PREVENTION OF FRACTURE AT THE DISTAL LOCKING SITE OF THE GAMMA NAIL

A BIOMECHANICAL STUDY

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To investigate the origin of fractures at the distal locking site of the Gamma nail, we loaded ten paired human cadaver femora fixed with a Gamma nail in torsion until they fractured. When an awl was hammered in to start the hole for distal locking a fissure appeared in the lateral cortex of all the femora, and the mean torsional load to create a fracture was reduced by 57.8% compared with that in a control group in which the distal locking hole had been started with a centre drill. When an additional drill hole was made, the mean failure load in torsion decreased by 35.7%.

We strongly recommend that an awl should not be used at the distal locking site of the Gamma nail; we recommend the use of a centre drill. Additional drill holes should be avoided because they act as stress raisers.

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The sliding hip screw (SHS) is the preferred method for fixation of intertrochanteric fractures of the femur, giving better results and lower rates of technical failure than one-piece devices (Bannister and Gibson 1983; Heyse-Moore, MacEachern and Jameson Evans 1983; Esser, Kassab and Jones 1986). Failure rates of between 5% and 23%, however, have been reported (Simpson, Varty and Dodd 1989; Bannister et al 1990; Davis et al 1990). Because of an increasing interest in intramedullary fixation the Gamma nail (Howmedica UK, London, UK) was introduced as an alternative to the SHS, especially for 'unstable' intertrochanteric fractures and for subtrochanteric fractures.

Recent studies have shown some advantages of the Gamma nail over the SHS (Boriani et al 1991; Lindsey et al 1991; Halder 1992; Leung et al 1992), but they have also indicated that one of its main complications is a spiral fracture around the distal locking screws (Fig. 1).

Fig. 1

A spiral-type fracture at the distal locking site of a Gamma nail. The proximal femur was intact.

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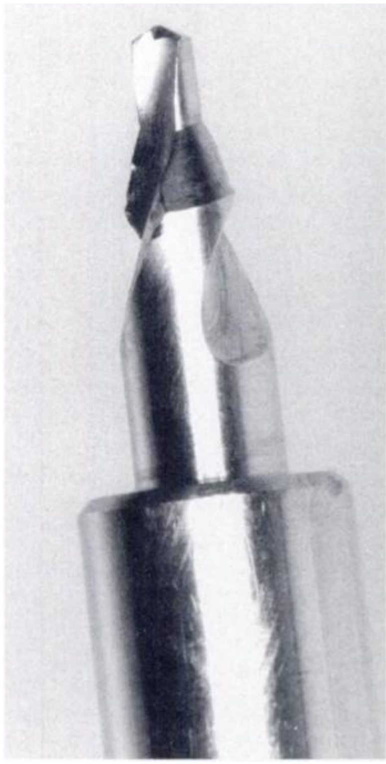

Fig. 2

A centre drill.

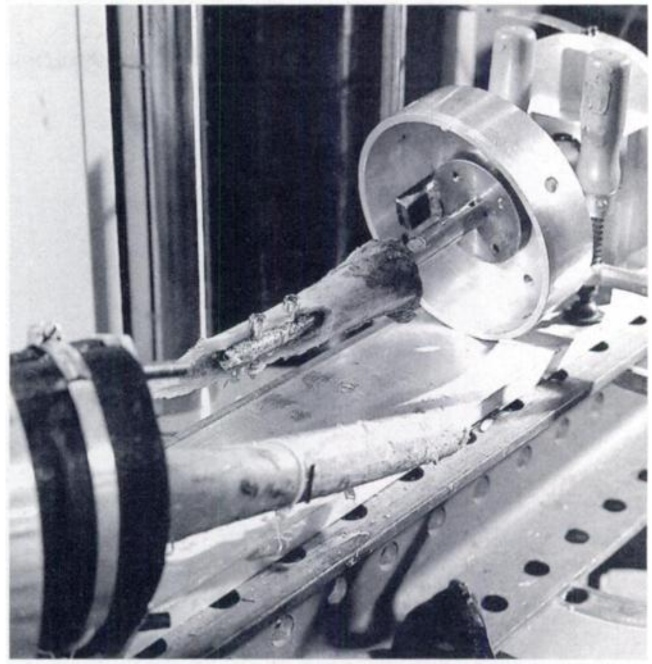

Fig. 3

An experimental fracture caused by loading a nailed cadaver femur in torsion. A specially-designed torsion instrument is attached to the Zwick bench.

We believe that these fractures are caused by incorrect use of an awl and by accidental additional drill holes which are often made during the distal locking procedure. These drill holes could act as stress raisers, especially in cortical bone. We therefore undertook a biomechanical study to investigate the hypothesis.

MATERIAL AND METHODS

In ten paired human cadaver femora we imitated a high subtrochanteric fracture by resection of the proximal part of the femur at the level of the lesser trochanter. A Gamma nail was inserted into the femur which had been over-reamed by 2 mm and distal locking was accomplished by means of the appropriate guide device.

There were two groups of femora. In group 1 a Gamma nail was inserted on one side according to the manufacturer's operating guide, which recommended "tapping a small prehole with the awl by hammering gently on it and turning it around". In group 2, a Gamma nail was inserted on one side and one additional hole was drilled dorsal to the nail at its distal end.

In both groups a Gamma nail was inserted into the contralateral femur of the same cadaver with the hole for distal locking prepared with a centre drill instead of an awl (Fig. 2). The use of the contralateral sides as control groups allowed the exclusion of variables such as osteoporosis, bone mass, and nail size. Radiographs were taken to exclude abnormal pathology.

The femora were placed on a computer-controlled Zwick bench with an additional torsion instrument (Fig. 3) and fixed distally. A torsion load was applied to the proximal end until a fracture occurred.

The data were analysed statistically using the paired samples *t*-test.

RESULTS

In group 1 the use of the awl led to a fissure in the lateral cortex of all femora and the mean failure load in torsion at the distal locking point of the Gamma nail was decreased by 57.8% compared with the control group ($p = 0.001$; Table I). In group 2 the mean failure load in torsion decreased by 35.7% compared with the control group ($p = 0.02$).

DISCUSSION

We have shown that the use of an awl to make a prehole for the distal locking of the Gamma nail always causes a fissure in the lateral cortex of the femur. The mean torsion load required to create a fracture through this fissure was significantly lower than in the control group in which the prehole had been made by a centre drill. These fissures probably explain the high incidence of spiral fractures

Table I. Torsion test results (mean ± SD) in both groups

	Torsion moment (Nm)	Control group (Nm)	Difference (%)	p value
Group 1	41.9 ± 9.8	99.4 ± 12.5	*57.8*	0.001
Group 2	72.7 ± 25.0	113.1 ± 24.8	*35.7*	0.02

around the distal locking screws of the Gamma nail. They would not be visible on plain radiographs in most cases because they are in the lateral cortex of the femur and therefore covered by the intramedullary nail in a lateral view. They would be seen only if they extended distal to the tip of the nail. The use of an awl without hammering, by just turning it around, did not have this effect on the bone. In their latest instructions, the manufacturers of the nail emphasise that surgeons should avoid causing fissures through excessive force, for example by the use of a hammer. We recommend that the awl should be replaced by a centre drill.

Another complication associated with the Gamma nail is the mainly lengthwise fracture which may occur during the operation (Lindsey et al 1991; Halder 1992; Leung et al 1992). This can be attributed to the use of excessive force when the nail is inserted. To avoid jamming, a nail with a diameter of at least 2 mm less than that of the reamed femur should be chosen and inserted by hand. As the proximal part of the Gamma nail is 16 mm in diameter, the proximal part of the femur should always be reamed to at least 18 mm.

Secure placement of the distal locking screws can be difficult; error may result in the drilling of additional holes in the lateral and medial cortex (Lindsey et al 1991). A drill hole is a well-known stress raiser and influences the yielding properties of bone (Rosson et al 1991). The need for additional holes may result from incorrect seating of the target device. This will allow movement at its junction with the nail, and allow the drill to follow a dorsal route. Another cause may be an eccentric position of the nail in the medullary canal, which will direct the tip of the drill to the posterolateral side of the femur. Because the drill is not then perpendicular to the middle of the shaft, it may tend to slip dorsolaterally.

Our study has confirmed that an additional hole acts as a stress raiser and decreases the mean failure load in torsion by 36%. Distal screws should be used only when the fracture requires additional rotational stability.

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