Acta Orthop Scand *56*, 145–146, 1985

Implant-induced trabecular damage in cadaveric femoral necks

After insertion of Newman's pins, Smith-Petersen nails and compression hip screws into human cadaveric proximal femora, the area of trabecular damage was measured. The nail and hip screw caused four times the area of damage seen with Newman's pin. The Smith Petersen nail caused significant peripheral damage which was undetectable radiographically.

Correspondence: W. A. Scott, Northwick Park Hospital, Watford Road, Harrow, Middlesex, England

William A. Scott
Robin L. Allum
Keith W. J. Wright

Department of Biomedical Engineering, Institute of Orthopaedics, Royal National Orthopaedic Hospital, Brockley Hill, Stanmore, Middlesex, England

Linton (1944) raised the possibility that the fixation of intracapsular fractures by Smith-Petersen or similar large nails may be associated with an increased incidence of necrosis. Sevitt (1964) found haemorrhagic necrotic foci and avascular segments associated with nail tracks in post-mortem studies and Catto (1965) suggested that the blood vessels of the ligamentum teres could be damaged by accidental perforation of the fovea by a low-lying nail; both authors also felt that the position and extent of the nail could prevent revascularisation. Strömqvist (1983) has shown that in displaced subcapital fractures, the vitality of the head, as shown by scintimetry, was greater following pinning than nailing. Bingold (1977) has shown that extensive fractures of the articular cartilage and avulsions of the cartilage, as a result of peripheral stresses, may also occur. Hall (1957) has reported the damage that a trifin nail may produce in the treatment of slipped upper femoral epiphysis, and Kalén (1968) has made similar observations in cadaver studies of hip arthrodesis fixation.

We have studied the direct damage inflicted on the femoral head by implants evaluated with emphasis on fixation with multiple pins.

Material and methods

Human cadaveric proximal femora were taken from patients over the age of 60, without evidence of osteoarthritic change in the hip, and were fixed in formalin. Three types of fixation device were investigated: a Smith-Petersen nail, Newman's pins and a Richard's hip compression screw. the Smith-Petersen cannulated trifin nail was hammered into the femoral head after reaming of the lateral femoral cortex only. Newman's pins were drilled into place without preliminary drilling or reaming. The Richard's hip compression screw with the three-quarter-inch thread length was inserted after preliminary reaming and tapping.

Following insertion of the fixation device, it was removed and the specimen was sliced into 3-mm slices in the coronal plane using a band saw (Catto 1965). The slices were then radiographed at 1:1 magnification, using a Faxitron dual cabinet laboratory unit with a 10–11 kv range, Kodak Industrex CX medium speed fine grain non-screen film, exposure factors 35 kv for 30 s at 3 ma with 107 cm focus to film distance, and standard manual processing in May and Baker chemicals. The area of direct trabecular damage was measured with Vernier calipers, and an assessment was made of the indirect damage to the femoral head and articular cartilage.

Results

The diameter of the trabecular damage was 3 mm for the Newman's pins in all five specimens, 12 mm in three and 13 mm in one specimen for the trifin nail and 11 mm in three and 12 mm in one specimen for the compression screw. The pattern of damage with Newman's pins was a narrow area of trabecular destruction with a thin surrounding area of compressed trabeculae (Figure 1). The compression screw produced a well-defined area of damage related to the screw threads (Figure 2). The tri-

Figure 1. Trabecular damage with Newman's pins.

Figure 2. Trabecular damage with a compression hip screw.

Figure 3. Trabecular and peripheral damage caused by a Smith-Petersen nail.

Figure 4. Splitting of the articular surface caused by a Smith-Petersen nail.

fin nail produced an irregular, ill-defined area of damage. A consistent feature with this implant was the degree of damage at a distance from the actual nail track, with fissuring of the subchondral bone and articular cartilage (Figure 3). This did not occur with the other two devices. Figure 4 illustrates another example of the damage done to the articular cartilage

Discussion

This study has shown that a trifin nail or a compression screw driven into a femoral head causes four times as much trabecular damage as a single Newman's pin. Thus, if three pins are used, the overall trabecular damage is still less than a trifin nail. In addition, it has been shown that the trifin nail may cause major damage to the articular surface of the femur which would be undectable radiographically in the clinical situation.

Although the moment of fracture has been widely regarded as the time when the vascular injury to the femoral head takes place (Massie 1973, Lucie et al. 1981), there is clinical evidence to suggest a peroperative risk to the vascular supply as there is a higher incidence of avascular necrosis in nailed than in untreated femoral neck fractures (Bentley 1980). The recent work by Strömqvist (1983) has shown that there is a difference in femoral head vitality and healing complications between fractures fixed with a flanged nail and those fixed with multiple pins.

This study has shown that there is a significant difference in implant-induced damage between different types of fixation device as measured by direct trabecular damage. This in turn supports the concept that the type of implant can influence the degree of peroperative vascular interference and suggest that the moment of fracture is not entirely responsible for the long-term outcome.

References

Bentley, G. (1980) Treatment of nondisplaced fractures of the femoral neck. *Clin. Orthop.* **152**, 93–101.

Bingold, A. C. (1977) The science of pinning the neck of the femur. *Ann. R. Coll. Surg. Engl.* **59**, 463–469.

Catto, M. (1965) The histological appearances of late segmental collapse of the femoral head after trans-cervical fracture. *J. Bone Joint Surg.* **47**-B, 777–791.

Hall, J. E. (1957) The results of treatment of slipped femoral epiphysis. *J. Bone Joint Surg.* **39**-B, 659–673.

Kalén, R. (1968) Internal fixation in hip joint arthrodesis. Experimental studies in autopsy specimens. *Acta Orthop. Scand.* Suppl. 112, 75–77.

Linton, P. (1944) On the different types of intracapsular fractures of the femoral neck. *Acta. Chir. Scand.* **90**, Suppl. 86.

Lucie, R. S., Fuller, S., Burdick, D. C. & Johnston, R. M. (1981) Early prediction of avascular necrosis of the femoral head following femoral neck fractures. *Clin Orthop.* **161**, 207–214.

Massie, W. K. (1973) Treatment of femoral neck fractures emphasising long-term follow up and observations on aseptic necrosis. *Clin. Orthop.* **92**, 16–62.

Sevitt, S. (1964) Avascular necrosis and revascularisation of the femoral head after intra-capsular fractures. A combined arteriographic and histological necropsy study. *J. Bone Joint Surg.* **46**-B, 270–296.

Strömqvist, B. (1983) Femoral head vitality after intracapsular hip fracture. *Acta Orthop. Scand.* Suppl. 200.