Acta Orthop. Belg., 2007, **73**, 258-262

CASE REPORT

Osteonecrosis of the femoral head following medullary nailing of the femur in an adult

Anand PILLAI, Kevin LITTLE, Andrew CHAPPELL

From Western Infirmary, Glasgow, and Inverclyde Royal Hospital, Greenock, United Kingdom

The femoral head receives the majority of its blood supply via branches of the medial femoral circumflex artery, whose course runs across the piriformis fossa and along the superior aspect of the femoral neck. Cadaveric studies have demonstrated damage to the medial femoral circumflex artery in cases where the piriformis fossa was the entry point for intramedullary nailing. Although well recognised in children, osteonecrosis of the femoral head after intramedullary nailing has exceptionally been reported in adults. We present a case of osteonecrosis of the femoral head post-epiphyseal closure following IM nailing for a femoral fracture in a 22-year-old Caucasian adult.

Keywords : osteonecrosis ; intramedullary nailing ; femur ; hip ; trauma.

INTRODUCTION

Closed cephalo-medullary nailing is a common method of treatment in fractures of the femoral shaft. Osteonecrosis of the femoral head following intramedullary (IM) nailing of the femur has been reported in children and adolescents prior to epiphyseal closure (*1, 2, 3, 9, 11, 14*). We present what appears to be the first case report in the English literature of osteonecrosis of the femoral head post-epiphyseal closure following IM nailing for a femoral fracture in an adult.

CASE REPORT

A 22-year-old Caucasian male, who was a restrained passenger in a road traffic accident, sustained a closed mid-shaft fracture of his left femur. His only other injury was a closed medial malleolar fracture in the contralateral ankle. There was no proximal femoral or acetabular trauma, or any evidence of hip dislocation or subluxation. At the time of injury, he was taking no prescribed medications and had no significant past medical history.

Following assessment and stabilisation, he was taken to theatre the same day for locked IM nailing of the femur. Following reaming to 16 mm, a 14 mm AO nail was used (*10*), with the piriformis fossa as the proximal entry point. The procedure was uneventful, and post-operative radiographs were satisfactory. The ankle fracture was reduced and fixed at the same sitting.

■ Anand Pillai, Registrar Orthopaedics.
■ Kevin Little, Registrar Orthopaedics.
Western Infirmary, Glasgow, United Kingdom.
■ Andrew Chappell, Orthopaedic Surgeon.
Inverclyde Royal Hospital, Greenock, United Kingdom.
Correspondence : Anand Pillai, 3/2. 63 Avenuepark Street, Glasgow, United Kingdom. E-mail : Aorthopod@aol.com.

No benefits or funds were received in support of this study

Fig. 1. — Twelve months post-operatively. Changes in femoral head suggestive of osteonecrosis.

Fig. 2. — Progression of osteonecrosis despite extraction of the intramedullary nail.

Post-operatively, the patient was allowed to mobilise fully weight-bearing. Serial radiographic follow-up showed progressive evidence of fracture healing. The fracture was deemed to have united clinically and radiologically at three months, and the patient was discharged from further outpatient follow-up.

Twelve months post-injury, he re-presented at clinic complaining of a two month history of increasing left hip and groin pain. There was no history suggestive of any repeat trauma. Radiographic appearance was suggestive of osteonecrosis of the femoral head (fig 1). Considering his young age, a decision was taken at this time to remove the nail in the hope of allowing the medullary canal to reform, and precipitate some symptomatic relief. It was felt that this would also facilitate any future surgery.

Despite extraction of the nail, his symptoms continued. Further radiographs showed progress of the osteonecrosis (fig 2). MRI assessment showed granulation tissue replacing bone marrow in the upper half of the femoral head and collapse of the weight-bearing aspect with cystic changes (fig 3). These changes were consistent with Ficat grade 4 osteonecrosis (*5*). The patient is currently awaiting a hip arthroplasty.

DISCUSSION

Since first being advocated by Küntscher in the 1940s, intramedullary nailing has become the treatment of choice for most fractures of the femoral shaft (*8*). Cephalo-medullary technique is the most widely practised, and Harper and Carson propose the piriformis fossa as the most biomechanically sound point of entry (*7*). Retrograde passage of nails demonstrated the piriformis fossa to be the natural point of exit. When passed antegrade, this affords ease of insertion with reference to the sagittal curvature of the femur, and limits the stress riser on the superior femoral neck. Surgical technique manuals for most commonly used intramedullary nails also recommend the piriformis fossa as the starting point.

The femoral head receives its blood supply from a combination of epiphyseal and metaphyseal vessels of which there are four ; superior and inferior

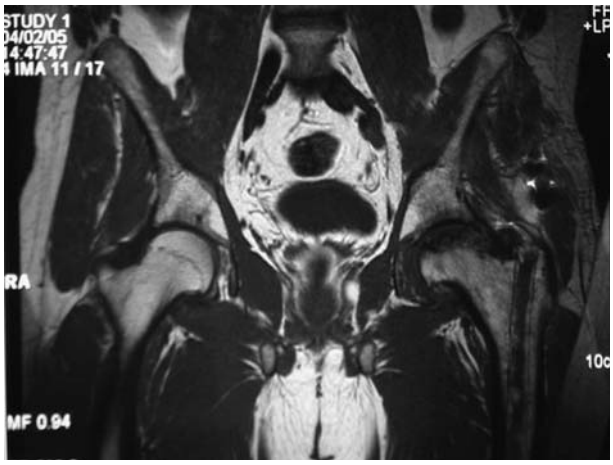

Fig. 3. — MRI showing collapse of the left femoral head, and cystic change consistent with grade 4 osteonecrosis. Note also granulation tissue filling the tract of the nail following extraction.

Fig. 4. — Axial view of a prosected adult male proximal femur. Red arrow shows the ramus profundus of the MFCA lying within the piriformis fossa. Green arrow highlights the trochanteric tip ; a possible safe entry point.

metaphyseal, and lateral and medial epiphyseal. Between 50 and 80% of the supply to the head is from the lateral epiphyseal and both metaphyseal arteries. All of these are branches of the medial femoral circumflex artery (MFCA), whose course runs across the piriformis fossa and along the superior aspect of the femoral neck. The medial epiphyseal artery is a continuation of the acetabular branch of the obturator artery within the ligamentum teres.

In the developing femur, the presence of an intact epiphyseal growth plate acts as a barrier keeping the epiphyseal and metaphyseal circulations apart (*15*). At this time, damage to the MFCA results in osteonecrosis of the femoral head (*1, 2, 9*) at a relatively high incidence of 3 to 4% (*14*) as the anastomotic supply is not developed. Once the growth plate begins to break down, anastomoses are able to form and provide compensatory supply (*16*). In the adult, there are abundant anastomoses between the epiphyseal and metaphyseal circulation in the region of the femoral head and the likelihood of osteonecrosis is substantially lower (*17*).

Cadaveric studies by Dora *et al* demonstrated damage to the medial femoral circumflex artery in all cases where the piriformis fossa was the entry point for IM nailing (fig 4). In the majority of cases, this injury was sufficient to completely interrupt the distal blood supply via this artery (*4*). Sevitt and Thompson suggested that the anastomotic blood supply to the femoral head cannot compensate for a complete disruption of the end-branches of the MFCA (*13*). If this is the case, then osteonecrosis following femoral nailing in adults should occur in a similar incidence as reported in children.

Tucker demonstrated contribution to the femoral head supply from nutrient arteries. These enter the mid-shaft of the femur and run upwards in the medullary canal to anastomose with the epiphyseal and metaphyseal vessels in the head (*17*). This was however refuted by Trueta from his cadaveric studies (*15, 16*). It is hence difficult to quantify the exact contribution to femoral head blood supply from the medullary vasculature. If the blood supply from the MFCA is completely disrupted, then these contributions from the medullary circulation to the vascularity of the femoral head would assume greater significance.

Grundnes and Reikeras demonstrated damage to the medullary and cortical blood supply in rat

femora if intramedullary reaming is sufficient to damage the endosteal cortex. This reduction in total blood flow was reported to be as much as fifty percent (*6*). If there is a significant contribution to the femoral head supply from the medulla, then it follows that this will be damaged to a variable extent by reaming during insertion of the nail. It is also possible that the medullary blood supply may be interrupted by the fracture itself.

Although not a common cause, traumatic posterior subluxation of the hip has also been shown to lead to osteonecrosis of the femoral head (*12*). It is postulated that the intracapsular haematoma which develops compromises the vascular supply to the femoral head via a direct tamponade effect. Whilst this injury is well recognized in victims of road traffic accidents, our patient showed no clinical or radiological evidence of such an injury. It is therefore highly unlikely that this was involved in the aetiology in this case.

We suggest that the likely chain of events in the case presented was that the MFCA was damaged during insertion of the nail via the piriformis fossa, and the medullary supply was compromised during reaming. The remaining anastomotic supply to the femoral head was probably insufficient, and therefore osteonecrosis subsequently developed. Removal of the nail did not halt the progression of osteonecrosis, as the contents of the medullary canal was found to be replaced with granulation tissue and did not appear to re-vascularise.

In the light of this report and the existing evidence, we feel certain considerations should be observed in cephalo-medullary femoral nailing in adults. Though the piriformis fossa is the easiest and biomechanically soundest point of entry (*7*), its use correlates with the highest incidence of injury to the MFCA. Entry via the trochanteric tip lessens this risk (*4*), and therefore may represent a safer entry point for cephalomedullary nails. Excessive reaming of the medullary canal is also to be avoided, as this may compromise the blood supply to the femoral head via this channel (*6, 17*). When consenting patients for this procedure, they should be warned of the potential risk, though small, of osteonecrosis of the femoral head. In turn, in patients complaining of hip and groin pain post-nailing, osteonecrosis should be sought and excluded as a cause.

Acknowledgement

Acknowledgement to Dr J. Shaw-Dunn, Senior Lecturer, University Department of Anatomy, University of Glasgow, UK, with respect to photographs of dissected specimens of the femoral head.

REFERENCES

1. **Astion DJ, Wilber JH, Scoles PV.** Avascular necrosis of the capital femoral epiphysis after intramedullary nailing for a fracture of the femoral shaft : a case report. *J Bone Joint Surg* 1995 ; 77-A : 1092-1094.
2. **Beaty JH, Austin SM, Warner WC *et al.*** Interlocking intramedullary nailing of femoral shaft fractures in adolescents : preliminary results and complications. *J Pediatr Orthop* 1994 ; 14 : 178-183.
3. **Buckaloo JM, Iwinski HJ, Bertrand SL.** Avascular necrosis of the femoral head after intramedullary nailing of a femoral shaft fracture in a male adolescent. *J Southern Orthop Assoc* 1997 ; 6 : 97-100.
4. **Dora C, Leunig M, Beck M *et al.*** Entry point soft tissue damage in antegrade femoral nailing : a cadaver study. *J Orthop Trauma* 2001 ; 15 : 488-493.
5. **Ficat RP, Arlet J.** Necrosis of the femoral head. In : DS Hungerford, ed. *Ischemia and Necrosis of Bone*. Williams and Wilkins, Baltimore, 1980 : pp 171-182.
6. **Grundnes O, Reikeras O.** Acute effects of intramedullary reaming on bone blood flow in rats. *Acta Orthop Scand* 1994 ; 65 : 175-178.
7. **Harper MC, Carson WL.** Curvature of the femur and the proximal entry point for an intramedullary rod. *Clin Orthop* 1987 ; 220 : 155-161.
8. **Küntscher G.** Intramedullary surgical technique and its place in orthopaedic surgery. My present concept. *J Bone Joint Surg* 1965 ; 47-A : 809-818.
9. **Mileski RA, Garvin KL, Huurman W.** Avascular necrosis of the femoral head after closed intramedullary shortening in an adolescent. *J Pediatr Orthop* 1995 ; 15 : 24-26.
10. **Müller M, Allgöwer M, Schneider R *et al.*** *Manual of Internal Fixation*. 3rd ed. Springer-Verlag, Berlin, 1991.
11. **O'Malley DE, Mazur JM, Cummings RJ.** Femoral head avascular necrosis associated with intramedullary nailing in an adolescent. *J Pediatr Orthop* 1995 ; 15 : 21-23.
12. **Orler R, Hersche O, Helfet DL *et al.*** Die avaskuläre Hüftkopfnekrose als schwerwiegende Komplikation nach Marknagelung bei Kindern und Jungendlichen. *Unfallchirurgie* 1998 ; 101 (6) : 495-499.
13. **Sevitt S, Thompson RG.** The distribution and anastomoses of arteries supplying the head and neck of the femur. *J Bone Joint Surg* 1947 ; 47 (B) : 560-573.

14. **Thometz JG, Lamdan R.** Osteonecrosis of the femoral head after intramedullary nailing of a fracture of the femoral shaft in an adolescent : a case report. *J Bone Joint Surg* 1995 ; 77-A : 1423-1426.
15. **Trueta J.** The normal vascular anatomy of the human femoral head during growth. *J Bone Joint Surg* 1957 ; 39-B : 358-394.
16. **Trueta J, Harrison MHM.** The normal vascular anatomy of the femoral head in adult man. *J Bone Joint Surg* 1953 ; 35-B : 442-461.
17. **Tucker FR.** Arterial supply to the femoral head and its clinical importance. *J Bone Joint Surg* 1949 ; 31-B : 82-93.