

Avascular Necrosis and Related Complications Following Healed Osteoporotic Intertrochanteric Fractures

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Abstract

Background: Femoral hip fractures are a common occurrence in the elderly. Of the various fracture patterns, intertrochanteric injuries have the lowest rate of complications. Case reports of ensuing subcapital fracture have all been linked to incorrect placement of fixation devices or to osteomyelitis, while cases of avascular necrosis have only been reported rarely in the literature and are considered to occur at the rare rate of 0.8%.

Objectives: To check the incidence and outcome of AVN in intertrochanteric hip fractures.

Methods and Results: In a retrospective analysis of patients who had surgical treatment for intertrochanteric fractures, 10 patients (0.5%) underwent dynamic hip screw fixation for intertrochanteric fractures and subsequently developed painful AVN as their primary presentation. Three of these patients were also found to have subcapital fractures. On revision of the primary fixation no fault was found with nail placement.

Conclusions: The reported rate of AVN may be understated since many patients have limiting factors that prevent them from consulting a physician when in pain, and one-third of these patients die within 2 years. Therefore, we suggest that hip pain following fixation of an intertrochanteric fracture should prompt the clinician to consider the rare possibility of AVN or subcapital fracture.

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Femoral hip fractures are extremely common in the western world, with an incidence in the United States of 80 per 100,000 population [1-3]. Such injuries are divided into three main categories: femoral neck (subcapital), intertrochanteric, and subtrochanteric. Femoral neck and intertrochanteric fractures account for over 90% of hip fractures, occurring in approximately equal proportions [2]. Femoral neck fractures can disrupt the blood supply to the femoral head and are therefore associated with an increased incidence of healing complications (e.g., non-union, avascular necrosis). Intertrochanteric fractures, which occur in the well-vascularized metaphyseal region, do not interfere with the blood supply to the proximal femur and are thus not associated with the healing complications characteristic of femoral neck fractures [2].

It is generally assumed that once the fracture heals there are no more foreseeable problems. In patients who have sustained intertrochanteric fractures and have healed, the late complications of AVN and subcapital fracture occur only infrequently. A review of the literature reveals only a few cases of subsequent avascular

necrosis following surgical treatment of intertrochanteric fractures, but several cases of ensuing subcapital fractures. We report here 10 cases of avascular necrosis following screw and plate fixation of intertrochanteric fractures, 3 of which had concomitant subcapital fractures.

Patients and Treatment

Ten patients aged 52-91 years sustained an intertrochanteric fracture and underwent immediate internal fixation with a dynamic hip screw and plate 1-3 days following the fracture. None of the patients had any potential known risk factors associated with AVN (such as steroid therapy, alcoholism, systemic lupus erythematosus, etc.). All patients suffered from advanced-stage avascular necrosis and the diagnosis was based on histologic and X-ray findings. These included histologic appearance of osteonecrotic zone with extensive cancellous bone loss within the reactive interface, and marginal bony reinforcement. These findings correlated with the radiographic appearance of relatively increased density triangle osteonecrotic segment accompanied by subchondral fracture or collapse. In some cases there was a typical crescent sign.

All femoral necks were set in anatomic or valgus position, with neck shaft angles measuring 135-160 degrees. Screws were placed in the central/inferior portion of the femoral neck, 2 mm deep to the femoral head cortex. All but two patients healed, were walking on the injured extremity and experienced a pain-free period.

All eight patients who healed had recurrence of pain 1-4 years later (average 2.3 years), three of whom presented with significant limb length discrepancy. No recurrent trauma was reported. X-rays showed AVN in all eight cases, with a subcapital fracture in one (Figure 1). Five underwent total hip replacement, and the histologic review of the femoral head was consistent with AVN. At the present time one patient is reluctant to undergo a total hip replacement.

The remaining two patients were not free of pain. As the result of a fall 2 months after the initial intertrochanteric fixation, one patient sustained an ipsilateral subtrochanteric fracture and could not bear weight on the injured limb for 2 months. A follow-up X-ray revealed AVN with a subcapital fracture that was not present on previous X-rays. A total hip replacement was performed 6 months after her initial intertrochanteric fracture, and a histologic review of the femoral head was consistent with AVN.

The remaining patient continued to suffer hip pain after her fixation, and X-rays 6 weeks after surgery showed signs of AVN of the femoral head with deformation and protrusion of the nail into

AV = avascular necrosis

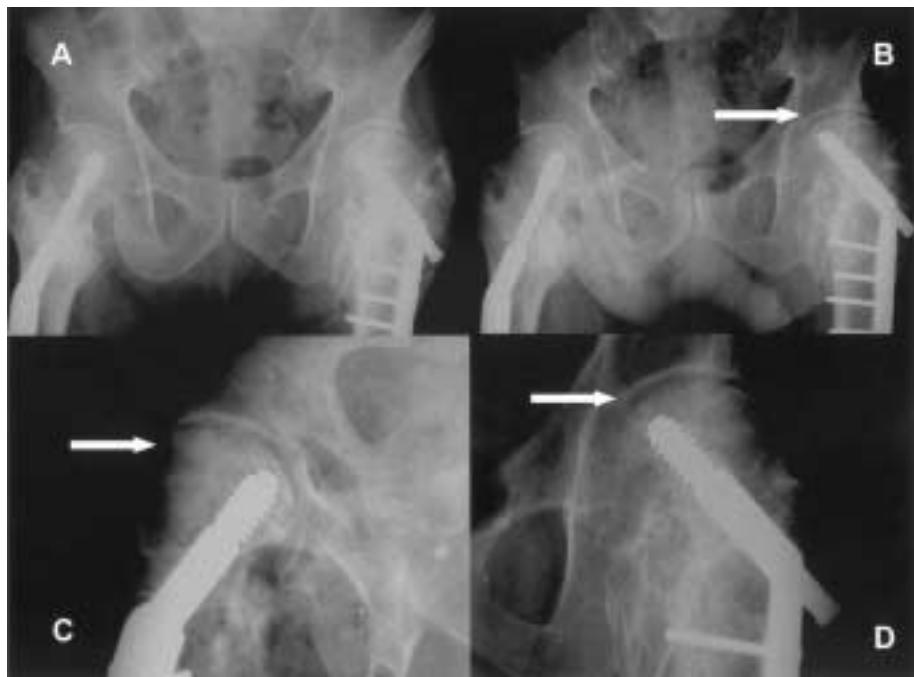


Figure 1. **[A]** Radiograph 3 months after surgery, showing bilateral dynamic hip screw fixation. The fracture in the left healed with shortening, but the articular surface looks normal. **[B]** X-ray one year later shows no change on the right hip but a narrowing and sclerosis in the left (arrow). **[C]** Anteroposterior and **[D]** lateral magnification of the left hip, demonstrating a typical radiographic picture of AVN with segmental collapse and a crescent sign.

the joint. Since the protrusion of the nail was believed to be the cause of her pain, the hardware was removed 7 months after the intertrochanteric fixation. After weight-bearing, when pain continued, X-rays showed a subcapital fracture as well. Due to the patient's general condition she elected not to undergo total hip replacement. Detailed patients' data are shown in Table 1.

Discussion

Intertrochanteric hip fractures are a frequent occurrence, with an

incidence currently estimated at 32 per 100,000 in the USA [2-4]. This figure, however, is not static. An increase in population survival is reshaping the demographics of western society, such that more people are living to an older age. As a result, the incidence of hip fractures is on the rise, with estimates projecting the number to double by the year 2040 [2,3]. At the same time, improvements in surgical techniques and rehabilitation programs have meant that more people are surviving fractures and returning to independent living. Consequently, rare complications such as AVN, which may follow subcapital fracture, will be seen more often by the orthopedic surgeon of the future. We report here 10 cases of intertrochanteric fractures complicated by AVN, and 3 cases with concomitant subcapital fracture.

Intertrochanteric fractures occur through metaphyseal cancellous bone, which has an excellent blood supply, and usually unite regardless of the mode of treatment [4]. Today, these fractures are

mainly treated with reduction and internal fixation via a sliding hip screw construct. Short-term complications including double vessel disease and wound infections can and do occur. In the past, these factors combined with the inability to regain presurgical general health led to mortality rates of up to 30% in the first year after fracture [4].

Mechanical and technical failure is another source of short-term complication. Inappropriate nail placement leading to penetration of the hip joint may account for up to one-third of treatment

Table 1. Patient history and relevant data

No.	Age/ Gender	Time to fixation	Type of fixation	Complications	X-ray	Histology	Nail plate angle (degrees)
1	80/F	1 day	DHS	Pain after 2 years + LLD	Subcapital fracture	AVN	140
2	82/F	3 days	DHS	Pain after 1 year	AVN	Not done	135
3	73/F	1 day	DHS	Second fall with subtrochanteric fracture	Subcapital fracture	AVN	-
4	75/F	1 day	DHS	Pain after 11 months	AVN	AVN	150
5	91/F	2 days	DHS	Pain after 6 weeks	AVN + subcapital fracture	Not done	160
6	77/F	2 days	DHS	Pain and LLD after 3.5 years	AVN	AVN	145
7	52/M	1 day	fixed hip screw	Pain and LLD after 4 years	AVN	AVN	150
8	82/F	1 day	DHS	Redo of first operation, pain after 1 year	AVN	-	140
9	86/M	2 days	DHS	Severe pain after 2 years	AVN	-	135
10	78/F	1 day	DHS	Pain after 1 year	AVN	AVN	145

failures. Failure of nail fixation may lead to an unstable reduction, which may displace into a varus deformity when weight-bearing is initiated. In addition, unstable reductions may also become rotationally deformed. Long-term complications of intertrochanteric fracture remain very rare. Non-unions occur at a rate of 1–2% and are generally treated by re-operation and bone grafting [4].

Subcapital fracture following trochanteric fracture and fixation remains extremely rare. To date, only 14 cases of this complication have been reported in the orthopedic literature [1–3,5–8], with only one case involving concomitant AVN.

Four articles report subcapital fracture following minor trauma in cases where non-dynamic nail fixation was used. Tronzo [8] in 1973 first described two cases in which the static nail failed to pass into the femoral head. In both cases the fracture occurred at the tip of the device, and he theorized that a stress fracture had occurred. Baker, in 1975 [9], reported three cases in which a femoral neck fracture developed at least 1 year after a healed intertrochanteric fracture of the femur. Minor trauma to osteoporotic bone was believed to be responsible, and he advocated extending the nail to the articular cartilage of the hip joint to prevent this complication. In 1975 Cameron et al. [10] diagnosed a subcapital fracture occurring at the tip of an intertrochanteric fracture fixated with a blade plate, which they attributed to a stress concentration effect of the stiff metallic device. They advocated placing the fixation device close to subchondral bone, and removing it as early as possible. In 1977 Hunter and Mehta [11] were the first to report subcapital fracture following dynamic sliding screw fixation, in three patients. In their series, patients presented approximately 9 months after surgery with hip pain and were found on X-ray to have subcapital fractures. The authors of these four studies suggested a previously unrecognized subcapital fracture as a possible cause. MacDonald [2] presented a case of an early subcapital fracture without minor trauma. His patient presented with sudden onset of hip pain 11 weeks after trochanteric fixation with a McLaughlin nail plate without a history of fall. X-rays revealed a subcapital fracture below the tip of the nail. Histology showed no evidence of avascular necrosis. In his assessment, the nail did not allow for adequate fixation. This necessitated prolonged non-weight-bearing and led to osteoporosis. In 1989 Mariani and Rand [1] reported three cases of intertrochanteric fractures in osteoporotic patients treated with sliding hip screw and plate, McLaughlin nail and plate, and Enders rods. All presented with sudden hip pain without associated trauma. Subcapital fractures were discovered on X-ray, and malpositioning of the nail was thought to be the cause of failure. Lombardi et al. [5] reported a case of subcapital fracture 18 months following an intertrochanteric fracture treated with a sliding hip screw. Avascular necrosis and osteomyelitis were diagnosed at operation. That case represents the only documented example of AVN as the cause of subcapital fracture following intertrochanteric fixation.

Isolated avascular necrosis following healed intertrochanteric fracture remains an even rarer long-term complication than subcapital fracture. Of the five major retrospective studies conducted on the topic, only 13 cases of proven AVN were noted [1,12–15]. The specific etiologic cause for this rare complication

remains unknown, but five theories have been proposed: a) more proximal intertrochanteric fracture (base of neck fracture), b) high energy injury, c) abnormal rotation of the femoral head during reaming, d) heat necrosis of the surrounding bone during reaming, and e) damage to the vascularity of the head by intraosseous placement of the fixation screw.

Of the seven cases of ensuing AVN described in the present report, three suffered concomitant subcapital fracture. In all cases dynamic stabilization was employed, thus a stress fracture is an unlikely etiology. In addition, because all the fractures occurred far from the tip of the nail, a stress riser etiology is equally unlikely. In one of the cases, the patient fell 2 months after fixation and sustained a subtrochanteric fracture without evidence of injury to the femoral head. Two months later, a subcapital fracture was diagnosed on follow-up X-rays. A second patient had the femoral neck set in extreme valgus and suffered protrusion of the femoral head by the dynamic hip screw. In all three cases there was avascular necrosis of the femoral head and it was assumed that the fracture was part of an ongoing process of necrosis.

The other four cases presented with avascular necrosis and no fracture. A review of old X-rays revealed no fault in the placing of the nail. Good reduction was seen in valgus, and the nails were placed at the inferior-central portion of the femoral head approximately 2 mm from the cortex. One of the fractures in our series was a proximal intertrochanteric fracture (base of neck), which might carry a higher rate of avascular necrosis although no data are available on the subject. These proximal fractures are extracapsular and are often not reported in the literature as separate from intertrochanteric fractures.

According to the literature to date, the rate of AVN following intertrochanteric fractures is 0.8% [1,12]. Of the 1,300 cases of intertrochanteric fractures treated by dynamic hip screw fixation in our institution during the past 10 years, 7 developed AVN, yielding an incidence of 0.5%. However, we believe that these numbers underestimate the true incidence since only surviving symptomatic ambulatory patients were evaluated.

Failure to present to an orthopedic surgeon is likely the major cause of under-reporting of AVN. Patients are generally followed only until union is achieved and any subsequent visits must be initiated by the patient, usually secondary to complaints of pain. Because many older patients are limited by socioeconomic factors such as lack of access to transportation and institutionalized living arrangements, they may be unable to contact and meet their physician. Furthermore, many elderly patients may not be able to communicate their pain owing to physical handicap or mental illness. In addition, the combined effect of an aging population and improvements in long-term surgical survival will further increase the rate of AVN-associated complications.

Therefore, we suggest that any hip pain following fixation of an intertrochanteric fracture should be investigated fully. Although rare in occurrence, the physician must consider the possibility of AVN or a subcapital fracture and must look for such complications. We advocate following patients for a minimal period of 5 years after surgery.

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