal fixation (Fig. 2, *A*). There were no Type-I, one Type-II, three Type-IIIa, two Type-IIIb, two Type-IV, and two Type-V fractures according to Seinsheimer's classification[26].

We used 90-90 traction (Fig. 3) in eleven patients in whom the proximal fracture fragment assumed a position of marked flexion, abduction, and external rotation. In four patients the proximal fragment was not flexed.

Four patients were treated with femoral pin traction and ten, with tibial pin traction. One patient who was treated with 90-90 traction with a tibial pin subsequently required a femoral pin because of symptoms in the knee.

All patients were seen personally by one of us and were evaluated for union, angulation, rotational deformity, shortening, and range of motion of the hip and knee joints.

Technique

All patients initially were placed in skeletal traction with the limb in a Thomas splint with a Pearson attachment by means of a Steinmann pin through either the tibial tubercle or the distal part of the femur and with the hip in slight flexion. Eleven kilograms (twenty-five pounds) of weight was used initially, which was decreased appropriately if the roentgenograms made forty-eight hours later showed distraction. Forty-eight hours after the initiation of traction, the patient was taught quadriceps-setting exercises and then progressed to resistive quadriceps exercises. If the initial roentgenograms showed the proximal fragment to be flexed, abducted, and externally rotated, the traction was changed to the 90-90 configuration to align the distal with the proximal femoral fragment (Fig. 3)[20]. The 90-90 position is comfortable for the patient and good roentgenograms are relatively easy to make. Regardless of the position of traction, maintenance of adequate reduction of the fracture must be demonstrated on both anteropos-

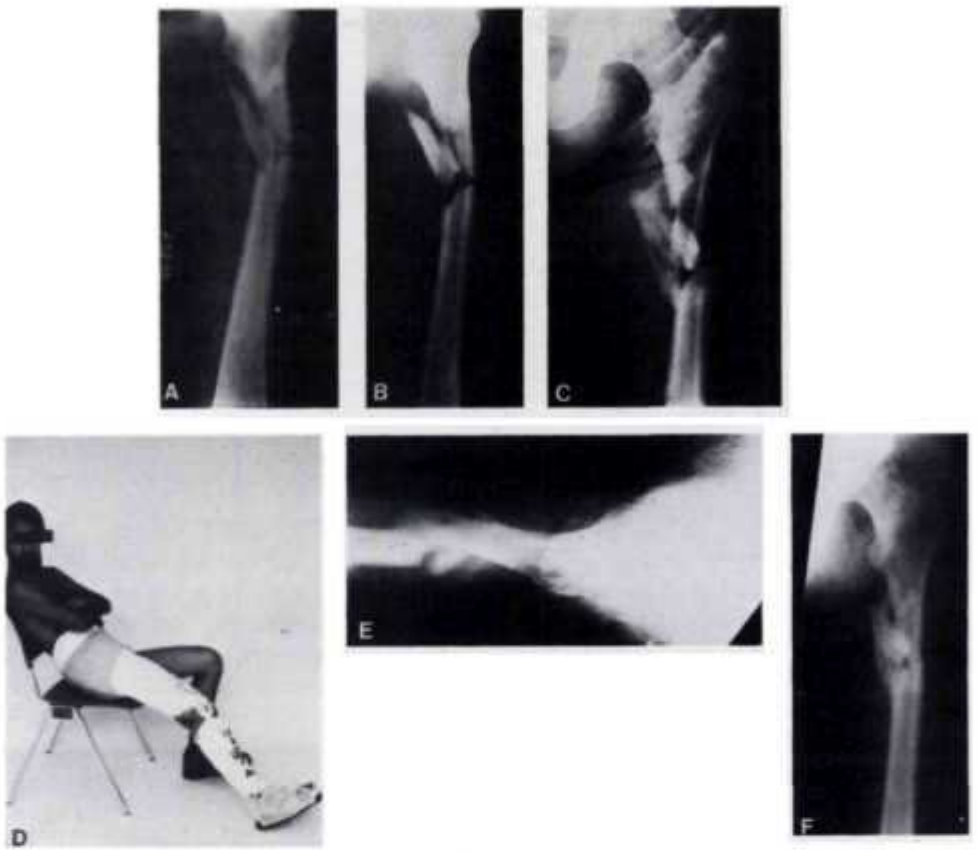

FIG. 2

Anteroposterior roentgenograms of a patient with an open, comminuted subtrochanteric fracture *(A, B. C,* and *F).* At the end of the third week in traction *(B)* there is only a trace of ossification at the fracture site. In the cast (C), there is no varus malalignment. The narrow pelvic band allows the patient to sit at an angle in a standard chair (D). Anteroposterior (*F*) and lateral roentgenograms (*E*) were made at the time of cast removal.

terior and lateral roentgenograms — that is, more than 50 per cent apposition of the fracture on both roentgenograms, a 135-degree neck-shaft angle (if the trochanteric mass is involved) on the anteroposterior roentgenogram, and no more than 10 degrees of angulation on the lateral roentgenogram. The 90-90 position is maintained for three weeks. During the fourth week, hip flexion is decreased daily until the lower limb is flat on the bed. Serial roentgenograms are made to ensure continued proper alignment. By the end of the third week early healing at the fracture site usually is present, and gentle movement of the thigh is not painful to the patient. Roentgenograms made at this time usually do not reveal more than a trace of visible callus at the fracture site (Fig. 2, *B).* We have learned from experience that one cannot go from 90 degrees of hip flexion to full extension too rapidly, as anterior angulation will develop at the fracture site. If hip flexion is gradually decreased over seven to ten days, however, angulation will not occur.

When the described criteria for early healing of the fracture have been met. the traction is removed and the cast is applied.

The patient is placed on a standard fracture table with the feet secured to the foot rests. Without anesthesia, the Steinmann pin is removed and the fractured lower limb is positioned in 15 to 20 degrees of abduction (Fig. 4. *A).* Anteroposterior and lateral roentgenograms are made to check the fracture alignment. A standard long cast incorporated into a fifteen to twenty-centimeter-wide pelvic-band then is applied over a stockinette or a Fracture Cast Sock (Knit Rite, Kansas City, Missouri) with felt padding around the pelvis, in the groin, and behind the ankle. Only minimum sheet wadding is used to protect bone prominences. The knee is maintained in zero degrees of extension and the hip, in zero or 5 degrees of flexion. Then one layer of elastic **plaster** covering the entire lower limb is applied, followed by the application of regular **plaster**. While it is still wet, the thigh portion of the cast is molded anteriorly, laterally, and posteriorly. This can be done by using the jig employed in preparing the type of immediate-fitting cast that is used after an above-the-knee amputation. Alternatively, by using two flat boards, one laterally and one posteriorly, and the heel of the hand to mold a depression in the femoral triangle, the cast can be snugly fitted to the thigh. Some correction of any significant residual angulation is possible by adjusting the position of the lower limb in traction. The pelvic band is incorporated further into the **plaster** around the thigh with **plaster** splints (Fig. 4, *B).* The pelvic band must be sturdy and secure to ensure that the involved lower limb is **main-**

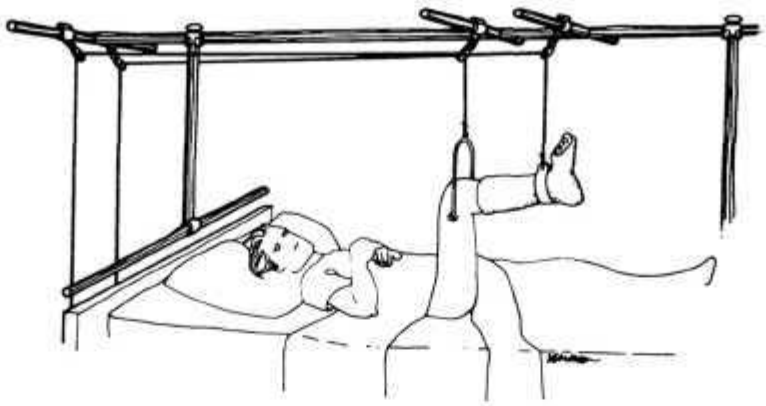

FIG. 3

With the patient in 90-90 traction, a pin is placed in the distal part of the femur and a short cast is applied with the ankle in the neutral position in order to support the leg. Anteroposterior and lateral roentgenograms are relatively easy to make with the patient in this position.

tained in the necessary 15 to 20 degrees of abduction. A second set of roentgenograms is made and any angulation is corrected by wedging the cast (Fig. 2, *C).* The neck-shaft angle should be 135 degrees on the anteroposterior roentgenogram and zero degrees on the lateral roentgenogram. At the fracture site, we accept only a maximum of 5 degrees of varus angulation and 10 degrees of valgus angulation on the anteroposterior roentgenogram, and 10 degrees of angulation on the lateral roentgenogram. Twenty-four hours later, medial and lateral windows, fifteen centimeters long and seven and one-half centimeters wide, centered on the medial and lateral knee-joint line, are cut in the cast, leaving a seven and one-half to ten-centimeter bridge anterior and posterior to the knee joint. Medial and lateral aluminum or steel polycentric knee hinges (Pope Brace Company, Greenwood, South Carolina) then are applied with plaster, using as guides the femoral epicondyles, which are exposed through the windows in the cast. Great care is taken to ensure that the axis of the hinges coincides with that of the knee joint, otherwise the knee cannot move through a full range of motion and some limitation of motion may develop. The patient then is allowed to walk with a walker or crutches with the cast bridge and hinges in place. Forty-eight hours later, when the plaster is dry and the hinges are secure, the anterior and posterior cast bridges are removed and range-of-motion exercises of the knee are begun. After removal of the bridges, the drop locks are used during walking until the patient has sufficient quadriceps-muscle power to hold the lower limb in extension with the hinges unlocked.

A seven and one-half-centimeter shoe-lift is used on the contralateral foot to functionally lengthen the lower limb. The longer limb, together with the 20 degrees of abduction of the fractured limb in the cast, causes the patient to displace the center of gravity over the injured limb when walking (Fig. 4, *C).* The longer, normal limb also maintains abduction of the fractured limb, which decreases the possibility of varus angulation.

The patient progresses from partial weight-bearing with a walker or crutches to use of a cane. Many patients use a cane throughout the period of cast-brace immobilization, but some can walk in a week without either a crutch or a cane. For the first month after discharge the patient is seen at weekly intervals so that we can make anteroposterior weight-bearing roentgenograms. Any varus angulation of more than 5 degrees should be corrected by wedging the cast. During the second month after discharge, the patient is seen at two-week intervals and weight-bearing anteroposterior roentgenograms are made to detect any change in angulation. The cast is removed twelve weeks after fracture, but if wedging has been necessary the cast is removed at sixteen weeks. Roentgenograms made at the time of cast removal usually show only minimum callus. Stress adduction and abduction roentgenograms are made if there is a question of clinical stability (Fig. 2, *E* and *F).* After cast removal the patient is ambulatory on crutches with progressive weight-bearing.

Results

The average time in traction was 4.8 weeks, with a range of 3.5 to seven weeks, and the average time in the cast-brace was 12.5 weeks, with a range of seven to twenty-one weeks.

The average time to clinical union and cast removal was 17.3 weeks, with a range of twelve to twenty-six weeks. The time to roentgenographic union averaged 18.2 weeks (range, fifteen to thirty-four weeks). All fractures united and no secondary bone-grafting procedures were needed. There were no refractures of the femur after removal of the long quadrilateral cast-brace.

By clinical measurement, there was an average shortening of the involved limb of 0.7 centimeter (range, zero to 2.5 centimeters). Angulation in the frontal plane was less than 5 degrees in all but one patient with 10 degrees of varus angulation. In the sagittal plane, anterior angulation ranged from zero to 5 degrees and posterior angulation, from zero to 10 degrees. One patient showed a loss of 15 degrees of internal rotation.

There were no cases of pulmonary infection, urinary tract infection, thrombophlebitis, or pulmonary embolism

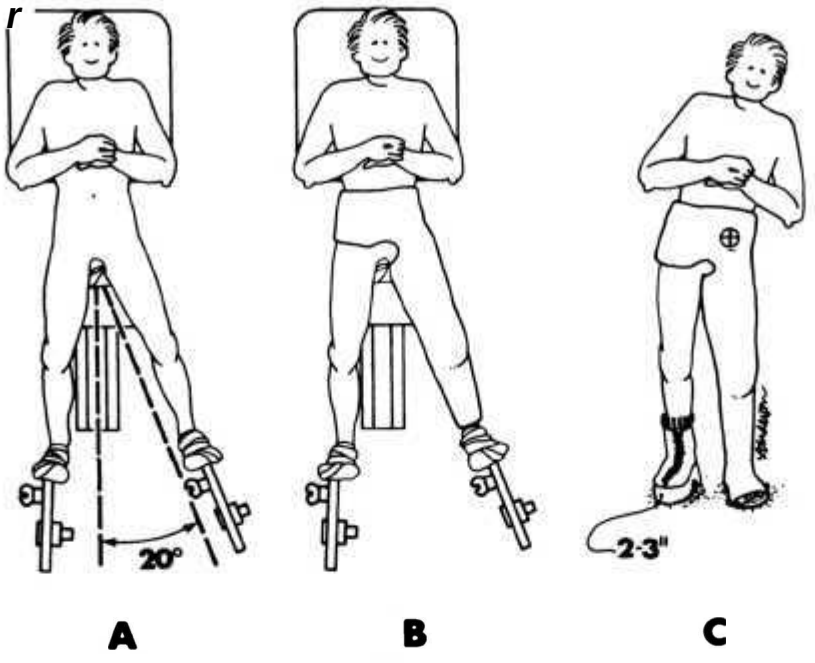

FIG. 4

A, The patient is placed on a standard fracture table with the fractured limb abducted 15 to 20 degrees for cast application. *B*, A long plaster quadrilateral cast-brace with a pelvic band is applied to the fractured extremity. Note that the extremity is kept in 20 degrees of abduction. C. After the cast has dried, a five to seven and one-half-centimeter (two to three-inch) elevated shoe is placed on the non-injured lower limb. This makes the non-injured extremity longer and thereby shifts the center of gravity (⊕) of the body over the fractured limb. This helps to maintain the abducted position of the fractured extremity and prevents varus angulation at the fracture site.

in this group. Decubitus ulcers developed in two patients while they were in traction and in one during cast treatment. There was one patient with a pin-track infection, which resolved with local care after pin removal. In one wound, after secondary closure superficial cellulitis developed, which resolved in the cast.

The average postoperative range of motion of the knee was from zero degrees of extension to 130 degrees of flexion. The most limited range of motion in a knee was from zero degrees of extension to 95 degrees of flexion in a patient with a fracture of the ipsilateral lateral femoral condyle and a tear of the anterior cruciate ligament that required surgical repair. Other post-fracture complaints in the ipsilateral knee included crepitus in eight patients, pain with vigorous activity in two patients, and pain in cold weather in three patients.

The range of motion of the ipsilateral hip was equal to that of the opposite hip in fourteen patients. Only one patient had less flexion (10 degrees) than in the opposite, normal hip.

Discussion

Before 1950, subtrochanteric fractures were treated predominantly by closed **methods**[1,23]. Improvement of internal fixation devices and techniques recently has led authors to recommend internal fixation of these **fractures**[2,5,19,26,35]. However, the results of internal fixation of subtrochanteric fractures have not been uniformly successful. The subtrochanteric area is composed of cortical bone and often is comminuted, both factors that may result in a slower rate of union[2,9,26]. Also, the large biomechanical stresses in the subtrochanteric area may result in the failure of internal fixation **devices**[15,26]. Due to these facts, several authors thought that unless *stable* internal fixation can be obtained, closed treatment should be **considered**[10,26,33].

The development of the cast-brace has decreased dramatically the time required for clinical union of femoral shaft fractures and has enabled patients to be mobile during **treatment**[11,12,21,22,25]. However, the reports of angulation and shortening in patients with fractures of the proximal third of the femur have suggested that cast-brace treatment is less satisfactory in this **group**[11,22,25]. We believe that our modifications of the cast eliminate the complication of varus angulation of the fracture.

In the literature, the reports of treatment of subtrochanteric fractures often have been included with those of hip fractures, including intertrochanteric **fractures**[7,17,23,24]. In addition, authors reporting on only subtrochanteric fractures usually have included those that occurred secondary to minor trauma in the aged patient together with comminuted subtrochanteric fractures in younger **patients**[2,4,5,13,14,16,18,19,24,26,27,30,34,35]. Watson et al. were the first to recognize that young patients with comminuted subtrochanteric fractures secondary to high-energy violence should be considered as a separate **group**[31]. These factors make comparison of previously reported series of subtrochanteric fractures very difficult.

The average age of our patients was 27.4 years, with only two patients older than forty. The associated injuries

that occurred in nine of the fifteen patients indicate the high-energy violence that caused the injury. Fielding and Magliato reported on sixty-four patients with subtrochanteric fractures whose average age was seventy-one years[14]. The mechanism of injury in this older age group usually is a simple fall. The two groups therefore pose different treatment problems, and the results are not comparable.

Five of our patients had open fractures, none of which became infected. Other series did not contain a comparable number of open fractures[9,14,26,27,30,31].

We agree with Seinsheimer, and with Winter and Clawson, that unless the surgeon is certain that stable internal fixation — that is, sound medial cortical contact and rigid lateral plate fixation — can be assured, closed treatment is recommended[26,33]. Traction was used in our series because of the comminution present in nine of the ten closed fractures (Fig. 2, *A*).

We stress that *reduction* of the fracture must be obtained to expect a good anatomical result and union[30,31]. We did not find reduction difficult, as was suggested by Cech and Sosna[9]. Velasco and Comfort[30] emphasized that even with closed treatment, a good reduction of the fracture and contact of bone fragments are necessary to eliminate a medial cortical defect at the level of the fracture. Watson et al.[31] stated that if closed reduction cannot be obtained, it may be due to embedding of the comminuted fragments in the thigh muscles, which could result in delayed union or non-union. In each of our fifteen patients the reduction was thought to be adequate and was maintained in traction.

The degree of fracture-healing was determined in these patients by both clinical and roentgenographic examination. A fracture was considered to be healed clinically when the patient could walk without external support. These fractures produce less roentgenographically visible callus than do femoral shaft fractures that are treated similarly (Fig. 2, *F*), and abduction and adduction roentgenograms often are needed to prove that clinical stability of the fracture is present. In spite of this minimum callus formation, in no patient did progressive varus angulation occur after cast removal. The patients of Velasco and Comfort[30] required an average of 23.5 weeks for union. In the patients of Aronoff et al., six and one-half months was needed for union after open reduction and internal fixation by an intramedullary rod[3].

Boyd and Lipinsky stated that the non-union rate was increased in patients who underwent open reduction and internal fixation, and in younger patients[8], and Watson et al. reported a non-union rate of 10 per cent in subtrochanteric fractures in young patients treated conservatively[31]. However, Seinsheimer[26] and Velasco and Comfort[30] reported union in all patients who were treated conservatively. Patients treated by open reduction have non-union rates of from 12.5 per cent, as reported by Hansen and Tullos[18], to 26 per cent, as reported by Fielding and Magliato[14]. The fact that there were no patients with non-union in our series is particularly noteworthy when one considers that they all had open or severely comminuted fractures.

The greatest amount of shortening in our series was 2.5 centimeters in one patient. The average amount of shortening was 0.7 centimeter. Velasco and Comfort[30] considered shortening of more than 1.25 centimeters to be unsatisfactory. Only one of our patients had an unsatisfactory result due to shortening by this criterion.

One must consider the risk of infection after open reduction and internal fixation of subtrochanteric fractures. Of the eighteen subtrochanteric fractures treated by open reduction in the series of Heiple et al.[19], there were two cases of infection and one apparently of chronic osteomyelitis. Five of the fifteen patients in this series had open fractures, none of which resulted in either acute infection or chronic osteomyelitis.

Sarmiento[25] stated that the tendency of fractures of the proximal third of the femur toward varus angulation makes cast-brace treatment unsuitable. Mooney[22] also reported that fractures of the proximal third of the femur are less satisfactorily treated in the cast-brace. However, in the thirty-three fractures of the proximal third of the femur in the series of Connolly et al., only five patients had varus deformities of more than 15 degrees[11]. However, these subtrochanteric fractures were not classified as to the degree or presence of comminution. Of our patients, fourteen had a varus angulation of 5 degrees or less and only one had a varus deformity of 10 degrees. We believe that the pelvic band, which maintains the lower limb in abduction, and the build-up of the shoe on the contralateral foot, shift the center of gravity toward the fractured limb and prevent varus deformity (Fig. 2, *F*).

Anterior angulation ranged from zero to 5 degrees and posterior angulation, from zero to 10 degrees in this series. Sagittal angulation of this amount was not considered either functionally or cosmetically significant by previous authors[11].

We agree with others that angulation that is present after treatment usually was present prior to cast application[11], and we wish to stress the fact that angulation must be corrected while the patient is in traction. Comminution medially will lead to varus malalignment in traction unless great care is taken to prevent it. Wedging the cast to correct angulation is not always successful.

The fear of systemic complications from closed treatment of subtrochanteric fractures comes from reports dealing with elderly, poor-risk patients. In 1956, Robey demonstrated that the closed treatment of subtrochanteric fractures resulted in a higher incidence of systemic complications[24]. However, the average age of his patients was sixty-four years and they were "elderly, poor-risk patients". There were no cases of urinary tract infection, pneumonia, documented pulmonary embolism, or known phlebitis in our patients. Decubitus ulcers developed in three patients, all of which resolved without surgical care.

Range of motion and symptoms in the ipsilateral knee have not been mentioned in other papers reporting open reduction and internal fixation or non-operative treatment

of subtrochanteric fractures. The range of motion of the knee in our series was found to be quite functional and was comparable with that in other series of fractures of the femur treated with the quadrilateral cast-brace[11,22].

In none of our patients was the loss of motion of the hip clinically significant. The range of motion of the hip was normal in all patients except one with a 10-degree loss of flexion. Connolly et al. reported that six of thirty-three fractures of the proximal end of the femur that were treated with a cast-brace had "a minimal loss of hip motion''[11].

Finally, the closed treatment of subtrochanteric fractures alleviates the problem of removal of an implant in the young patient. Removal of either the Zickel nail or a nail-plate device renders the site of removal subject to refracture and requires protected ambulation for as long as three months. When this time is added to the hospitalization time for insertion and removal of the implant, the actual period of disability may be shorter in conservatively treated patients. Only Heiple et al., using the fluted Samson nail, did not recommend a long period of protective weight-bearing for the proximal part of the femur after implant removal[19].

References

1. ANDERSON, ROGER; McKIBBIN, W. B.; and BURGESS, ERNEST: Intertrochanteric Fractures. Non-Operative. Castless, and Ambulatory Method of Treatment. J. Bone and Joint Surg., 25: 153-168, Jan. 1943.
2. ARONOFF, P. M.; DAVIS, P. M.. JR.; and WICKSTROM, J. K.: Intramedullary Nail Fixation as Treatment of Subtrochanteric Fractures of the Femur. J. Trauma, 11: 637-650, 1971.
3. ARONOFF, P. M.; DAVIS. P. M., JR.; and WICKSTROM, J. K.: Subtrochanteric Fractures of the Femur Treated by Intramedullary Nail Fixation. Southern Med. J., 65: 147-153, 1972.
4. ASHER, M. A.; TIPPETT, J. W.; ROCKWOOD, C. A., JR.; and ZILBER, SERGE: Compression Fixation of Subtrochanteric Fractures. Clin. Orthop.. 117: 202-208, 1976.
5. BEAVER, R. H., and BACH, P. J.: Zickel Nail: A Retrospective Study of Subtrochanteric Fractures. Southern Med. J., 71: 146-149, 1978.
6. BOYD, H. B., and ANDERSON, L. D.: Management of Unstable Trochanteric Fractures. Surg., Gynec. and Obstet., 112: 633-638, 1961.
7. BOYD, H. B.. and GRIFFIN, L. L.: Classification and Treatment of Trochanteric Fractures. Arch. Surg., 58: 853-866, 1949.
8. BOYD. H. B., and LIPINSKI, S. W.: Nonunion of Trochanteric and Subtrochanteric Fractures. Surg., Gynec. and Obstet., 104: 463-470. 1957.
9. CECH, O.. and SOSNA, A.: Principles of the Surgical Treatment of Subtrochanteric Fractures. Orthop. Clin. North America, 5: 651-662, 1974.
10. CLEVELAND, MATHER; BOSWORTH, D. M.; and THOMPSON, F. R.: Intertrochanteric Fractures of the Femur. A Survey of Treatment in Traction and by Internal Fixation. J. Bone and Joint Surg., 29: 1049-1067, Oct. 1947.
11. CONNOLLY, J. F.; DEHNE, ERNEST; and LAFOLLETTE, BRUCE: Closed Reduction and Early Cast-Brace Ambulation in the Treatment of Femoral Fractures. Part II: Results in One Hundred and Forty-three Fractures. J. Bone and Joint Surg., 55-A: 1581-1599, Dec. 1973.
12. CONNOLLY, J.F.; KING. PAUL; and DEHNE, ERNEST: *In Vivo* Measurements of Femoral-Fracture Immobilization with Early Weight-Bearing. *In* Proceedings of the Orthopaedic Research Society. J. Bone and Joint Surg.,' 54-A: 1127, July 1972.
13. DISTEFANO, V.J.; NIXON, J. E.; and KLEIN, K. S.: Stable Fixation of the Difficult Subtrochanteric Fracture. J. Trauma, 12: 1066-1070, 1972.
14. FIELDING, J. W., and MAGLIATO, H. J.: Subtrochanteric Fractures. Surg., Gynec. and Obstet., 122: 555-560, 1966.
15. FIELDING, J. W.; COCHRAN, G. V. B.; and ZICKEL, R. E.: Biomechanical Characteristics and Surgical Management of Subtrochanteric Fractures. Orthop. Clin. North America, 5: 629-649, 1974.
16. FROIMSON, A. I.: Treatment of Comminuted Subtrochanteric Fractures of the Femur. Surg., Gynec. and Obstet., 131: 465-472, 1970.
17. GOLDENBERG, R. R., and SANTORO, A. J.: The Conservative Treatment of Trochanteric Fractures of the Femur. Bull. Hosp. Joint Dis.. 12: 27-40, 1951.
18. HANSON, G. W., and TULLOS, H. S.: Subtrochanteric Fractures of the Femur Treated with Nail-Plate Devices: A Retrospective Study. Clin. Orthop., 131: 191-194, 1978.
19. HEIPLE. K.G.; BROOKS, D. B ; SAMSON, B. L .; and BURSTEIN, A.H.: A Fluted Intramedullary Rod for Subtrochanteric Fractures. Biomechanical Considerations and Preliminary Clinical Results. J. Bone and Joint Surg., 61-A: 730-737, July 1979.
20. HIBBS, R. A.: The Management of the Tendency of the Upper Fragment to Tilt Forward in Fractures of the Upper Third of the Femur. New York Med. J.. 75: 177-179, 1902.
21. KAUFER, HERBERT: Nonoperative Ambulatory Treatment for Fracture of the Shaft of the Femur. Clin. Orthop., 87: 192-199, 1972.
22. MOONEY, VERT: Fractures of the Shaft of the Femur. *In* Fractures, edited by C. A. Rockwood and D. P. Green. Philadelphia. J. B. Lippincott, 1975.
23. MOORE, MOORE, JR.: Treatment of Trochanteric Femoral Fractures with Special Reference to Complications. Am. J. Surg., 84: 449-452, 1952.
24. ROBEY, L. R.: Intertrochanteric and Subtrochanteric Fractures of the Femur in the Negro. J. Bone and Joint Surg., 38-A: 1301-1312, Dec. 1956.
25. SARMIENTO. AUGUSTO: Functional Bracing of Tibial and Femoral Shaft Fractures. Clin. Orthop., 82: 2-13, 1972.
26. SEINSHEIMER, FRANK: Subtrochanteric Fractures of the Femur. J. Bone and Joint Surg., 60-A: 300-306. April 1978.
27. SHELTON, M. L.: Subtrochanteric Fractures of the Femur. Arch. Surg., 110: 41-48, 1975.
28. TAYLOR, G. M.; NEUFELD, A. J.; and NICKEL, V. L.: Complications and Failures in the Operative Treatment of Intertrochanteric Fractures of the Femur. J. Bone and Joint Surg., 37-A: 306-316, April 1955.
29. TRONZO. R. G.: Surgery of the Hip Joint, pp. 576-582. Philadelphia, Lea and Febiger, 1973.
30. VELASCO, R. U.. and COMFORT, T. H.: Analysis of Treatment Problems in Subtrochanteric Fractures of the Femur. J. Trauma. 18: 513-523, 1978.
31. WATSON, H. K.; CAMPBELL, R. D., JR.; and WADE, P. A.: Classification, Treatment and Complications of the Adult Subtrochanteric Fracture. J. Trauma, 4: 457-480, 1964.
32. WATSON-JONES, REGINALD: Fractures and Joint Injuries. Ed. 5, vol. II, pp. 987-990. Edinburgh, Churchill Livingstone, 1976.
33. WINTER, W. G., JR., and CLAWSON, D. K.: Complications of Treatment of Fractures and Dislocations of the Hip. *In* Complications in Orthopaedic Surgery, edited C. H. Epps. Vol. 1, pp. 439-441. Philadelphia, J. B. Lippincott, 1978.
34. ZICKEL, R. E.: A New Fixation Device for Subtrochanteric Fractures of the Femur. A Preliminary Report. Clin. Orthop., 54: 115-123, 1967.
35. ZICKEL, R. E.: An Intramedullary Fixation Device for the Proximal Part of the Femur. Nine Years' Experience. J. Bone and Joint Surg.. 58-A: 866-872. Sept. 1976.