Open Reamed Femoral Intramedullary Nailing–Revisited

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Objective: **Locked intramedullary nailing is the preferred treatment for femoral shaft fractures but it requires a relatively expensive implant. Patients have to pay for the specialized implants and those who could not afford the cost had open Kuntscher nailing. This study was done to see the outcome of open Kuntscher nailing for femoral shaft fractures with regard to infection, time to union, limb shortening, malunion and range of motion at the knee.**
Method: **Thirty-two patients with 34 femoral shaft fractures underwent open Kuntscher intramedullary nailing. Their average age was 23 years. Ten fractures involved the upper third of the femoral shaft, 19 the middle third and 5 the distal third. When categorized according to degree of comminution there were 18 Type I, 11 Type II and 5 Type III fractures. Comminuted type IV fractures, per-trochanteric and supracondylar fractures were not included in the study.**
Results: **All 34 fractures healed on an average in 14 weeks. One patient developed deep seated infection. There was one nail breakage at 10 weeks, which required re-nailing. 6 patients had shortening of one cm or less. No patient had symptomatic rotatory malunion. All patients could fully squat at one year.**
Conclusion: **Kuntscher intramedullary nailing gives good clinical results in fractures with minimal comminution. Locked nailing is not essential for less severely comminuted fractures.**

Key words: *Kuntscher nailing, femoral fractures*

Closed locked intramedullary nailing is the preferred treatment for femoral shaft fracture as it offers better control of the limb length and the rotational alignment but it requires relatively expensive implant (1-8). Patients have to pay for the special implants at our hospital, therefore those who could not afford the cost had open Kuntscher nailing. To answer the ethical question whether these patients received "inferior" treatment, the clinical results in 34 femoral shaft fractures treated by open reamed intramedullary nailing were reviewed with regard to infection, time to union, limb shortening, mal-rotation and range of motion at the knee. Very little has been published on the use of Kuntscher nail for last 10 to 15 years, even though it is still a widely used implant in poorer countries.

Material and Method

Between June 1995 and June 2000, thirty-four femoral shaft fractures in 32 patients were treated by reamed open intramedullary nailing. There were 29 men and 3 women; their average age was 23 years (range 15-45 years). Thirty-one patients were involved in motor vehicle accident, 19 of them were motorcyclists (61%). One patient was victim of an assault. There were 6 open fractures, 2 of Grade I, 3 of Grade II and 1 of Grade III B (9). The injury severity score was not recorded but the associated visceral injuries, head injury and other fractures were recorded individually.

The shaft of femur, from 5 cm distal to the lesser trochanter to 5 cm proximal to the adductor tubercle, was divided into three equal thirds. Ten fractures were situated in the upper third, 19 fractures in the middle third and 5 in the distal third of the femoral shaft. Per-trochanteric and supracondylar fractures were excluded. The fracture pattern was transverse in 18, short oblique in 12, split cortex in 2, long oblique in 1 and segmental in 1. In 9 out of 18 transverse fractures there were inter-digitating "teeth" (spikes) at the ends of the fragments. The fractures were further categorised according to Winquist et al (10) for the degree of comminution. There were 18 of Type I (53%), 11 of Type II (32%) and 5 of Type III (15%). Patients with Type IV comminuted fractures were excluded from the study (Table I).

For open fractures, nailing was done after the wounds had healed following initial debridement. All patients had open nailing, the fracture site was exposed through a postero-lateral incision over the thigh, the vastus lateralis was reflected anteriorly, care was taken to strip the soft tissues for not more than 3 to 4 cm from the ends of the fracture fragments. The medullary canal was reamed with a powered reamer, to the same size as the diameter of the nail. A straight blunt tipped cloverleaf shaped Kuntscher nail was used in all cases. The nail was first passed in a retrograde manner and then driven across the fracture site from proximal to distal. Matching the fracture ends or aligning the linea aspera was used as a guide for reduction. Whenever the fracture ends had "teeth" (spikes) these were "engaged" to provide additional rotatory stability. Cerclage wiring was not done for any patient.

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Table I. Patients' characteristics and results.

Case No	Age (Yrs)	Sex M / F	Closed or Open – Grade & Site of fracture	Morphology of fracture	Degree of comminu-tion Winquist type	Interval between injury and operation (days)	Time to union (weeks)	Limb shortening (cms)	Follow-up (months)
1.	18	M	L – closed mid-shaft	transverse	I	8	16	Nil	12
			R- open II mid-shaft	transverse	I	8	16	Nil	12
2.	36	M	R – closed mid-shaft	short oblique	II	19	14	Nil	12
3.	28	M	R – closed mid-shaft	transverse	I	1	12	Nil	20
4.	18	M	R – closed mid-shaft	short oblique	II	14	14	Nil	60
5.	24	M	L – open I lower-third	split fragment	III	20	11	Nil	36
6.	27	M	R – closed lower-third	transverse with teeth	I	6	15	Nil	20
7.	24	M	R – closed upper third	transverse	I	10	11	1cm	19
8.	17	M	L – closed lower-third	transverse with teeth	I	14	10	Nil	17
9.	22	M	R – closed mid-shaft	transverse	I	2	10	Nil	15
10.	21	F	L – open II mid-shaft	transverse	II	10	10	1 cm	21
11.	43	M	L – closed upper-third	transverse with teeth	II	60	14	1cm	12
12.	20	M	R – closed upper-third	short oblique	I	7	16	Nil	18
13.	19	M	R – closed mid-shaft	transverse with teeth	II	37	10	Nil	12
14.	45	M	L – open I mid-shaft	short oblique	III	20	12	Nil	22
15.	17	M	R – closed mid-shaft	short oblique	I	7	16	Nil	64
16.	24	M	L – closed mid-shaft	short oblique	II	7	10	Nil	12
17.	17	M	R – closed upper-third	transverse with teeth	I	7	12	1 cm	21
18.	21	M	L – closed upper-third	short oblique	I	12	11	Nil	21
19.	31	M	R – closed mid-shaft	short oblique	I	7	15	Nil	21
20.	19	M	L – open II upper-third	short oblique	III	33	16	0.5 cm	18
21.	17	M	R – closed mid-shaft	segmental	I	14	16	Nil	12
22.	18	M	L – closed mid-shaft	transverse with teeth	I	3	12	Nil	12
23.	29	M	R – closed upper-third	short oblique	II	8	20	Nil	12
24.	19	M	L – closed mid-shaft	transverse with teeth	I	6	12	Nil	17
25.	15	F	R –closed upper-third	transverse	I	6	16	Nil	12
			L – closed mid-shaft	short oblique	II	6	16	Nil	12
26.	19	F	R – closed mid-shaft	transverse	II	11	15	Nil	12
27.	20	M	L – closed mid-shaft	transverse	II	2	14	Nil	12
28.	26	M	R – closed upper-third	long oblique	III	9	16	0.5 cm	12
29.	29	M	R – open IIIB lower-third	short oblique	I	25	26	Nil	19
30.	15	M	L – closed lower-third	transverse with teeth	I	14	14	Nil	12
31.	19	M	L – closed mid-shaft	transverse with teeth	II	8	14	Nil	12
32.	24	M	R – closed upper-third	split fragment	III	1	12	Nil	12

Table II. Incidence of shortening and malrotation as reported by various authors following intramedullary nailing for fracture shaft of femur.

Authors	Method of intramedullary nailing	Total no. of fractures	Shortening (details)	External rotation deformity in number of fractures
Winquist et al. (10) 1984	Closed	520	9% (1 to 2 cm. in 47 fractures)	up to 10° in 43
Kempf et al. (4) 1985	Interlocked	52	21% (upto 2.5 cm in 11 fractures)	nil
Harper (15) 1985	Closed	80	9% (1.4 cm in 7 fractures) 12% (1.8 cm in 5)	20° to 35° in 5
	Open	39		20° in 3
Thoresen et al. (6) 1985	Interlocked	48	14% (up to 2 cm. in 7 fractures)	Criteria for excellent to good grading up to 15° 38 fractures were so graded
Hooper and Lyon (8) 1988	Closed unlocked	50	22% (1 cm. in 11 fractures)	over 15° in 6
Brumback et al Part I (14) 1988	Dynamic interlocked	133	13% (2 cm. in 13 fractures)	not mentioned
Sojbjerg et al. (5) 1990	Interlocked	40	12% (1 to 2 cm. in 5 fractures)	5° to 10° in 3
Present study	Open Kuntscher	34	17% (upto 1 cm. in 6 fractures)	none clinically

Postoperatively, patients were encouraged to do quadriceps exercises as tolerated by pain. Non-weight bearing crutch walking was allowed after they could lift the leg off the bed. As a precaution, a plaster gaiter cast was applied to the thigh to act as a sort of reminder to the patient to refrain from premature weight bearing.

The average interval between injury and operation was 12 days (range 1 to 60). The delay was frequently for non-medical reasons such as waiting for consent for operation from the family. While awaiting operation patients had skeletal traction.

The average length of follow-up was 19 months (range 12 to 64). All patients were reviewed regularly. Fracture union was defined as absence of pain on full weight bearing and bridging callus in both antero-posterior and lateral radiographs (6,11). Range of motion at the knee was recorded using a mechanical goniometer; leg lengths were measured clinically. Valgus and varus angulation was measured on the most recent radiographs, but the rotatory malunion were noted clinically. Radiographs were taken as required.

Results

The average delay prior to operation was 12 days (range 1- 60). The longest delay, 60 days was in the case 11, he had ipsilateral grade III B open fracture of tibia and fibula. The other two patients, case 13 with liver rupture and case 20 with spleen rupture had delay of 37 and 33 days, respectively. The average stay in the hospital following the operation was 13 days (range 6 to 19) and the average total stay in the hospital was 25 days (range 13 to 75).

All 34 fractures united on an average in 14 weeks (range 10 to 26 weeks) (Table I). Callus was noticed invariably on the medial side. Iliac cancellous bone grafts were used only in case 21. This patient had initial plate fixation elsewhere and came with a broken plate 4 months later. Bone-grafts were applied at the time of removal of broken plate and intramedullary nailing. The fracture united in 16 weeks.

No patient had clinically symptomatic angulatory or rotatory mal-union; even though 15 (44%) patients had fractures situated either in the proximal or distal third of the shaft. No patient either requested or was advised corrective osteotomy.

Six (17.6%) patients had shortening ranging between 0.5 to 1 cm. Four patients had 1 cm shortening, the first patient had re-nailing because of broken nail 10 weeks after the initial operation, the second had open Grade II fracture, the third patient had ipsilateral open fracture of the tibia-fibula and the fourth had closed type I comminuted fracture of the femur. On further analysis, 4 patients with 1 cm shortening had type I and II comminution, whereas 2 patients with type III comminution had 0.5 cm shortening. However none of the 6 patients complained of shortening or were prescribed a shoe raise.

All patients regained full range of motion at the hip and the knee by one year, including the two patients who had re-operation i.e. case 17 for removal of broken plate and case 21 with a broken intramedullary nail. All patients could fully squat and stand up easily at one year. This was important for the patients for social and religious customs.

There was one nail breakage at 10 weeks (case 17) when the patient attempted full weight bearing against advice; he required re-nailing with a larger diameter nail. The fracture healed at 14 weeks after re-operation. No patient had a post-operative nerve injury.

There were 2 cases of infection, one deep and the other superficial (5.8%). Both patients sustained closed fractures with type I comminution. One patient (case 25) had bilateral fractures but only the right side developed superficial wound infection. This settled within six weeks with dressings and antibiotics. The other patient (case 15) developed a discharging sinus in the distal end of the wound after four months. The nail was retained for 9 months, it was then removed and the medullary canal was curetted. Even then the infection did not settle and required further curettage 18 months later. He developed osteomyelitis. Fortunately, the infection had remained healed at the latest follow-up 3 years later.

Discussion

Theoretically, open reamed intramedullary nailing creates very unfavorable conditions for the fracture to unite. The blood supply from the nutrient artery is interrupted by the fracture itself, the periosteal blood supply is disrupted by stripping the soft tissues and reaming damages the endosteal blood supply (12). However, in clinical practice non-union of fracture shaft of femur following open intramedullary nailing is between 1 to 2% (2,13). All the 34 fractures of the shaft of femur treated by open reamed nailing united on an average in 14 weeks (10 to 26 weeks). Gentle dissection and stripping of soft tissues for 3 to 4 cm from the fracture ends does not seem to affect the blood supply to inhibit the fracture union. The femur is enveloped by thigh muscles and the fracture heals regardless of the severity of comminution or the method of treatment (1,2,11,12).

The major advantages of locked nailing are to control shortening and malrotation in comminuted fractures (3-8,13,14). Despite locking, the problem has not been eliminated. Many authors in their criteria for grading of the results, include 1 to 2 cm of shortening and 10° to 15° of malrotation as excellent to good result (4-6,8,10,15). With closed locked nailing, misjudgment of rotation is common (3,7,10) especially with the patient in lateral position (11). Further over-reaming necessary to negotiate the pre-bent interlocking nail decreases the resistance to rotation between the nail and the medullary canal (4,14,15) and requires interlocking screws to provide rotational stability. Harper (15) compared the closed with open nailing and reported lower incidence of malrotation with open nailing. Winquist et al (10) in their series of closed nailing in 500 patients reported 43 patients (9%) with more than 10° of external rotation deformity. They listed operative mal-positioning and post-operative loss due to instability especially in the fractures in the proximal third as some of the causes for malrotation (8,10). Only three of their patients opted for corrective derotation osteotomy. Fortunately, patients can disguise the rotation deformity when walking provided it is less than 20° and the hip has good range of motion. It is for these reasons the clinical detection of the deformity is difficult unless specifically looked for (7). In this study 15 out of 34 fractures (44%) were situated in either the proximal or the distal third, but there was no symptomatic rotatory malunion. The medullary canal was reamed to the same size as the diameter of the nail thus providing larger length of endosteal contact with the nail (14). Whenever the fractures had inter-digitating "teeth" these were used as guides for accurate coaptation. Once reduced, these "teeth" provided additional rotational stability.

Another limitation of the Kuntscher nail cited is the inadequate fixation of comminuted fractures leading to shortening (13,16). To avoid shortening, static interlocking is advised (5,14). With the Kuntscher nail, prevention of shortening is relied upon cortical apposition of the fracture ends as in type I and II comminution (14). For type III comminuted fractures, some cortical apposition of the fracture ends and the three point purchase of the straight nail on the endosteal surface of the medullary canal along with delayed weight bearing helps to prevent the shortening (12). In the present study no patient had shortening greater than 1 cm (Table II). Patients with type IV comminution were not included in this study.

The fear of infection has persuaded many surgeons to refrain from opening the fracture site. The reported rate of infection, following internal fixation of fractures is between 1 to 5% irrespective of the technique or the implant used (10,11,15,17). Brumback et al (17) reported between 3 to 5% infection in 89 fractures and Williams et al (11) reported 2.4% infection rate in 42 fractures. In the present study 1 out of 34 fractures (3%) developed deep-seated infection.

All patients had regained full range of motion at the knee by one year. The complications unique to closed nailing, such as failure of closed reduction, improper insertion of nails leading to fracture neck of femur, iatrogenic comminution and difficulty with insertion of distal screws, chronic pain over the prominent distal interlocking screw heads and breakage of screws, are reported to be between 13 to 29% (1,8,14,15,18,19). These are avoided with open Kuntscher nailing.

In conclusion open reamed Kuntscher nailing gives good clinical and functional results in short oblique or transverse fractures with lesser degree of comminution, more so when the fracture ends have inter-digitating "teeth". Locked nailing is not essential for less severely comminuted femoral shaft fractures.

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