Treatment of traumatic conditions of the femur using the Huckstep nail

T F Wisniewski MD PhD(Orth)

Department of Orthopaedic Surgery and Bone and Joint Research Unit
University of the Witwatersrand, Johannesburg, South Africa

M.B.E.Sweet MD PhD(Med)

Department of Orthopaedic Surgery and Bone and Joint Research Unit
University of the Witwatersrand, Johannesburg, South Africa

Key words: Huckstep, intramedullary nail, femoral fracture

The Huckstep nail is essentially an intramedullary nail. We assessed 53 patients treated for complex fractures of the femur between 1982 and 1988. Our series included 41 acute fractures, seven malunions or non-unions and five pathological fractures. We modified the Huckstep technique by using a traction table and image intensification for closed reduction and introduction of screws into the femoral neck. However, half of our patients required open reduction. All but one of the acute fractures united, occasionally after some delay. We were able to achieve lengthening of between 3cm and 5cm where this was indicated but all these patients' fractures required bone grafting before uniting. Despite extensive surgical exposure knee function was surprisingly good. Complications included one broken nail, 12 fractured distal screws and 3 cases of intra-operative "bursting" of the distal cortex. The procedure was lengthy and blood loss considerable but no sepsis occurred. Although locking nails have now largely superseded the Huckstep nail, it remains useful for special cases where a short implant is needed, or in situations where specialised equipment such as image intensifiers are unavailable.

Address for Correspondence: T F Wisniewski MD PhD (Orth), P O Box 130742, Bryanston 2021, South Africa

Introduction

Intramedullary nailing has long been a satisfactory method of treating fractures of the femur. With the introduction of interlocking nails, the indications have expanded to include more complex, comminuted fractures[1,2,3,4,6,19]. Furthermore this procedure has, in certain situations, become the treatment of choice in open fractures[2,6,12].

At present several interlocking femoral nails are available but the Huckstep nail has been in use since 1974[8]. This four-sided, straight intramedullary femoral nail of solid titanium alloy was introduced to South Africa in 1982, well before interlocking nails became readily available. The nail is 12.5mm in diameter and has 4.5mm transverse holes at 15mm intervals. These are for 4mm screws. It has four oblique holes in the proximal end to allow insertion of 4.5mm lag screws into the femoral head. The nail can be used for fixation of fractures of the entire femoral diaphysis. Ipsilateral fractures of the neck and shaft can be held with oblique screws inserted into the neck and screws across the femoral condyles will stabilise fractures down to 5cm proximal to the knee joint. The fractures may be compressed or distracted. The instrumentation is simple, consisting of an inserter to which are attached the nail and four different types of jigs for the insertion of the locking screws[9].

In this retrospective study we present our clinical experience using this intramedullary device in the treatment of complex fractures of the femur.

Materials and methods

Between 1982 and 1988 61 patients were treated with the Huckstep nail, of whom 53 (42 men and 11 women) were available for assessment. The age of the patients ranged from 17 to 66 years (mean 34 years).

There were 41 acute and complex fractures, seven malunions or non-unions and five pathological fractures. Of the 41 acute cases, 15 were open and 26 closed. Twenty-four patients had multiple injuries (Table I).

Twenty-one patients were injured in motor vehicle accidents and in 17 a motorcycle accident was responsible. Pedestrian accidents and gunshot wounds each accounted for 5 cases (Table 1). None of our patients had isolated femoral neck intertrochanteric or condylar fractures.

Ipsilateral hip and shaft fractures had occurred in 11 patients, subtrochanteric fractures in 8, femoral shaft fractures in 12, ipsilateral shaft and condylar fractures in 4 and segmental femoral shaft fractures in 6. Of the 7 patients with malunion or non-union 4 underwent surgery to correct malalignment and shortening of between 3cm and 5cm. The other three underwent nailing and bone grafting. The pathological fractures were due to Paget's disease[1], fibrous dysplasia[1] or metastatic disease[3].

TABLE I *Materials and methods*

Patients	53
Mean age	34 (17-66)
Male/female	42:11
Acute fractures	
open	41
closed	15
Pathological features	26
Mal- and non-union	5
Mean operation time	2.4 hours (2-4)
Mean blood loss	2.8 units (2-5)
Primary bone grafting	10 patients
Mechanisms of injury	
MVA	43
Gunshot	5
Pathological	5

Operative Technique

Our technique differed from that of Huckstep[9]. The patient was placed supine on the traction table. The standard lateral approach was used to expose and to enter the femur just medial to the greater trochanter and a reaming guide wire was inserted after closed reduction of the fracture, using image intensification. The medullary cavity was over-reamed to between 14mm and 16mm in order to permit manual introduction of the nail attached to the jig (Fig 1). The shaft of the femur was approached laterally to allow for insertion of the

locking screws above and below the fracture with minimal disruption of the soft tissues at the fracture site. The jig allows this procedure to be done without recourse to an image intensifier. When closed reduction failed, or corrective osteotomy or bone grafting was required, the fracture was exposed using the standard lateral approach and reflecting the vastus lateralis anteriorly. Image intensification is helpful for the introduction of locking screws into the femoral neck and for preliminary closed reduction but it is not essential.

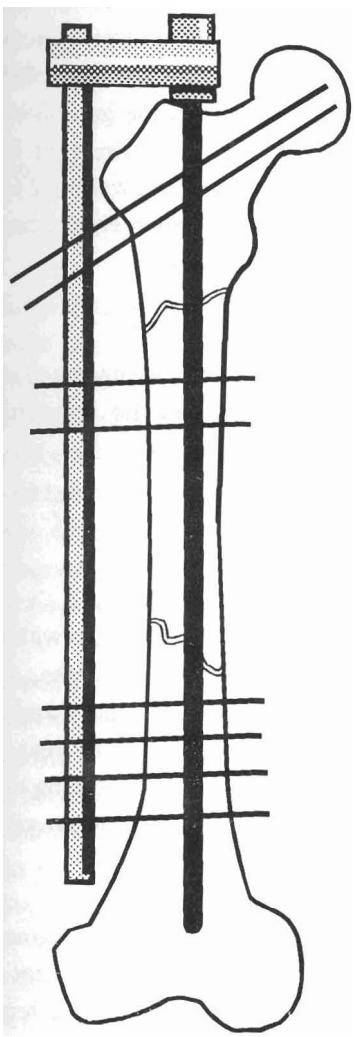


Fig 1
Diagram illustrating the Huckstep nail, the jig and interlocking fixation.

Management of Acute Fractures

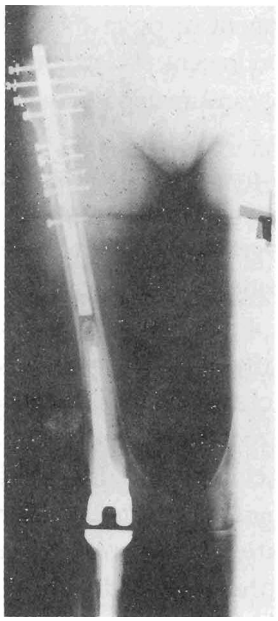
Surgery was delayed for 3 to 14 days in closed fractures and for 2 to 4 weeks in open fractures. Primary treatment of open fractures consisted of thorough debridement, skeletal traction through the tibial tuberosity and antibiotic cover. Operating time was from 2 to 4 hours (mean 2.4 hours) and average blood replacement was 2.8 units (range 2 to 5 units). Because of extensive comminution or loss of bone, primary bone grafting was performed in 10 patients. Half of our patients needed open reduction of the fracture and it was necessary to over-ream the medullary cavity to 14 to 16mm to permit manual introduction of the nail. Comminuted fractures of the mid shaft required less reaming than transverse or oblique fractures in the distal shaft. In the latter group, even greater over-reaming was indicated. In three patients where over-reaming was insufficient, the cortex "burst" during forceful insertion of the nail.

Huckstep nails of 37cm or 40cm length were used in the majority of our patients. In two patients needing shorter nails the implants were cut to the appropriate length. One of these patients, who had a knee replacement, sustained a fracture of the femoral shaft above the prosthesis (Fig 2).

The other patient had malunion of a previous fracture of the distal shaft and presented with a fresh fracture proximal to the malunion (Fig 3).

In 20 patients lag screws were inserted into the femoral neck although only 11 patients had femoral neck fractures. The other nine patients had fractures of the proximal shaft which were too high to permit the insertion of a sufficient number of screws above the fracture. We encountered stripping of the hexagonal screw heads in the early part of this series and thereafter used standard 4.5mm AO cortical screws. Only one nail was removed, without

Fig 2
Sixty-year-old woman with arthroplasty of the right knee and subtrochanteric fracture of the femur.



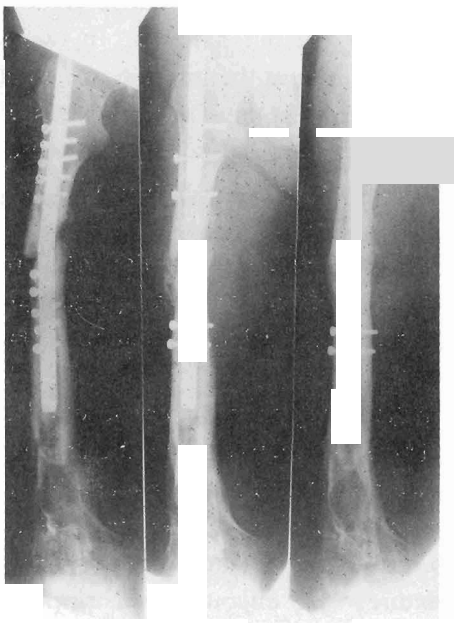


Fig 3
Thirty-five-year-old man with previous fracture distal right femur and subsequent sepsis. Shortened Huckstep nail failed and was replaced with good result and bony union.

complications, and this was at the request of the patient. Early mobilisation was encouraged and weight bearing slowly increased.

Management of Femoral Shortening and Malunion

An osteotomy of the femur was performed at the previous fracture site and the femoral shaft appropriately reamed. The nail was then introduced the rotational deformity corrected and the proximal femoral fragment fixed securely to the nail with 4 screws. The leg was then gradually lengthened by traction while the distal pulses were monitored. When the desired length was achieved the distal screws were inserted and the gap filled with bone graft. All patients who underwent lengthening required a second bone graft within 12 to 16 weeks. Patients continued on "touch weight bearing" until adequate callus had formed.

Pathological Fractures

The principal aim of the treatment was to permit early weight bearing and the standard operative technique was used.

Results

Acute Fractures

Of the 41 acute fractures, 25 united within 6 months and a further 13 united by 9 months. One patient required bone grafting after injury and all but one of the fractures had united by one year. There was no case of malrotation but shortening of up to 1cm was observed in four patients. No avascular necrosis occurred.

At follow-up, three patients complained of some discomfort in the region of the greater trochanter. All three had screws inserted in the femoral neck. The patient with non-union had thigh pain. The remainder were free of pain. Knee function was excellent in 35 patients, 4 patients had limitation of

albeit with some delay. Surgery was complicated by distal cortical burst in three cases and this was associated with eventual shortening of up to 1cm and with delayed union (Table III).

One screw penetrated the hip joint and was subsequently removed. One patient with ipsilateral femoral neck and shaft fractures was operated upon 6 weeks after injury and no correction of varus deformity of the femoral neck was possible. In one patient the nail fractured one year after insertion (Fig 3). This fracture united after replacement of the nail and bone grafting.

There were no cases of sepsis.

TABLE III *Complications*

Cortical burst		3
Breakage		
	Locking screws	12
	Nail	1
Sepsis		0

Discussion

Mechanical stability and soft tissue preservation are the two most important principles in the biomechanics of fixation of femoral fractures. Implants provide mechanical stability to promote tissue healing and the return of function. Tissue preservation enhances bone regeneration[15,16].

In recent years, our understanding of the biomechanics of fracture healing has advanced. The structural properties of materials have been improved and the mechanical ability of intramedullary locking nails increased[10,14,15,16].

In the context of modern intramedullary interlocking nails, the four-sided straight, rigid titanium alloy Huckstep nail should be regarded more as an intramedullary plate than a locking nail. Closed intramedullary nailing of femoral fractures has long been regarded as a desirable treatment[3,4,7,11,14,17,18]. Although we have modified the open technique of Huckstep, many of the fractures were in fact exposed in order to facilitate the reduction of the fracture or insertion of locking screws. Tissue disruption probably contributed to delayed union in some cases and thus the frequent need for bone grafting.
Early intramedullary fixation of open fractures has been recommended by some authors[2,5,12] and delayed nailing for gunshot fractures for others[17]. Of our 15 open fractures, 5 were from gunshot injuries. Nailing was delayed some days or weeks after initial debridement, and adequate antibiotic prophylaxis. All these fractures united without sepsis. Most of the patients regained full knee function despite the extensive surgical exposure. Only patients who sustained very distal femoral fractures had limited knee movement.

The Huckstep nailing procedure is time consuming, technically demanding and necessitates wide exposure, extensive medullary reaming and blood transfusion. In the light of the extensive exposure required, the absence of infection in this series was surprising. This may be due to the delay before definitive surgery was performed.

The indications for removal of intramedullary rods remains controversial. They can include pain above the greater trochanter or implant failure[13]. Removal of a Huckstep nail poses a great challenge to the surgeon who may be faced with difficulties during the procedure.

The development of modern intramedullary interlocking nails has markedly reduced the indications for use of the Huckstep nail. We believe is should be reserved for specific fractures requiring a short nail such as those presented in this study. We have limited experience of a shortened Huckstep nail having used it in only two patients. The principle, however, is a device that fixes the proximal

continued on page 42

continued from page 30

femur regardless of the presence of bony deformity or other distal intramedullary obstruction. In addition the nail offers the facility of distal locking at any suitable level. This cannot be achieved with any other standard AO-type intramedullary nail. Shortening AO nails would result in loss of distal locking. The Huckstep nail may be of use where traction tables and image intensifiers are unavailable, for it has a jig for accurate distal locking, a feature that is lacking in the AO-type nail. Fractures which are very comminuted are often treated conservatively and will almost certainly heal with shortening and malrotation. Use of the Huckstep nail obviates such an outcome. In addition, malunion requiring correction can also be treated with the Huckstep nail. This nail therefore offers the chance of a reasonable result in situations where a modern intramedullary interlocking nail can not be used.

References

1 **Bone L B,** Johnson K D, Weigelt J, Scheinberg R. Early versus delayed stabilization of femoral fractures *J Bone and Joint Surg* 1989; 71A:336-440.

2 Brumback R J, Ellison T S, Poka A, et al. Intramedullary nailing of open fractures of the femoral shaft *J Bone and Joint Surg* 1989; 71A:1324-1330.

3 Brumback R J, Ellison T S, Poka A, et al. Intramedullary nailing of femoral shaft fractures *J Bone and Joint Surg* 1992; 74A:106-112.

4 Cameron C D, Meek R N, Blachut P A, et al. Intramedullary nailing of the femoral shaft: a prospective randomised study *J Orthop Trauma* 1992; 6:448-451.

5 Folleras G, Alho A, Stromsoe K, et al. Locked intramedullary nailing of fractures of femur and tibia *Injury* 1990; 21:385-388.

6 Grosse A, Christie J, Taglang G, et al. Open adult femoral shaft fracture treated by early intramedullary nailing *J Bone and Joint Surg* 1993; 75B:562-565.

7 Hindley C J, Evans R A, Holt E M, Metcalfe J W. Locked intramedullary nailing for recent lower limb fractures *Injury* 1990; 21:239-244.

8 Huckstep R L. Early mobilization and rehabilitation of fractures and orthopaedic conditions *Aust NZ J Surg 1977; 47*:345-353.

9 Huckstep R L. The Huckstep intramedullary compression nail *Clin Orthop* 1986; 48-61.

10 Johnson K D, Tencer A F, Sherman M C. Biomechanical factors affecting fracture stability and femoral bursting in closed intramedullary nailing of femoral shaft fractures, illustrative case presentations *J Orthop Trauma* 1987; 1:1-10.

11 Karachalios T, Atkins R M, Sarangi P P, et al. Reconstruction nailing for pathological subtrochanteric fractures with co-existing femoral shaft metastases *J Bone and Joint Surg* 1993; 75B:119-122.

12 Lhowe D W, Hansen S T. Immediate nailing of fractures of the femoral shaft *J Bone and Joint Surg* 1988; 70A:812-820.

13 Miller R, Renwick S E, De Coster D A, et al. Removal of intramedullary rods after femoral shaft fractures *J Orthop Trauma* 1992; 6:460-463.

14 Riquelme A G, Rodriques A J, Mino G L, Sanmartin R M. Treatment of the femoral tibial fractures with Grosse Kempf locking nails *Clin Orthop* 1992; 86-89.

15 Russell T A, Taylor J C, LaVelle D G, et al. Mechanical characterization of femoral interlocking intramedullary nailing system *J Orthop Trauma* 1991; 5:332-340.

16 Russell T A. Biomechanical aspects of femoral intramedullary nailing *Internat J Orthop Trauma* 1991; 1:35-51.

17 Taylor J C, LaVelle D G, Walker B J. Long bone fracture management at the Campbell Clinic: experience gained from 1700 fractures treated with the R-T interlocking nail system *Campbell Clinic* 1991.

18 Zuckerman J D, Veith R G, Johnson K D, et al. Treatment of unstable femoral shaft fractures with closed interlocking intramedullary nailing *J Orthop Trauma* 1987; 1:209-218.