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Fractures of the Femoral Neck in Patients between the Ages of Twelve and Forty-nine Years*

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From Harborview Medical Center, Seattle

ABSTRACT: **Femoral neck fractures in young adults have a poor prognosis because the incidence of non-union and aseptic necrosis is high. We reviewed the results in twenty-seven consecutive patients with a femoral neck fracture who were younger than fifty years and who were treated with a standard protocol at Harborview Medical Center from 1975 to 1981. There were twenty-two male and five female patients, and they ranged in age from twelve to forty-nine years (mean, 32.4 years). Twenty patients were involved in high-velocity trauma and twelve of them had significant injuries to other organ systems. One of the remaining seven patients had sustained the fracture while running, and in the other six the fracture was associated with a metabolic disorder. Eight patients had a Garden Stage-II fracture; twelve, Stage-III; and seven, Stage-IV. The fractures were fixed with multiple 6.5-millimeter cancellous screws after adequate closed reduction, which was usually performed within eight hours after injury. All of the fractures united and there were no wound infections. Aseptic necrosis of the femoral head developed in five patients (20 per cent), three of whom had symptoms at the time of writing and will require surgical revision of the hip.**

Intracapsular fractures of the proximal part of the femur are not common in adults younger than fifty years old[2], but they are associated with a high incidence of non-union and aseptic necrosis[13,22]. Furthermore, aseptic necrosis is more likely to be symptomatic in the younger population[13], and both non-union and avascular necrosis are so devastating functionally that they affect not only the patient but also society. Reconstructive procedures, such as total hip-replacement arthroplasty and surface replacement arthroplasty, have a higher incidence of failure in younger, more active patients[4,7]. Therefore a critical assessment of the results of each technique for treating femoral neck fractures in young adults, as distinct from adults of all ages, is important.

In young patients, fractures of the femoral neck most often are the result of high-velocity trauma, and therefore are often associated with injury to the head, chest, or abdomen as well as other musculoskeletal injuries. In treatment, priority must be given first to the life-threatening injuries and then to the musculoskeletal injuries.

Femoral neck fractures may also occur in young patients as a result of systemic disease. Such fractures are often caused by minor trauma and have been associated with osteopenia in metabolic conditions such as chronic renal failure, steroid therapy, antiseizure therapy, and alcoholism. The results of treatment of such fractures tend to be better

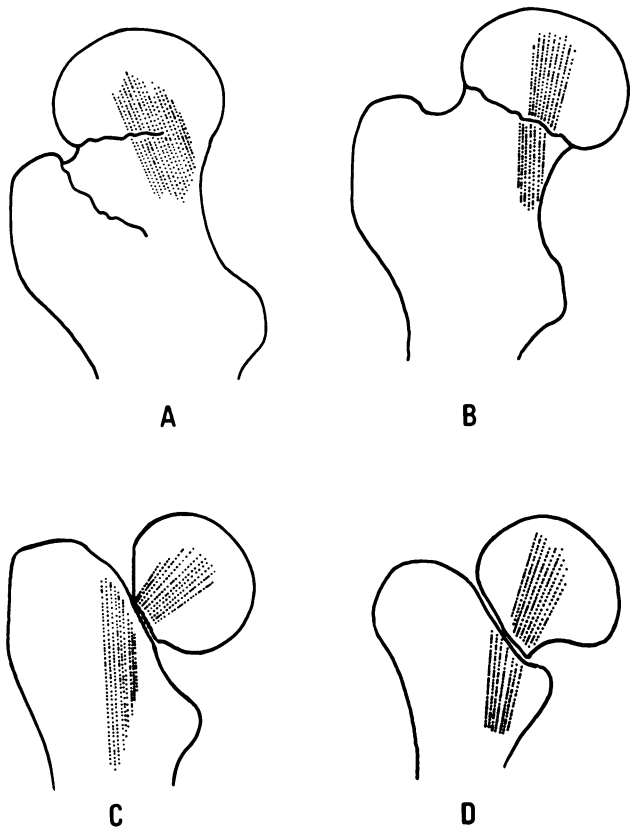

FIG. 1

A, Stage I — incomplete fracture, commonly known as the abducted or impacted fracture. *B*, Stage II — complete fracture without displacement. *C*, Stage III — complete fracture with partial displacement, but with the fracture surfaces still in apposition posteroinferiorly. *D*, Stage IV — complete fracture with full displacement; contact between the fracture surfaces has been lost, and the proximal fragment is thus free to resume its natural position in the acetabulum, as shown by the direction of its medial group of trabeculae, which lie in normal alignment with their projections in the pelvis. (Adapted with permission from: Barnes, R.; Brown, J. T.; Garden, R. S.; and Nicoll, E. A.: Subcapital Fractures of the Femur. A Prospective Review. J. Bone and Joint Surg., 58-B(1): 4, 1976.)

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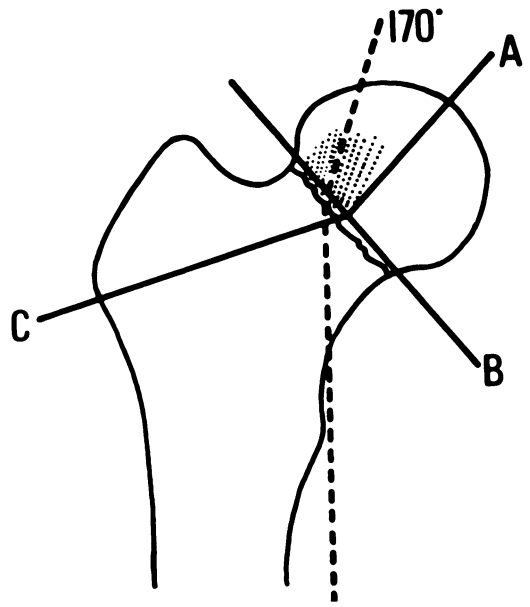

FIG. 2

Tracing from a post-reduction radiograph showing measurement points A, B, and C; the Western Infirmary, Glasgow, angle (between A and C), here 150 degrees; and the Garden angle[2], here 170 degrees. The level of the fracture is determined by dividing the distance between point C and point B by the distance between point A and point B; that is, ratio CB:AB. (Adapted with permission from: Barnes, R.; Brown, J. T.; Garden, R. S.; and Nicoll, E. A.: Subcapital Fractures of the Femur. A Prospective Review. J. Bone and Joint Surg., 58-B(1): 5, 1976.)

than with fractures due to high-velocity trauma[1], and in general they should be evaluated separately.

Reports on young patients with a femoral neck fracture[1,13,22] have emphasized not only the various devices used for internal fixation but also the importance of impaction or compression for minimizing the risk of non-union. Deyerle believed that non-union increased the risk of aseptic necrosis, and he and others[22] advocated rigid fixation for achieving union.

Since 1975 the protocol in our trauma center has been to treat a femoral neck fracture as an orthopaedic emergency immediately after injuries to the head, chest, abdomen, and vessels have been attended to. An important part of our rationale for prompt treatment of the fracture is preservation of the blood supply to the femoral head, which is critical for a satisfactory long-term result. The fracture is regarded as a vascular injury[9,10] to the bone's blood supply, and the amount of displacement is thought to correlate directly with the degree of vascular compromise[2]. Restoration of the blood supply to the femoral head follows anatomical reduction, as has been demonstrated by measurements of oxygen tension and by angiography[11,19]. The mechanism for this restoration is probably unkinking of the retinacular vessels[11,19] and removal of pressure on the vessels from fracture fragments. Nailing of these fractures has been shown to cause greater disruption of the blood supply to the femoral head than does pre-drilling and internal fixation with screws or pins[8,16,18]. Intracapsular tamponade of a hematoma has also been found to damage the blood flow to the femoral head[17,21]. On the basis of these laboratory and clinical data, we established a protocol of prompt anatomical reduction, internal fixation with compression screws, and capsulotomy to evacuate the hematoma. The femoral neck fracture was reduced and internally fixed within twelve hours after injury whenever possible. Fixation was achieved with AO 6.5-millimeter cancellous screws, which offer good compression of the fracture site[20]. We reviewed the results obtained with this protocol over a period of six years.

Materials and Methods

From June 1975 to September 1981, excluding children, twenty-seven adults younger than fifty years old were treated for a fracture of the femoral neck at Harborview Medical Center, Seattle's regional trauma center (Tables I and II). The mean age was 32.4 years (range, twelve to forty-nine years). The two twelve-year-old boys (Cases 1 and 9), who were nearing skeletal maturity, were included in the series because the risk of complications in this age group is even greater than it is in young adults[14].

Twenty-one patients were involved in high-velocity trauma (Table I): five were injured in a motorcycle accident; five, in a motor-vehicle accident; five were struck by an automobile; five were injured in a fall or jump of more than three meters; and one patient (Case 17), a cross-country runner, sustained a displaced stress fracture while sprinting. Six patients with osteopenia that was attributable to metabolic phenomena, including medication against epileptic seizures, sustained an isolated fracture of the femoral neck in a minor fall (Table II).

In the group with high-velocity injury twelve patients had injury to multiple organ systems, sixteen had multiple orthopaedic injuries, and four had an isolated femoral-neck fracture (Table I). No orthopaedic injury was given priority over the femoral neck fracture during treatment. Three patients (Cases 3, 11, and 15) sustained an anteroposterior compression-type[12] pelvic fracture and were treated with bed rest, mobilization being permitted as tolerated. One patient (Case 12) sustained an obturator hip dislocation on the contralateral side, and was treated with closed reduction and early motion. Additionally, one patient (Case 19) sustained a fracture of the fourth lumbar pedicle and was treated with a single-leg hip spica for six weeks. Twelve patients were hospitalized for longer than two weeks (range, three to fourteen weeks) and fourteen had more than a two-week delay before they could walk with crutches because of other injuries. None of the twenty patients had had a pre-existing medical condition.

At Harborview Medical Center the general surgeon, the leader of the trauma team, performs initial resuscitation and diagnostic studies and dictates the priority of each injury. In this series patients with an intra-abdominal injury, as diagnosed by a positive result on peritoneal dialysis, were taken to the operating room immediately for laparotomy. Afterward an orthopaedic team performed irrigation, débridement, and management of open fractures. In keeping with the philosophy that the condition of the multiply injured patient is often better immediately after injury than in the subsequent three to four weeks, any fracture requiring sur-

TABLE I

PATIENTS WITH FRACTURE DUE TO HIGH-VELOCITY TRAUMA

Case	Age, Sex (Yrs.)	Associated Injuries	Stage of Fracture*	Interval between Fracture and Fixation (Hrs.)	Postop. Treatment	Follow-up (Yrs. + Mos.)	Comments
1	12, M	Thoracic, splenic	IV	5	Crutches, 12 wks.	6	Malleolar screws used
2	19, M	Ipsilat. fem. fract., other fracts.	II†	10 days	Bed rest, 6 wks.; crutches, 6 wks.	5	Returned to construction work
3	47, M	Other fracts.	III	7	Crutches, 3 wks.	3 + 6	
4	35, M	Ipsilat. fem. fract.	II†	5 days	Crutches, 8 wks.	4	Returned to heavy labor
5	31, M	Ipsilat. fem. fract., other fracts.	III	5	Crutches, 12 wks.	3	
6	34, M	None	III	10	Crutches, 10 wks.	3	Working as roofer
7	34, M	Head, splenic, ipsilat. fem. fract.	III	4	Crutches, 6 wks.	3 + 4	
8	28, M	Ipsilat. fem. fract.	II	8	½ hip spica for fixat. of fem. shaft, 6 wks.; crutches, 6 wks.	3 + 3	Full range of motion, asymptomatic
9	12, M	Head, splenic, ipsilat. fem. fract., other fracts.	III	8	Traction for fixat. of contralat. fem. fract., 8 wks.; crutches, 6 wks.	4	
10	47, F	Ipsilat. fem. fract., other fracts.	II†	48	Crutches, 12 wks.	3	Weight-bearing segment collapsed 2-3 mm, early degen. arthritis, revision planned
11	31, M	Head, other fracts.	III	6.5	Bed rest, 12 wks.; crutches, 4 wks.	4 + 3	Malleolar screw used to lag fem. neck medially
12	39, F	Head, other fracts.	IV	5	Crutches, 12 wks.	3	Weight-bearing segment collapsed 3-4 mm; bipolar endoprosthesis
13	42, F	None	III	12	Crutches, 12 wks.	Lost at 4 mos.	
14	25, M	None	III	6	Crutches, 12 wks.	3	
15	28, M	Head, abdominal, other fracts.	IV	10	Crutches, 12 wks.	3 + 1	Bone-grafting done with screw removal at 18 mos. for 1-mm collapse of weight-bearing segment
16	23, M	Head, ipsilat. fem. fract.	IV	14	Crutches, 12 wks.	3 + 2	
17	19, F	None	III	5	Crutches, 12 wks.	2 + 10	
18	22, F	Head, thoracic, abdominal, ipsilat. fem. fract., other fracts.	IV	6	Crutches, 12 wks.	1 + 6	
19	31, M	Head, other fracts.	II	8	Bed rest, 6 wks.; crutches, 4 wks.	2 + 5	Weight-bearing segment collapsed 1 mm, no degen. changes
20	37, M	Ipsilat. fem. fract., other fracts.	IV	5	Crutches, 12 wks.	2 + 3	
21	42, M	Ipsilat. fem. fract., other fracts.	IV	4	Crutches, 12 wks.	2 + 4	Subtroch. fract. (see text)

* Garden classification[2].

† The fracture was missed initially.

gical intervention was treated at the initial operation, with the femoral neck fracture being given the highest priority.

There were eight Garden Stage-II, twelve Garden Stage-III, and seven Garden Stage-IV fractures (eight minimally displaced and nineteen displaced fractures)[2] (Fig. 1). The minimally displaced fractures were not the classic Stage-II injuries described by Barnes et al., but were complete and vertical, with less than two millimeters of displacement and no angulation. The fracture level, as determined by the classification of Garden[2], ranged from a ratio of 1.08 to 3.55 (mean, 1.81), the ratio being distance CB divided by distance AB (Fig. 2). These fractures therefore were in the distal part of the neck.

Twenty-two fractures were treated within eight hours after injury, and the other five had delayed treatment. Three of the delays involved patients with an associated ipsilateral femoral fracture. The femoral neck fractures were not diagnosed in those patients for forty-eight hours (Case 10), five days (Case 4), and ten days (Case 2). The fourth patient (Case 22) did not seek treatment for pain in the hip until thirty-six hours after injury, and the fifth (Case 23) was not seen at our trauma center until twenty-one days after injury.

The fractures in these patients were managed operatively, on the day of diagnosis, in the same manner as were the other fractures.

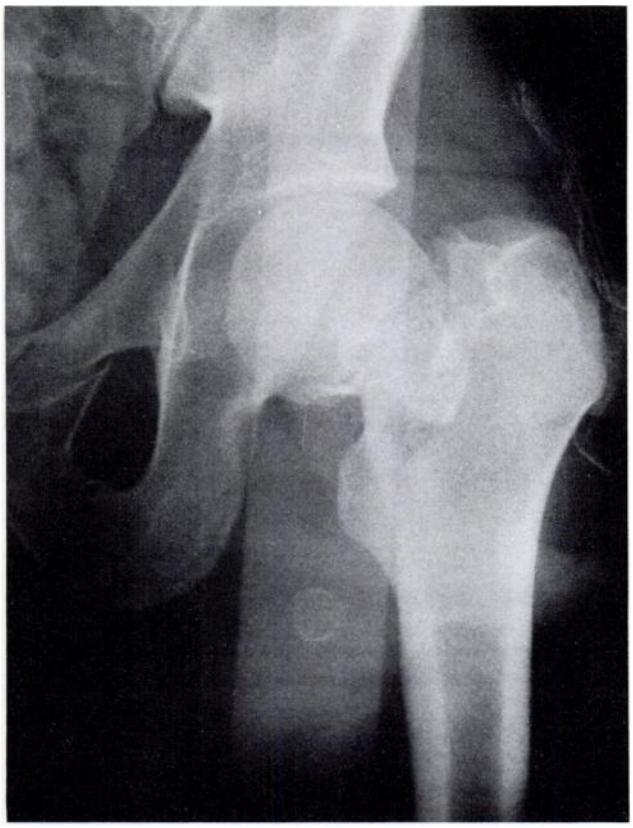

FIG. 3-A

Figs. 3-A through 3-E: Case 11, a thirty-one-year-old man.
Fig. 3-A: He sustained a Garden Stage-III fracture of the femoral neck when he jumped eighteen meters. He had a pelvic fracture, facial fractures, and a basilar skull fracture but no evidence of chest, abdominal, or genitourinary trauma.

Operative Procedure

The patient was placed on the fracture-table in the supine position and the image intensifier was positioned to allow visualization of the fracture in the anteroposterior and lateral planes. For displaced fractures (Garden Stage III or IV) a closed reduction was performed as outlined by Deyerle. The reduction was checked with the image intensifier, and the fracture was internally fixed as will be described. The reduction was then evaluated either by palpation through the capsulotomy incision (seventeen patients) or radiographically. For Garden Stage-II minimally displaced fractures, the internal fixation was performed without reduction.

In our institution, standard fixation for a fracture of the femoral neck consists of four 6.5-millimeter AO cancellous screws inserted parallel to the axis of the femoral neck in a so-called box pattern (anterosuperior, anteroinferior, posterosuperior, and posteroinferior) in order to avoid loss of reduction due to excessive compression of the posterior part of the femoral neck, which is frequently comminuted. Screws with thirty-two millimeters of thread are used whenever possible to ensure maximum compression, but screws with sixteen millimeters of thread are commonly used so that the unthreaded part of the screw will traverse the fracture.

This standard approach was not used in several patients. In one of the twelve-year-old boys (Case 1), two malleolar screws were used to avoid protrusion through the remaining open physis. In six patients we used three, rather than four, 6.5-millimeter cancellous screws. In one of them (Case 10) the screws had to be placed anterior to a Küntscher nail that was already in the femoral canal, and in the other five (Cases 2, 8, 9, 12, and 23) the cross-sectional area of the femoral neck was too small to accommodate more than

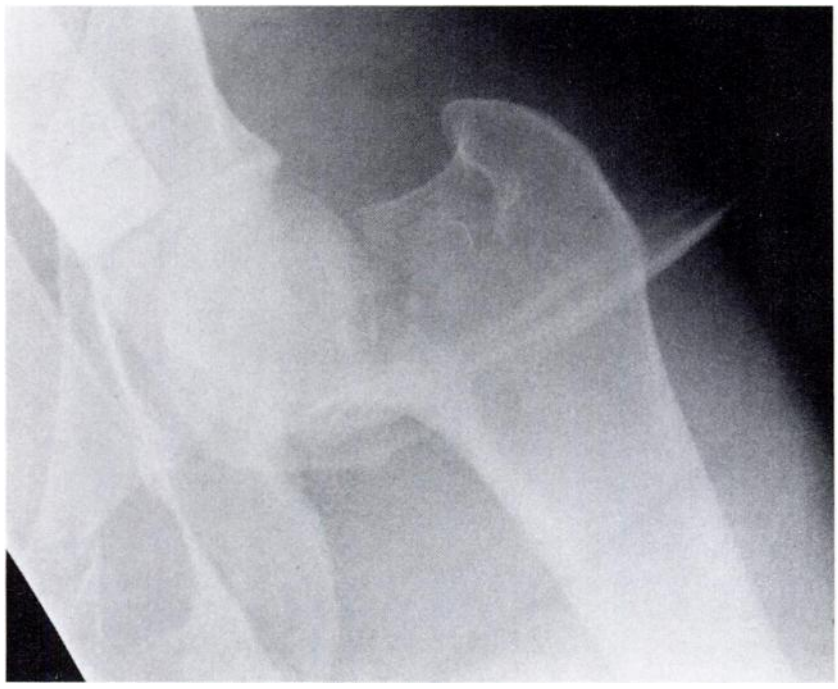

FIG. 3-B

Figs. 3-B and 3-C: The fracture was reduced.

three screws. In one patient (Case 11) five AO cancellous screws were required.

Intracapsular hematomas were evacuated by anterior capsulotomy in seventeen patients. This procedure involved extension of the lateral incision and use of the Watson-Jones approach, which allowed the reduction of the fracture to be checked by palpation. The estimated mean operative time for fixation of the femoral neck fractures, including the closed reductions, was two hours and eight minutes, but the time was difficult to establish precisely because several procedures often were performed together and it was not possible to determine exactly when one terminated and the next began. The mean estimated blood loss was 337 milliliters, but again precise figures were difficult to determine. Patients were given antibiotics (cephalosporin) preoperatively, perioperatively, and postoperatively. The duration of antibiotic prophylaxis was forty-eight hours for the first twenty patients but was decreased to twenty-four hours in the remaining seven. Unless the associated injuries contraindicated it, the patients sat up the day after operation. After discharge, six to twelve weeks of non-weight-bearing or partial weight-bearing with crutches was prescribed.

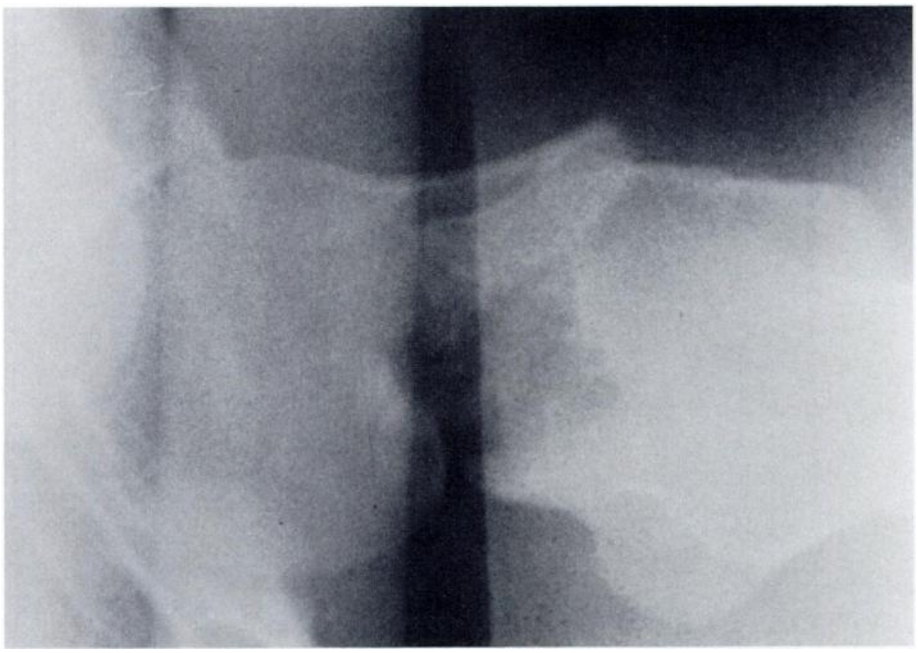

FIG. 3-C

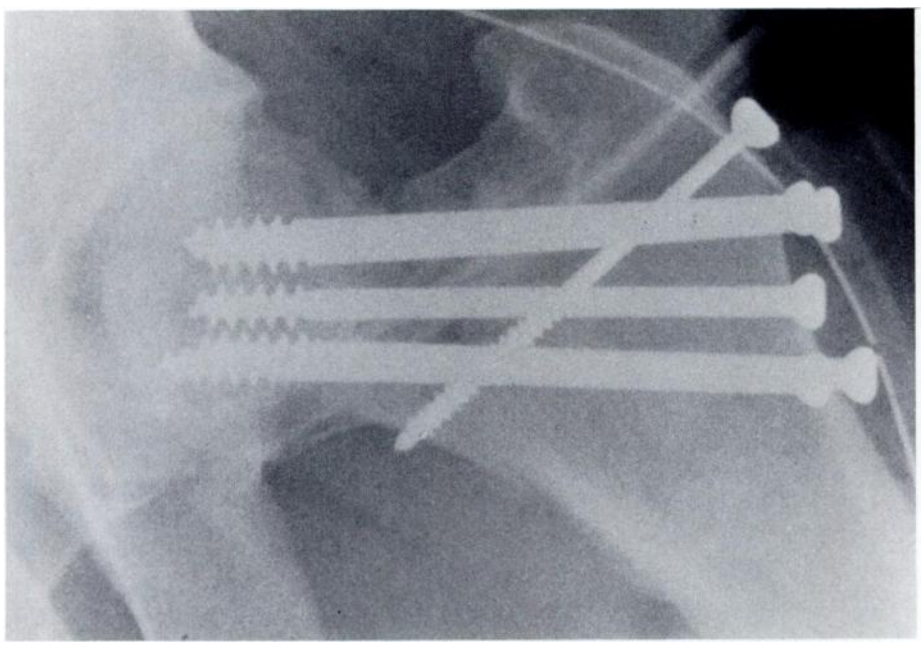

FIG. 3-D

The fracture was fixed with five AO screws after a capsulotomy.

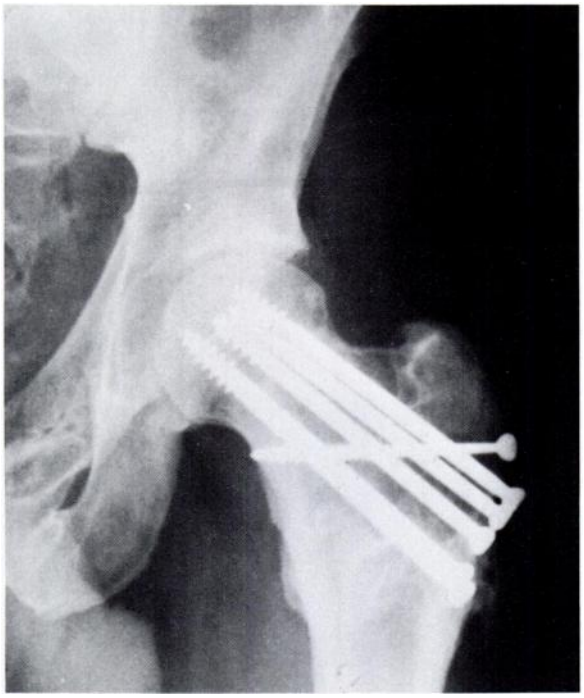

FIG. 3-E

At follow-up four years and three months after injury, the patient had a full range of motion of the left hip and no symptoms. The left femoral head had a normal radiographic appearance.

Results

All of the fractures united within sixteen weeks, as was confirmed by standard anteroposterior and lateral radiographs. The multiple injuries, long hospitalizations, and delays in active mobilization did not affect the healing of these fractures. All but three patients (Cases 13, 18, and 25) were followed for at least two years, and eighteen patients were followed for three years or longer. Follow-up evaluation consisted of an interview, an examination, and radiographs. One patient (Case 18) was followed for eighteen months, after which time she moved to a distant state and was not available for radiographic examination. The other two patients with short (four to six-month) follow-up (Cases 13 and 25) had left the country and could not be reached. Twenty-three patients were examined at final follow-up by one or more of us; the other two were examined by their local orthopaedists, who also made radiographs.

All but three patients (Cases 12, 15, and 23) of the twenty-five with adequate follow-up had obtained a full range of motion of the involved hip. A full range of motion was defined as symmetrical flexion and extension compared with the opposite, normal hip and loss of no more than 10 degrees of internal or external rotation. Nineteen of the twenty-five patients had no symptoms in the involved hip and no limitation of activity. At follow-up three years after operation, one patient (Case 6) complained of a nearly constant mild, dull ache in the involved hip, but he had normal radiographs, required no analgesics, and had returned to work as a roofer. One patient (Case 24), followed for three years and nine months, had occasional aching in the groin on the involved side. He required no analgesics or anti-inflammatory medications, had no limitations in activity, and had normal radiographs (with no evidence of aseptic necrosis).

The three patients who did not regain normal motion of the hip (Cases 10, 12, and 15) had moderate to severe pain and will require surgical revision for painful aseptic necrosis with collapse of the weight-bearing segment (Figs. 4-A through 4-F). Two other patients (Cases 19 and 23) had radiographic evidence of segmental collapse, but were symptom-free twenty-nine and thirty-six months after injury, respectively.

Evaluation of anteroposterior radiographs of the twenty-seven united fractures revealed that the Western Infirmary, Glasgow, angle ranged from 145 to 175 degrees (Fig. 2), with only two fractures having an angle that measured more than 165 degrees. The Garden angle[2] ranged from 135 to 180 degrees (two angles measured less than 145 degrees and three, more than 165 degrees). Despite mildly imperfect reduction in a few patients, union was uneventful.

The technical complications were minimum. No femoral head was penetrated intraoperatively by a drill, tap, or screw. One patient (Case 21) sustained a postoperative subtrochanteric fracture through the screw-holes, above a clo-

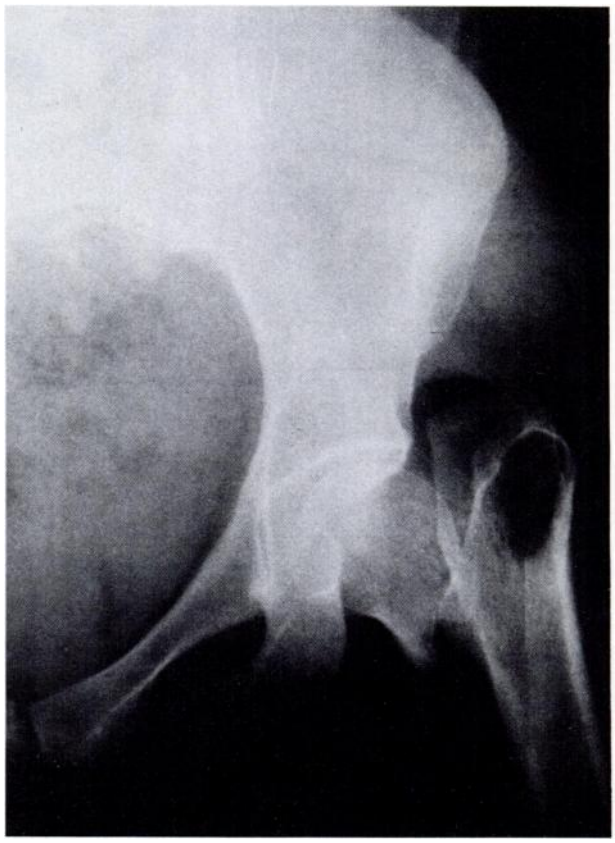

FIG. 4-A

Figs. 4-A through 4-F: Case 12, a thirty-nine-year-old woman.
Fig. 4-A: She fell five meters from a window ledge and was noted on admission to have an obturator dislocation of the right hip, severe facial fractures, a basilar skull fracture, and a Garden Stage-IV fracture of the left femoral neck.

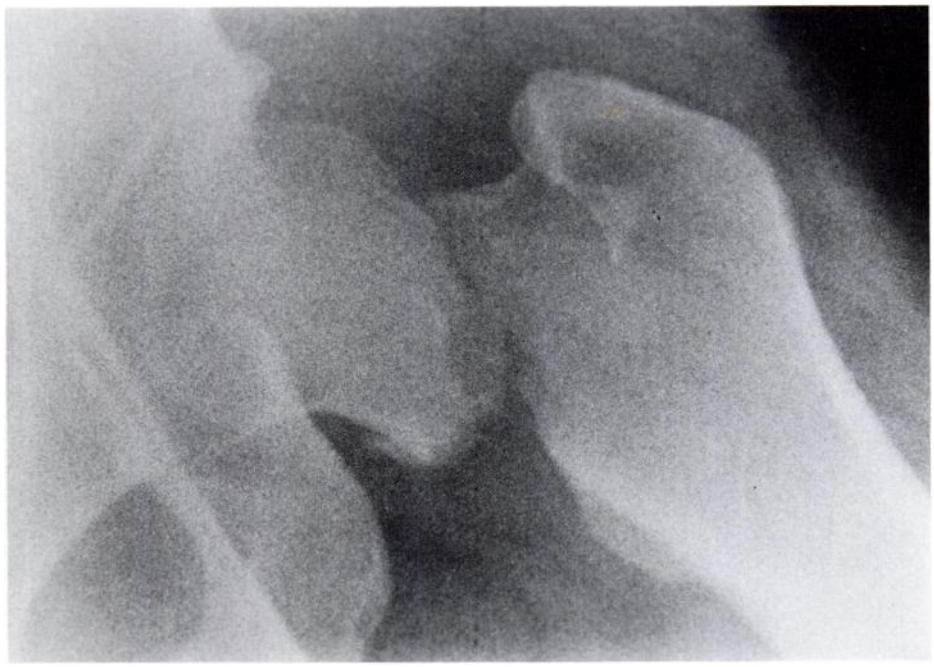

FIG. 4-B

Figs. 4-B and 4-C: After initial evaluation and reduction of the right hip, a capsulotomy and open reduction were performed. Radiographs were made after closed reduction.

verleaf nail that had been inserted in a retrograde fashion. Because this fracture occurred after the femoral neck fracture had united, it was fixed with a blade-plate. At twenty-three months the patient was asymptomatic, had a full range of motion of the hip, and had union of both fractures. We attempted to place all screws parallel to one another to allow possible settling of the fracture, but although one or more screws were out of parallel alignment by more than 3 degrees as compared with the other screws in ten patients, that technical imperfection apparently caused no trouble.

There were no wound infections. No postoperative complications could be attributed directly to the femoral neck fracture, but complications that were unrelated to the fracture occurred in several multiply injured patients: one superficial wound infection in an open femoral-shaft fracture (Case 5), one transient adult respiratory-distress syndrome (Case 4), and one prolonged respiratory compromise (Case 18). One patient reported a transient brachial-plexus palsy secondary to walking with crutches, and another sustained an ankle sprain in a fall while using crutches.

Five of the six patients (Table II) whose fractures were caused by trauma that was less severe than in the other

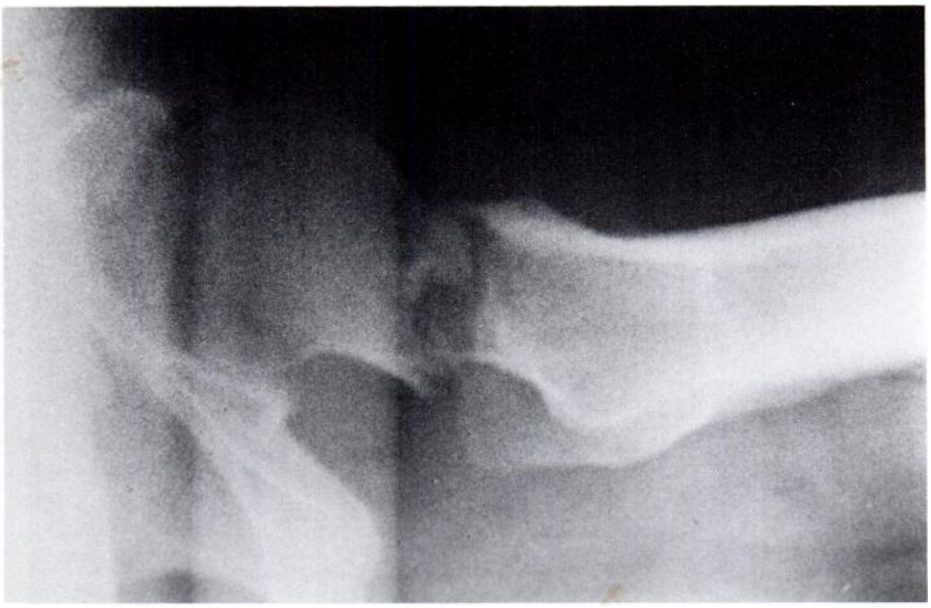

FIG. 4-C

FIG. 4-D

Figs. 4-D and 4-E: Fixation was excellent.

twenty-one and who had a significant metabolic disorder that induced osteopenia had a good result. The one exception was Case 23, who had segmental collapse.

Discussion

Most of the fractures in this series resulted from high-velocity trauma. Schatzker and Barrington theorized that high-velocity fractures of the femoral neck, as well as posterior dislocations of the hip or acetabular wall, or both, occur with the thigh in adduction. The distal location of the femoral neck fractures in our patients (mean Garden CB:AB ratio, 1.8; Fig. 2), and their tendency to a vertical orientation, seem to confirm this theory. It could be argued that because they were situated so far distally in the femoral neck they were extracapsular basilar-neck fractures and thus had a low risk for aseptic necrosis. However, against this argument is the fact that four of the five patients with aseptic necrosis in this series had a more distal fracture (CB:AB ratio, between 1.4 and 2.29). Moreover, one of the fractures was essentially undisplaced. We therefore believe that this argument is not valid. It is possible, however, that the vertical orientation of the fractures put the lateral epiphyseal artery at the superior aspect of the femoral neck at risk.

The multiply injured patient with a femoral neck fracture has an even higher risk of avascular necrosis and non-union than does the patient with an isolated injury, possibly because the isolated fracture is likely to be a low-velocity injury[1,13,22]. In their series of seventeen femoral-neck fractures in young adults, Askin and Bryan found a relatively low incidence of avascular necrosis (two patients), but only seven of their patients had multiple injuries and six of the others had low-velocity trauma. It is worth noting that the cases of their seventeen patients from the Mayo Clinic were collected over a period of thirty-six years, which reveals how infrequently the fracture occurs in young adults. In the multicenter study of Protzman and Burkhalter, twenty-two members of the military with a high-energy fracture had a higher incidence of avascular necrosis (nineteen patients, or 86 per cent) while the incidence of non-union also was high (thirteen patients, or 59 per cent). The results in these

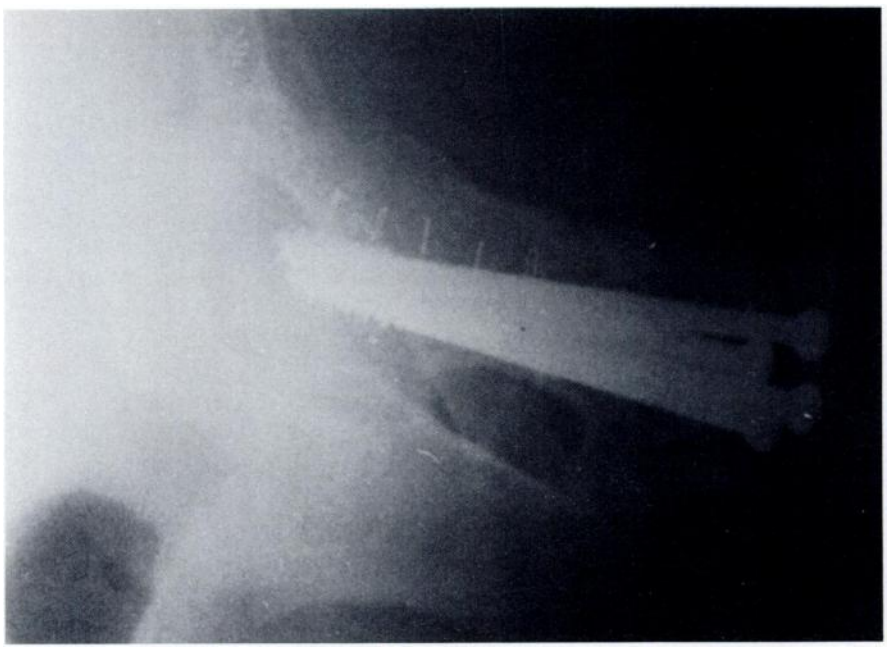

FIG. 4-E

TABLE II

PATIENTS WITH FRACTURE DUE TO LOW-VELOCITY TRAUMA AND METABOLIC FACTORS

Case	Age, Sex (Yrs.)	Stage of Fracture*	Interval between Fracture and Fixation (Hrs.)	Etiology of Osteopenia	Postop. Treatment	Follow-up (Yrs. + Mos.)	Comments
22	49, F	II	48	Antiseizure medication	Crutches, 6 wks.	4 + 3	Patient seen late
23	39, F	II	22 days	Antiseizure medication	Crutches, 6 wks.	3	Patient seen late; weight-bearing segment collapsed 3-4 mm; mod. degen. changes
24	46, M	II	14	Alcoholism	Crutches, 6 wks.	3 + 9	
25	31, M	III	8	Poliomyelitis involving injured extremity	Crutches, 12 wks.	Lost at 6 mos.	
26	26, M	III	12	Antiseizure medication	Bed rest, 6 wks.; crutches, 4 wks.	2 + 5	
27	47, M	III	6	Alcoholism	Bed rest, 12 wks.; crutches, 4 wks.	2	

* Garden classification[2].

series and in ours emphasize that treatment of fractures of the femoral neck in young adults must be evaluated separately for multiply injured patients who were involved in high-velocity accidents. Our study also showed that femoral neck fractures that are associated with metabolic factors producing osteopenia must be evaluated separately, as should fractures in older individuals with osteopenia.

In our series, we treated twenty-two patients promptly by closed reduction and seventeen by capsulotomy. Internal fixation with compression always was performed. The patients who were not operated on within twelve hours after injury had an associated ipsilateral fracture of the femoral shaft, and the fracture of the femoral neck was missed initially. Our protocol for managing this combination of fractures was described in a previous report[19]. Chapman, and Casey and Chapman, believed that most of the energy in this fracture combination is dissipated in the femoral shaft fracture, so that the femoral neck is exposed to lower-velocity trauma and there is less injury to the soft tissues surrounding the femoral neck. A lower incidence of aseptic necrosis would be expected in such patients.

We attribute the absence of non-union and the low (20 per cent) incidence of radiographic evidence of aseptic necrosis in our series to our protocol of immediate reduction and internal fixation with compression. Further follow-up is necessary to ascertain the true incidence because some patients may have late segmental collapse. We deviated significantly from the protocol in two of the five patients with aseptic necrosis. One (Case 23) was seen by us twenty-one days after fracture, and in the other (Case 10) the femoral neck fracture was not recognized or treated until forty-eight hours after injury. In this second patient the insertion

FIG. 4-F

The patient remained non-weight-bearing for three months, but painful aseptic necrosis developed. Three-year follow-up radiographs were made before insertion of a bipolar endoprosthesis.

of an intramedullary nail adjacent to the unrecognized fracture may well have caused additional damage to the blood supply to the femoral head. In a third patient with avascular necrosis (Case 12) the fracture fragments were fully displaced when the patient was seen (Fig. 4-A), and the blood supply to the femoral head may have been completely disrupted at the time of injury, so that there was no chance for its restoration when the fracture was reduced.

Although our series was too small to permit individual assessment of the effects of immediate fixation, optimum reduction, and capsulotomy, we believe that all three technical factors were important in the attainment of our results, which, compared with the other series that we have cited, were outstanding. Eighteen of the twenty-one patients with high-velocity trauma returned to their pre-injury level of function, including six patients who returned to an occupation requiring heavy manual labor. The two adolescent boys returned to competitive athletics, and a third patient (Case 17) returned to high-level competitive long-distance running.

Three of the five patients in whom aseptic necrosis developed had major symptoms at the time of writing. This result supports the findings of other series, in which younger patients with aseptic necrosis generally were symptomatic, often required secondary operations, and rarely regained their pre-fracture level of function[1,13,22].

The fixation screws were removed, mostly prophylactically, in fourteen of the twenty-five patients who were followed for more than a year. In young, active patients, it is our policy to remove the screws after twelve to twenty-four months to allow complete healing in the region of the screw-holes, with no residual areas of stress concentration. Three patients, all slender women, complained of mild tenderness over the screwheads, which resolved with removal of the screws.

In our series, the 6.5-millimeter cancellous screws provided excellent fixation. We think that parallel placement of the screws is important when the fracture is unstable because the screws can then back out if the fracture settles. No settling occurred in our patients, but it is more common in older individuals and in those with metabolic osteopenia. For the past two years, we have been using a simple template that ensures precise parallel placement of each drill-hole before the screws are inserted.

Fixation devices other than the screws that we used have been utilized successfully for femoral neck fractures, notably devices, such as Deyerle's, that depend on impaction of the fracture site and early weight-bearing to create compression, or cancellous lag screws that compress the fracture site. Triflanged or other nails should be avoided because of potential damage to the blood supply to the femoral head[18] by the blows of the mallet.

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