

Avascular Necrosis of the Femoral Head Following Intramedullary Nailing of the Femur in a Skeletally Mature Young Adult: A Case Report

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ABSTRACT

Avascular necrosis (AVN) of the femoral head is a well-documented complication of intramedullary nailing (IMN) of femoral shaft fractures in adolescents and children (age range, 10 years to 13 years 10 months). In adults, AVN after IMN has been reported in association with femoral neck fractures, intra-articular hip injuries, steroid use, and various other medical conditions. With those factors set aside, the literature includes only 1 case of AVN after IMN in an adult. Now we report the case of a previously healthy, skeletally mature young adult male who, at age 16 years 0 month, was treated with IMN after a traumatic femoral shaft fracture and subsequently developed AVN of the femoral head.

Avascular necrosis (AVN) of the femoral head is a well-documented complication of intramedullary nailing (IMN) of femoral shaft fractures

in adolescents and children.¹⁻⁸ The 9 patients reported in the US literature range in age from 10 years to 13 years 10 months. AVN is thought to occur when the blood supply to the femoral head and neck is damaged during placement of the nail in the piriformis fossa at the junction of the femoral neck and greater trochanter.^{1-6,8}

In adults, AVN after IMN has been reported in association with femoral neck fractures and intra-articular hip injuries.⁹⁻¹¹ With those factors set

evidence of preexisting AVN. The next day, at an outside institution, the patient was treated with placement of an antegrade intramedullary nail (Figure 2). Approximately 1 year later, because of constant hip/knee pain reported since insertion, the nail was removed at the same institution. Figure 3, an AP left hip x-ray taken 1 year after injury and immediately before nail removal, does not show any evidence of AVN. The patient reported immediate pain relief after

“Caution should be used when inserting and removing intramedullary femoral nails in teenagers and young adults...”

aside, the literature includes only 1 case of AVN after IMN in an adult.¹²

Now we report the case of a skeletally mature male young adult who, at age 16 years 0 month, was treated with IMN at an outside institution after a traumatic femoral shaft fracture. The patient presented to our clinic at age 22 years 3 months with femoral head AVN (Ficat stage 4).

CASE REPORT

A male 16-year-old with no significant past medical history and no prior history of steroid use sustained a midshaft left femur fracture in the late 1990s. Figure 1, an anteroposterior (AP) x-ray of the pelvis taken the day of injury, does not show a femoral neck fracture, any associated intra-articular hip injury, or any

nail removal, and he remained pain-free for the next 18 months.

Left hip pain returned about 2 years after nail removal and then became progressively worse. It was exacerbated by activity and somewhat relieved with activity modification and use of nonsteroidal anti-inflammatory drugs. The patient reported no other trauma to the hip between the time of injury and the most recent presentation to our institution and no new medical problems. Now 22 years old (and 6 years after injury), the man presented to our institution ambulating without assistance but with an antalgic gait. He experienced pain when putting on his shoes and socks, when using stairs, and when arising from a chair. The pain, in the groin region, inhibited him from

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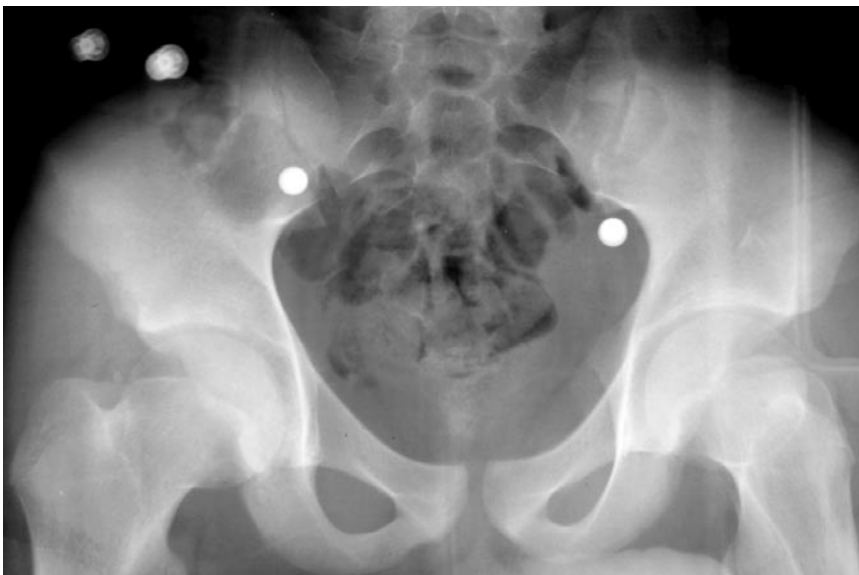


Figure 1. Anteroposterior pelvis x-ray taken at time of patient's original injury (age 16 years 0 month) shows no femoral neck fracture or osteonecrosis of left hip.

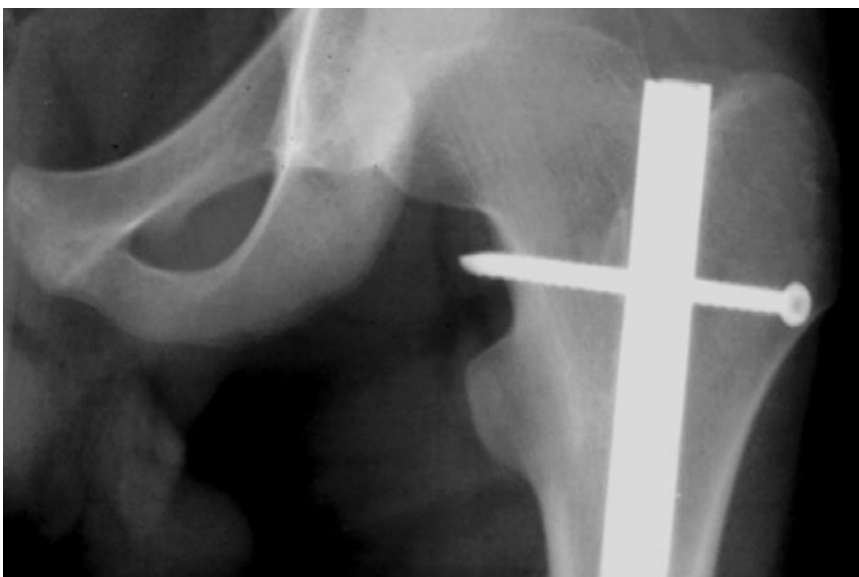


Figure 2. Postoperative anteroposterior left hip x-ray taken at 16 years 0 month shows intramedullary nail in center of medullary canal.

performing his job efficiently. On physical examination, he was tender to palpation about the groin on the left. A Stenchfield test was positive. Right/left range of hip motion was 120°/120° flexion, 30°/15° internal rotation, 45°/20° external rotation, and 40°/40° abduction. Strength on the left was 4/5 to hip flexion and abduction. Sensation and vascularity were intact distally. X-rays showed femoral head AVN (Ficat stage 4) secondary to acetabular involvement (Figure 4). A magnetic resonance imaging

scan confirmed a focus of AVN with partial femoral head collapse (Figure 5). The patient was offered fusion, femoral head resurfacing, osteotomy, observation, core decompression, or total hip arthroplasty for treatment of AVN. After discussing the risks and benefits of each option, the patient chose total hip arthroplasty.

The operation was uneventful. An intraoperative finding was that 75% of the femoral head surface was involved (Figure 6), along with a large portion of the acetabular surface.



Figure 3. Anteroposterior left hip x-ray taken 1 year after injury, before intramedullary nail removal, does not show any evidence of avascular necrosis of left hip.

DISCUSSION

The standard of care for adult femoral shaft fractures is IMN. The benefits of using IMN to treat femoral shaft fractures include early mobilization and weight-bearing, shorter hospitalization, no hip or knee immobilization, and a low rate of overall complications.¹³ Studies in adults have shown IMN complications of infection, shortening, nonunion, rotational deformities, valgus angulation, embolism, and iatrogenic fractures.¹⁴ In adolescents and children, AVN of the femoral head is a well-documented complication of IMN of femoral shaft fractures. Studies have found that the incidence of osteonecrosis ranges from 0% to 9%.¹⁻⁸

In 1994, Beatty and colleagues¹ reported a case of AVN after removal of an IM rod from a girl 11 years 6 months old. That same year, Mileski and colleagues² described a case of femoral head AVN developing after IMN of the femur in a girl 11 years 9 months old. Femoral head osteonecrosis after IMN of a fracture of the femoral shaft was documented in 1995 in 3 adolescents (12-13 years old).³⁻⁵



Figure 4. Anteroposterior pelvis x-ray at 22 years 3 months (6 years after injury) shows avascular necrosis of left hip.



Figure 5. T₁-weighted coronal magnetic resonance imaging scan of pelvis at 22 years 3 months shows osteonecrosis of left hip.

In 1998, Buford and colleagues⁶ reported 2 cases, in a 12-year-old boy and a 10-year-old girl, of AVN after IMN of femoral fractures. Stans and colleagues⁷ noted a case of AVN in an 11-year-old girl after IMN in 1999. Last, in 2002, Letts and colleagues⁸ described a case of AVN after rigid intramedullary rodding of femoral shaft fractures in a boy 13 years 10 months old. Each of these cases involved a skeletally immature patient in the age range of 10 years to 13 years 10 months.

The blood supply to the femoral head is age-dependent. Initially, from birth to 4 years, there are 3 major contributors, primary medial and lateral circumflex arteries from the deep femoral artery, and ligamentum teres from the posterior division of the obturator artery. From 4 years to adulthood, there is minimal contribution from the ligamentum teres, with the main supply the posterosuperior and posteroinferior retinacular branches from the medial femoral circumflex artery. Finally, at adulthood, the main artery



Figure 6. Intraoperative photograph of femoral head after total hip arthroplasty shows substantial loss of cartilage surface.

is the lateral epiphyseal branch of the medial circumflex artery, which supplies two thirds to three fourths of the weight-bearing portion of the femoral head.^{5,15-18} Before skeletal maturity, the posterosuperior branches of the medial femoral circumflex artery are in close proximity to the insertion point of a nail at the piriformis fossa.^{3,5,13}

In reports of osteonecrosis of the femoral head in adolescents, the nail insertion point was the piriformis fossa. Injury either to the posterosuperior branch of the medial femoral circumflex artery during rod insertion^{3,5,13} or to the lateral ascending circumflex artery is the proposed culprit.⁴ Authors of recent studies have advocated a greater trochanteric approach to eliminate injury to the medial femoral circumflex artery,^{13,19} though Stans and colleagues⁷ reported 1 case of AVN using this approach.

In adults, osteonecrosis after IMN has been reported in association with femoral neck fractures or intra-articular hip injuries.⁹⁻¹¹ With these factors set aside, the literature includes only 1 instance of AVN after IMN in an adult.¹² Hernigou and colleagues¹² attributed the complication to the posterior situation of the proximal insertion hole just posterior to the tro-

chanteric notch and piriformis fossa. This situation of the nail may have caused injury to the posterior branch of the circumflex artery at the time of rod insertion.

Besides being related to trauma, femoral head AVN has been associated, in all age groups, with many conditions—corticosteroid use, alcohol abuse, smoking, sickle cell anemia, coagulopathies, systemic lupus erythematosus, hypercholesterolemia, organ transplantation, Gaucher disease, Caisson disease, radiation therapy, arterial disorders, intramedullary hemorrhages, chronic pancreatitis, hypertriglyceridemia, and other rare entities.²⁰ The only condition positive for our patient, based on history, was trauma, with insertion and subsequent removal of the intramedullary nail.

By 16 years 0 month, when his injury occurred, our patient had already reached skeletal maturity for the proximal femur. Figure 1 shows his proximal femoral epiphysis closed at injury. Therefore, this young man now represents only the second documented case of AVN occurring after insertion of an IM nail without any other contributing factors.

Figure 1 also shows that the patient did not have a preexisting AVN of the left hip, a femoral neck fracture, or an intra-articular hip injury. Figure 3 shows no osteonecrosis at IM nail removal 1 year after injury. In concordance with the cases reported earlier, we propose that our patient developed necrosis secondary to damage to the blood supply of the femoral head. In most of those cases, the authors concluded that insertion was the cause of damage; the exception is Beaty and colleagues,¹ who identified IM rod removal as the cause in their patient's case. Our patient had constant hip pain radiating to the knee the entire year his nail was in place, and he reported being pain-

free for 18 months after removal. The hip pain returned 3 years after nail insertion and 2 years after removal. Radiographic evidence of osteonecrosis was not found until the patient sought treatment 6 years after injury. The pain variability suggests that the insult could have occurred during either insertion or removal of the nail but was definitely not preexisting. Figure 2 shows the nail in good position originally, on the medial edge of the greater trochanter and down the center of the medullary canal, and without an obvious poor entry point.

CONCLUSIONS

The present case shows that, even with a nail apparently in a good insertion point, AVN is a potential IMN complication in skeletally mature patients. Caution should be used when inserting and removing intramedullary femoral nails in teenagers and young adults, even those who have reached skeletal maturity.

AUTHORS' DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article. The views expressed in this article are those of the authors and do not reflect the official policy of the Department of Defense or the United States Government.

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