FIXATION OF INTERTROCHANTERIC FRACTURES OF THE FEMUR

A RANDOMISED PROSPECTIVE COMPARISON OF THE GAMMA NAIL AND THE DYNAMIC HIP SCREW

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We have prospectively compared the fixation of 100 intertrochanteric fractures of the proximal femur in elderly patients with random use of either a Dynamic Hip Screw (DHS) or a new intramedullary device, the Gamma nail. We found no difference in operating time, blood loss, wound complications, stay in hospital, place of eventual discharge, or the patients' mobility at final review. There was no difference in failure of proximal fixation: cut-out occurred in three cases with the DHS, and twice with the Gamma nail. However, in four cases fracture of the femur occurred close to the Gamma nail, requiring further major surgery. In the absence of these complications, union was seen by six months in both groups.

In the United Kingdom, the usual device for internal fixation of intertrochanteric fractures of the femur is some form of sliding hip screw. This has been shown to produce better results than one-piece devices such as the Jewett nail plate (Jensen, Tøndevold and Mossing 1978; Bannister and Gibson 1983; Esser, Kassab and Jones 1986). However, complications are frequent; failure of fixation has been reported in 10% to 20% of cases (Wolfgang, Bryant and O'Neill 1982; Nunn 1988; Simpson, Varty and Dodd 1989). The main problem has been cutting out of the femoral head; plate breakage, pulling off the shaft, and disengagement of the components have also occurred. Implant failure has been related to type of fracture, particularly its stability; and to inadequate reduction, osteoporosis, and inexact placement of the screw within the femoral head (Mulholland and Gunn 1972; Wolfgang et al 1982; Davis et al 1990).

The Gamma nail (Howmedica UK, Park Royal, London) is a new device, combining intramedullary fixation in the shaft with a screw in the proximal fragment (Figs 1 and 2). This differs from devices such as the

Zickel nail: it allows sliding between the two parts to produce impaction as in the sliding screw, and it can be inserted by a closed technique. Its theoretical advantages are that a smaller exposure is required than for a sliding screw; it may therefore be associated with less morbidity, shorter operating time, and lower blood loss. There may also be mechanical advantages, because the shaft fixation is nearer to the centre of rotation of the hip, giving a shorter lever arm and a lower bending moment on the device (Kaufer 1980).

We aimed to discover whether these theoretical advantages could be proved in practice, by a comparison of the results of the Gamma nail and the dynamic hip screw (DHS), a well-established device.

PATIENTS AND METHODS

One hundred consecutive patients, all over 60 years of age, with intertrochanteric fractures of the proximal femur, were randomly allocated for fixation with a Gamma nail or a DHS (Straumann GB, Welwyn Garden City, Hertfordshire).

Pre-operative assessment included the mental test score (Evans, Prudham and Wandless 1979), the American Society of Anesthesiologists (ASA) score (1963), an assessment of general medical condition, and of pre-fracture accommodation and walking ability. Fracture patterns were recorded as two-, three-, or four-part fractures. Four-part fractures and three-part fractures with posteromedial comminution were categorised as unstable (Evans 1949).

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Fig. 1

Fig. 2

The Gamma nail. The locking screws shown here were not used primarily in our series of cases.

Treatment was randomised at the time of induction of anaesthesia. All the operations were performed by one of four senior surgeons, all experienced in closed nailing techniques.

Dynamic hip screws were inserted using the standard technique. The Gamma nail is inserted using a 'closed' technique under image intensifier control. The patient is positioned on the traction table, and the fracture is reduced with the leg adducted. A 6 cm incision is made just proximal to the greater trochanter, which is entered using a curved awl. The entry point is just lateral to the tip of the trochanter. A guide wire is introduced into the femoral shaft, and flexible reamers are used to the appropriate size. A nail, usually the smallest size, 1 to 1.5 mm smaller than the final reamer, is selected. No attempt is made to ream the shaft to accept a large nail.

The angle of nail, ranging from 125° to 140° , is selected before operation by using templates on the radiograph of the normal hip. The nail is inserted by hand, never being hammered. Using the appropriate jig, a guide wire is passed into the neck, and the position checked. If the lateral view is unsatisfactory, the nail is withdrawn, its rotation is changed, and the nail is reinserted. The lateral cortex of the femur and the neck are reamed with a triple reamer, and a screw is then inserted. A set-screw in the top of the nail controls rotation. This is tightened, and then loosened by half a turn to allow sliding. Finally the fracture site is compressed. The nail can be locked distally by inserting two screws using the same jig, but this was not done in any of our cases.

The time taken to position the patient, and to reduce the fracture (setting-up time) were noted. Operating time, and any operative difficulties, peroperative blood loss, postoperative wound drainage, and the amount of blood transfused were recorded. Haemoglobin levels before, and at 48 hours after surgery, delay in wound healing or infection, and any other complications were also noted, as were duration of hospital stay, and the type of accommodation to which the patients were discharged.

Postoperative radiographs were assessed for fracture reduction, and for the position of the screw within the head. This was assessed on both the anteroposterior and the lateral radiographs, each image of the head and neck being divided into nine areas as a grid (Fig. 3). The position of the screw head on the radiographs was plotted; this allows the position to be determined in all

Fig. 3

Method of recording the position of the screw tip on three axes. On the anteroposterior film, the X axis shows a superior (-1) or inferior (+1) position and the Y axis gives proximity to the subchondral bone (0 or +1). On the lateral view, the Z axis shows anterior (+1) or posterior (-1) placement.

three axes, assuming that the radiographs were taken at right angles. The direction of any deviation of the screw tip from the central axis of the femoral head can therefore be assessed, as can its proximity to the subchondral bone.

Surviving patients were followed up clinically and radiologically for at least six months. Level of accommodation, ability to walk, and incidence of pain were noted. Any change in screw position was recorded, as were fracture union, sliding of the screw, shortening of the femur, and any complications relating to the fixation.

RESULTS

There were 49 patients in the Gamma nail group, and 51 in the DHS group. The groups were comparable with respect to age, sex, mental test score, ASA score, and fracture type and stability (Table I). There were no significant differences in pre-operative accommodation levels or mobility.

Table I. Details of 100 patients who had fixation of an intertrochanteric fracture

	DHS	Gamma nail
Mean age (yr)	82.7	81.0
Male	7	9
Female	44	40
ASA score		
I	2	2
II	22	23
III	16	20
IV	11	4
Mean mental test score	7	7
Fracture type		
Stable	23	18
Unstable	28	31

Setting-up time, type of anaesthesia, operating time, blood loss, and haemoglobin levels (Table II), showed no significant differences between the groups, and the amount of blood transfused was also comparable. There was no difference in the duration of hospital stay, which averaged 39 days with the DHS, and 37 days with the Gamma nail. Most of the surviving patients were discharged to their pre-operative accommodation, with similar numbers requiring institutional or hospital care (Fig. 4). Mobility was unchanged in 35%, and showed a loss of one level in 48%. Two patients were immobile prior to fracture, and nine at final review. Of 56 patients who were able to walk unaided before their fracture, only 16 could do so at six months (Fig. 5).

The mortality rate in hospital was 19%; at six months this figure had risen to 34%, but there was no difference between the two groups. The complication

rates were also similar (Table III), with no significant difference in wound healing or infection.

There was a significant difference in the position of the screw tip in relation to the central axis of the femoral neck between the groups (Cochran-Mantel-Haenszel test). The dynamic hip screws had been placed lower in the neck ($p < 0.02$), and nearer the subchondral bone ($p < 0.001$). These screws also tended to be placed more posteriorly, but this difference was not significant. The dynamic hip screws deviated more from the central axis of the femoral neck than did the screws of the Gamma nail ($p < 0.001$). Few screws in either group were in a bad position, but three in the Gamma nail group, and four in the DHS were placed superiorly in the neck.

At the final review, cut-out of the screw from the head had occurred in two cases with the Gamma nail, and three with the DHS. Secondary deviation of the screw from the central axis was more likely with the DHS ($p < 0.05$). The screw tip had migrated within the head in four cases in each group, but there was no migration at all in 87% of the fractures.

Where failure of fixation had not occurred fracture union was seen in all surviving patients by six months.

Table II. Operative and postoperative details of 100 patients who had fixation of an intertrochanteric fracture

	DHS	Gamma nail
Mean setting up time (min)	9	7
Mean operating time (min)	33.5	36
Anaesthesia		
spinal	7	6
general	44	43
Mean blood loss (ml)		
operative	141	162
wound drainage	133	116
Mean haemoglobin level (g/dl)		
pre-operative	12.1	12.0
postoperative	10.3	10.3

Table III. Mortality and complications

	DHS	Gamma nail
Deaths		
before discharge	9	10
during first six months	19	15
CVA	0	4
Bronchopneumonia	3	1
Pulmonary embolism	0	1
Pressure score	1	4
Wound infection	2	1
Wound haematoma	2	0

Sliding of the device occurred slightly more often with the DHS, but the difference was not significant. There was no correlation between screw migration and failure to slide in either group.

There were two complications which occurred only with the Gamma nail. In one case rotation occurred at the fracture site and re-operation was required to insert distal locking screws. Four patients sustained femoral shaft fractures following apparently uncomplicated nailing. One of these patients had been involved in a road traffic accident, and also fractured his tibia, but the other three fractures occurred with minimal trauma. Two of these three fractures were in the region of the nail (Fig. 6); the other was well distal to it.

DISCUSSION

In the management of shaft fractures considerable benefits have been shown from the use of closed intramedullary nailing (Johnson, Johnson and Parker 1984; Christie et al 1988). However, in intertrochanteric fractures, we have found none of the potential advantages of shorter operating time, lower blood loss, less postoperative morbidity or better fracture healing.

A central position of the screw is probably optimal for pertrochanteric fractures (Mulholland and Gunn 1972; Wolfgang et al 1982; Davis et al 1990). The screw of the Gamma nail proved more likely to go up the central axis of the femoral neck, and to give a better screw position. This may be because the entry point of the guide wire into the neck is controlled by the position of the nail within the medulla, close to the base of the neck, a point which is less variable than an entry point on the lateral cortex. Placement of the screw head close to the subchondral bone may improve fixation (Kyle, Gustilo and Premer 1979; Laskin, Gruber and Zimmerman 1979); this was achieved more often with the DHS. Despite these differences, however, we found no difference in screw migration or in cutting out from the femoral head. The frequency of these complications in our study was less than in some other reported series (Laros and Moore 1974; Wolfgang et al 1982; Nunn 1988), reflecting the good screw position that we usually obtained.

Cutting-out from the femoral head is usually due to technical error rather than poor function of the implant. It has been suggested that failure of the screw to slide,

Fig. 4

Histogram showing accommodation before injury (hatched) and at final review (unshaded). Non-institution includes warden controlled and similar accommodation.

Fig. 5

Histogram showing mobility before injury (hatched) and at final review (unshaded) for each device.

Fig. 6

Radiograph showing a femoral shaft fracture around a Gamma nail.

causing the implant to function as a one-piece device, predisposes to cutting-out (Simpson et al 1989; Flores, Harrington and Heller 1990). This may occur in up to 50% of fractures (Jensen et al 1978). In our series, failure to slide did not correlate with implant failure in either device. Impaction occurred as often with the Gamma nail as with the DHS.

No implant broke. The theoretically greater strength of the Gamma nail may not be necessary for intertrochanteric fractures, unless they have a subtrochanteric extension.

Of the four fractures of the femoral shaft which occurred in the Gamma nail group, one could be explained by the severe nature of the trauma. The second followed a peroperative fracture of the lateral cortex of the proximal shaft, which was only recognised on the postoperative radiograph. Eight weeks later the fracture extended distally around the nail when the patient was getting into a chair at home. A further operation was required to insert distal locking screws. The other two fractures occurred at 10 days, and at four weeks after surgery. One was a spiral fracture in the supracondylar region in very osteoporotic bone, sustained when the patient was being turned in bed by a physiotherapist. The second was caused by a minor fall, and resulted in a spiral fracture around the nail; this was treated by the insertion of distal locking screws.

It should be noted that all the operations were done by surgeons experienced with the techniques of closed intramedullary nailing; this is a prerequisite for the insertion of this device.

The explanation for some of these fractures is not clear, but there are three possible predisposing factors. First, the shape of the nail may produce three-point loading within the shaft, causing excess stresses on the porotic bone. Secondly, the increased stiffness of the proximal shaft produced by the nail may result in a stress raiser effect at its tip. Thirdly, over-reaming could have weakened the femur, particularly if reaming was eccentric. Over-reaming was not apparent radiologically in any of the fractures and we advise strongly against it. Templates are now available for sizing the femur, and a small medullary canal may be a contra-indication to the use of the device.

Rotation at the fracture site occurred in only one case and it seems that the fixation of the nail within the shaft is usually sufficient to control this. No other complications could be related to the lack of distal locking screws. We consider that routine distal locking is unnecessary for intertrochanteric fractures, but is definitely indicated where there is a subtrochanteric extension of the fracture.

We obtained a more central position of the screw with the Gamma nail, but found no other significant

differences between the two devices. In view of the secondary femoral fractures in the Gamma nail group, we do not recommend the routine use of this device until it can be shown that this problem has been resolved. However, for difficult fractures with a subtrochanteric extension or reversed obliquity, and for high subtrochanteric fractures, where other forms of fixation are less satisfactory, the Gamma nail may prove useful.

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