Treatment of Femoral Shaft Fractures with Locked Intramedullary Nailing

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ABSTRACT: Intramedullary nailing is one of the favourite treatment of the femoral shaft fractures. But it will not control rotation or telescoping of the comminuted fragments particularly in the fractures near the proximal or distal ends. The locked intramedullary nailing can solve these problems and provides greater stability which allow early motion of the hip and knee of the affected extremity.

At Siriraj Hospital, sixteen femoral shaft fractures in fifteen patients were treated with the Grosse-Kempf interlocking nails between 1985 and 1987. All of them were male with the median age of 26.1 years. They were involved in high energy injuries caused by traffic accidents. Most of them were comminuted fractures of the shaft; four at the proximal, four at the distal and five were segmental. Two cases suffered ipsilateral fracture of the femoral neck as well.

The patients were followed up for 8 months to 2.5 years. The results in four fractures were classified as excellent, in eleven as good and in one as fair. Only one case of subtrochanteric fracture (with an associated fracture of the odontoid process) developed delayed union which required cancellous bone grafting afterward.

The operative treatment of the femoral shaft fracture in adult has become routine in Siriraj Hospital due to the economical and logistical reasons.[1-3] For the midshaft or the transverse fracture of the middle third, the intramedullary nailing, open or closed, is the treatment of choice.[4-9] But for the fractures of the proximal and distal third particularly in the long oblique, spiral or comminuted one, the intramedullary nail cannot control the rotation or telescoping of the fractures.[5-7] The open reduction internal fixation with plating or nail plating are routinely used with or without external immobilization. Because of the extensive exposure and the delay of the motion, the stiffness of the joints, either hip or knee, is the most frequent complication. Besides, the high incidences of delayed union with eventual plate failure, secondary bone grafting, infection and refracture have been reported in many series.[10,11]

The interlocking intramedullary nail was developed to overcome these problems through the use of screws that were placed through the bone and into the prefabricated holes in the proximal and the distal ends of the nail. (Figure 1) There are two types of fixation by this method.[12-14] First, the static locking in which screws are inserted proximally and distally to the fracture site which prevents both rotation and telescoping. Secondly, the dynamic locking, with one or two screws are inserted on only one side of the fracture, which prevents rotation and angulation but allows interfragmentary compression during early weight bearing. (Figures 2, 3) Also, a static fixation can be converted to a dynamic by removing the screws on one or another side of the fracture once the adequate callus has formed and compression would be desirable.[3,12-15] By providing greater stability, this method, either the dynamic or the stati locking, can allow early motion of the hip and the knee joint.

The idea of interlocking the nail and the bone began with Küntscher,[3,5,15] who near the end of his life, developed a plastic nail into which the locking screws could be inserted directly. His invention "the detensor" could stabilizes the comminuted fractures with threaded bolts through the prefabricated holes in the nail above and below the fracture. In his presentation at the 1968 annual meeting of the German Surgical Society, he said[15] *"The method of detention assures my goal to provide stable fixation of all fractures without the dangers and disadvantages of conservative or open operative method"*

In 1972 Klemm and Schellmann[14,15] accepted the concept of the detention nail and developed a femoral nail that was fitted with one oblique, proximal locking screw and two distal screws directed at 90 degree. The procedure was first used for

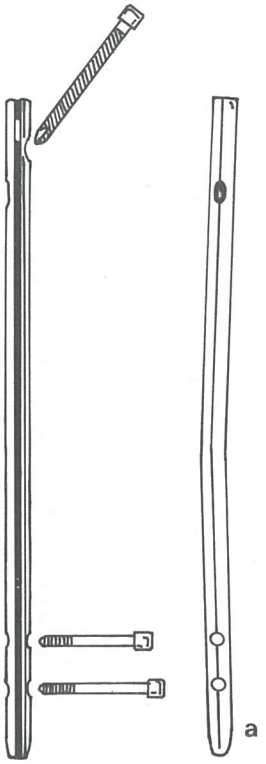


Fig. 1 Interlocking nail for femur.

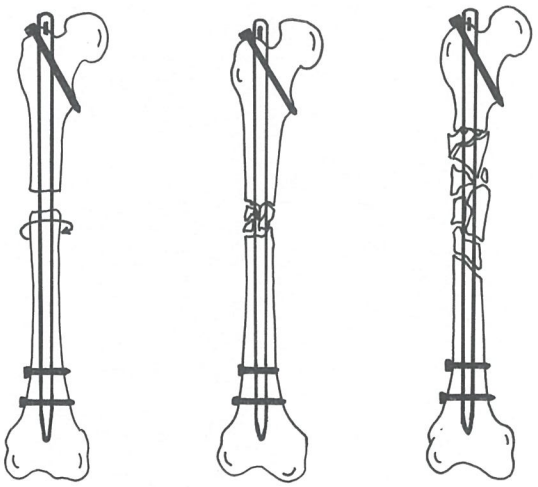


Fig. 2 Static interlocking nail in the femur.

fractures of the femur and was later accepted for fractures of the tibia as well.

In 1974, Kempf et al,[3,12-15] developed a stronger nail and a distal target device that protected the surgeons hand from X-ray exposure. Grosse and Kempf also recommended that, to enhance consolidation, a static nailing should be converted to a dynamic one during the third to fifth postoperative months.

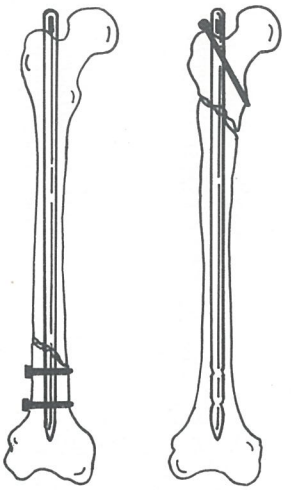


Fig. 3 Dynamic interlocking nail in the femur.

Since January 1985, we have used the Grosse Kempf device for treatment of femoral shaft in which ordinary intramedullary nailing would not have provided sufficient stability. The purpose of this retrospective study is to report our experiences with the first sixteen fractures of the femur that have been treated with the interlocking nail.

MATERIALS AND METHODS

At Siriraj Hospital, sixteen fractures of the femoral shaft in fifteen patients were treated with the Grosse Kempf interlocking intramedullary nail during January 1985 through January 1987. All of them were male with the median age of 26.1 years. (range from fifteen to forty five years of age.) One patient, a twenty-four year old male, sustained bilateral comminuted fracture of the femoral shaft with a compound one on the left. All of the patients were involved in high energy injuries caused by traffic accidents. Motorcycle injury was the most common cause. Severe comminuted fractures were routinely found in these cases, four located at the proximal, three at the middle and four at the distal third of the shaft. Five of them were segmental fractures. There were also two cases of ipsilateral fracture base of the neck and the shaft; one with the segmental and another with the distal third femoral shaft fracture.

Of the fifteen patients, six had only a fracture of a femoral shaft and nine had other associated lesions, which included multiple fractures in six, head injury in three and visceral injury in one. All of these associated injuries delayed the operative treatment of the femoral shaft fracture considerably. The longest delay was one month. (Tables 1,2)

TABLE 1
Clinical Data, Treatment and Result.

Case	Sex,	Age	Type of fracture	Treatment Locked nailing	Addition fixation	Length of follow up (months)	Result	Associated injury
1.	M,	25	S.T.	Dynamic	–	29	Excellent	–
2.	M,	25	S.T.	Dynamic	–	26	Excellent	–
3.	M,	15	S.O.	Static	–	24	Excellent	–
4.	M,	29	C.	Static	–	18	Good	–
5.	M,	23	C.	Static	Cerclage wire	17	Good	Odontoid process
6.	M,	21	P.T.	Dynamic	Cerclage wire	11	Good	ipsilateral femoral neck
7.	M,	45	S.C. + F.N.	Static	Hip pinning	11	Good	–
8.	M,	22	D.C.	Static	–	10	Good	–
9.	M,	21	P.T.	Dynamic	–	10	Excellent	–
10.	M,	21	P.T.	Dynamic	–	10	Good	–
11.	M,	23	P.C.	Static	–	10	Good	–
12.	M,	24	D.C. R	Static	–	9	Good	Sideswipe R forearm
			D.C. L	Static	Cerclage wire	9	Good	–
13.	M,	40	D.C. + F.N.	Static	Hip pinning	9	Fair	– head injury – ipsilateral tibial fracture – Colles fracture
14.	M,	32	S.C.	Static	–	8	Good	–
15.	M,	25	P.O.	Dynamic	Cerelage	8	Good	Head & visceral injury

ST. = Segmental, Transverse
SO. = Segmental Oblique
SC. = Segmental Comminuted
C = Comminuted
FN = Femoral neck
DC = Distal Comminuted
PT = Proximal Transverse
PO = Proximal Oblique
PC = Proximal Comminuted

TABLE 2
Associated Injuries

Associated fracture	
– forearm fractures	2
– tibia	2
– bilateral femoral shaft	1
– odontoid process	1
Associated injury	
– Head injury	3
– Visceral injury	1

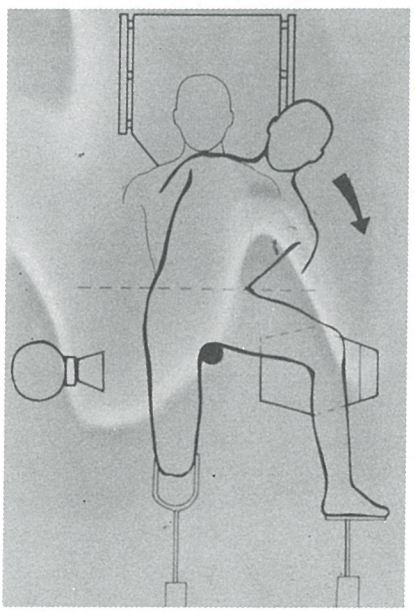


Fig. 4 Positioning of the patient on the fracture table.

Prior to the operation the patient was initially placed in skeletal traction. Any concomitant injuries were evaluated and treated in the accepted order of priority. At the operation, the patient was placed in the supine position on the fracture table. Traction was maintained on the femoral shaft fracture with skeletal traction through either the femoral condyle or the tibial condyle. (Figure 4)

Closed nailing was performed in eight fractures. In the other eight, in which a previous closed attempt was failed due to the delay, the reduction was achieved by open method. The medullary canal was reamed to the inner part of the cortex. In the comminuted and segmental fractures, the reaming was limited to twelve or thirteen millimeters to prevent further splintering or displacement of the fragments. The speed of the reamer was kept at a minimum so as to pass through the segmental fragment without further damage. The proximal locking screw was inserted into the proximal end of the nail, using the target device provided by the system. The distal two locking screws were inserted into the distal end of the nail using an image in-

tensifier and distal locking target device. In the early cases, the universal rod mounted distal target device were used. But later on we prefered to use the C-armed mounted distal target device instead.

Static nailing, in which interlocking screws were placed in both end of the nail, was routinely done in the comminuted fractures. It was performed in ten fractures. Dynamic nailing, in which either one screw was placed in the proximal or two screws in the distal end of the nail, were performed in six. In eight fractures which required open reduction, the cerclage wiring was used as addition fixation in four.

In two cases of the ipsilateral neck and shaft fractures; one was a segmental and another was the distal third fracture of the femoral shaft. The diaphyseal fracture was treated first, using the static locking nail. The femoral neck fracture was fixed with the anterior and posterior screws positioning. (Figure 5)

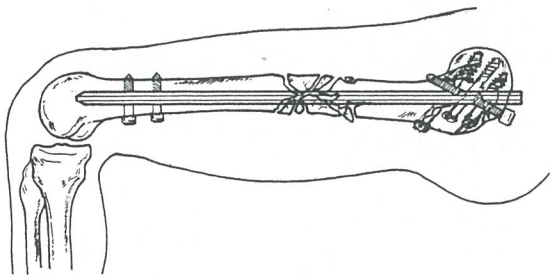


Fig. 5 Treatment of ipsilateral neck and shaft fracture by static interlocking nail and hip pinning anteriorly and posteriorly.

Postoperation, most of the patient was kept in bed with balance traction for five to seven days. The active and passive motion of the hip and knee were started immediately. Then the patients would be recommended to walk with partial weight bearing with crutches. All of them were allowed to bear full weight and use only one cane after two months, and there were no adverse effects.

The patients were followed for a median of 13.6 months postoperatively (range, eight to twenty nine months.) The results were designated as excellent, good, fair or poor according to the alignment of the fracture, the range of the motion of the ipsilateral knee, the degree of pain and swelling using the criteria of Thoresen et al.[3] (Table 3)

RESULTS

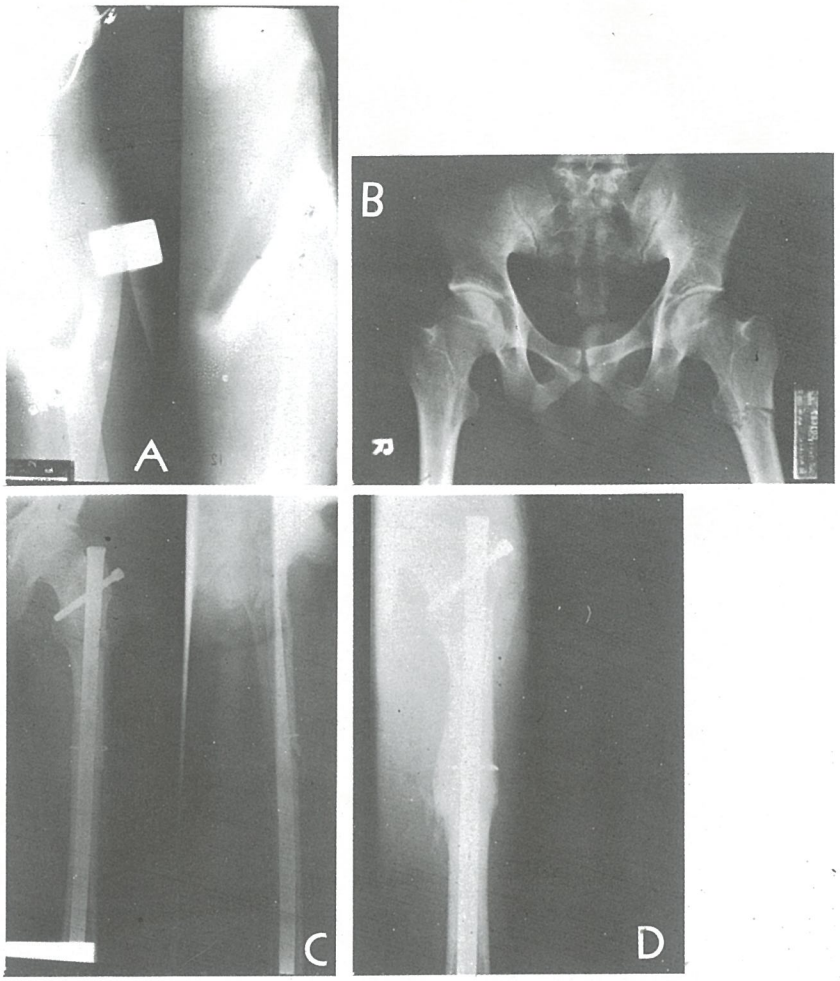
The results in four fractures were rated as excellent; in eleven as good and in one as fair. In an excellent result the malalignment and shortening was minimum. The patient had full, painfree function of the extremity.

Of the ten fractures with a good result, no shortening was found in any cases. The range of motion of the knee was limited in flexion 120° in six cases and 110° in four. The rating was improved to excellent in six cases after the gently manipulation was performed at the time of nail removal.

One case of fair result was a forty years old male who involved in a motorcycle accident. He sustained multiple injuries including severe head injury, comminuted fracture of the distal third of the femoral shaft with ipsilateral femoral neck frac-

TABLE 3
Classification System for the Results of Treatment

	Result			
	Excellent	Good	Fair	Poor
Malalignment of the femur *(degrees)*				
Varus or valgus	5	5	10	>10
Antecurvatum or recurvatum	5	10	15	>15
Internal rotation	5	10	15	>15
External rotation	10	15	20	>20
Shortening of the femur *(cm)*	1	2	3	>3
Range of motion of the knee *(degrees)*				
Flexion	>120	120	90	<90
Extension deficit	5	10	15	>15
Pain or swelling	None	Sporadic, minor	Significant	Severe



Figs. 5A, 5B A 25 year old man sustained closed segmental fracture of the femoral shaft.
5C, 5D Open dynamic interlocking nailing was done with additioning of the cerclage wiring. Radiographs was made six weeks showed good alignment, and solid union at six months postoperatively. He was rated as excellent.

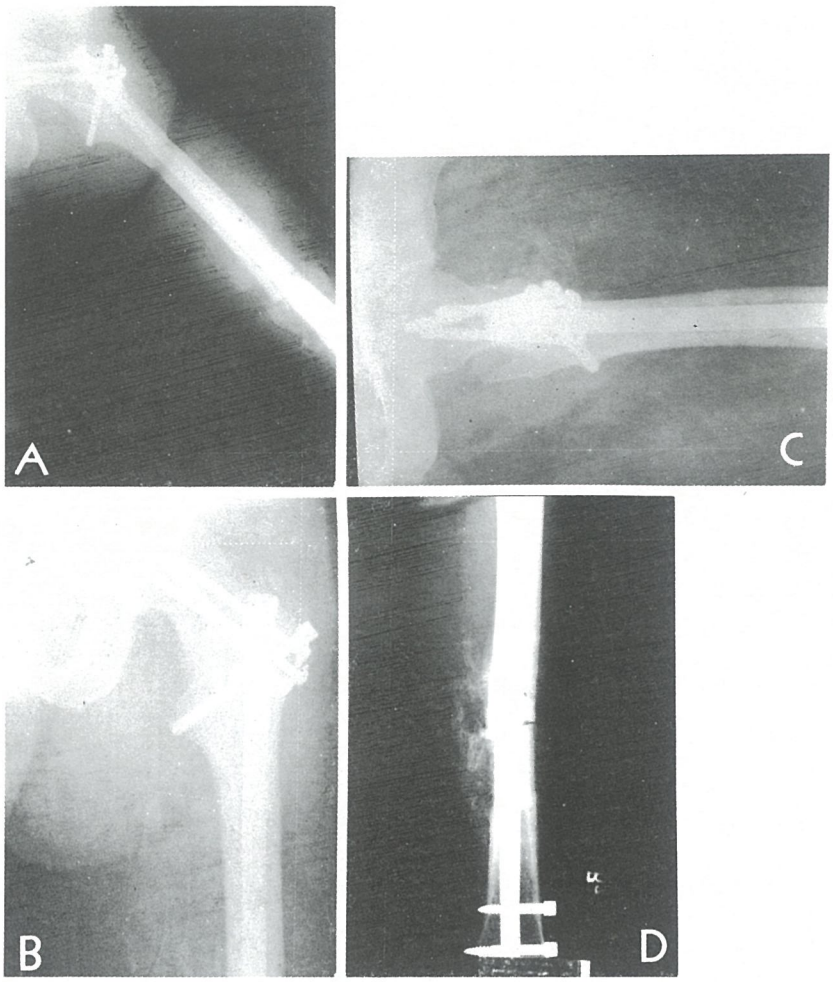
ture. He also sustained concomitant severe comminuted fracture of the ipsilateral tibial shaft as well. Because of the head injury the operative treatment for the femoral fractures was delayed for almost 3 weeks. The static interlocking intramedullary nailing and addition hip pinning were performed simultaneously. Ten days later, the tibial nailing was done with the addition cerclage wiring. Eight months later he was rated as fair. He lost 10 degrees of extension and 20 degrees of flexion of his affected knee.

COMPLICATIONS

One case of subtrochanteric fracture developed delayed union four months postoperation. He was a bus boy of twenty one years of age, who sustained associated fracture of the odontoid process as well. He underwent Gallie procedure for the atlanto-axial fusion three weeks after the initial injury. Four months later, the fracture line at the subtrochanteric region was remained and the cancellous bone grafting procedure was performed simultaneously. The fracture was eventually healed and he was rated as good ten months later.

DISCUSSION

Since January 1985, we have used an interlocking intramedullary nailing to fix comminuted fracture of the femoral shaft routinely. All of our cases were involved in high energy injuries caused by traffic accidents. Majority of the cases (thirteen of fifteen cases) were caused by motorcycle injury. Almost all of them sustained complex injuries which delay the operative treatment



Figs. 6A, 6B A 45 year old man sustained sugmental fracture shaft and ipsilateral fracture base of the neck of femur which could be treated satisfactorily with static interlocking intramedullary nailing and addition hip pinning.

6C, 6D Radiographs made 4 months postoperatively showed femoral fractures healed uneventfully and the result was graded as good.

considerbly. The longest delay was one month due to head injury and associated compound fracture of the other extremity.

Because of the delay in the treatment, open reduction was necessary in some cases in which a previous closed attempt was failed. Additional fixation such as cerclage wiring was always used without extensive strippling of the periosteum in the severe comminuted one.[11] Static locking was preferable in those comminuted fractures or of there was any in doubt.[3,13] In two cases of ipsilateral neck and shaft fractures, the hip pinning anteriorly and posteriorly could stabilize the femoral neck fracture satisfactorily. It should be performed right after the locking intramedullary nail was inserted in place. In both cases there were no complication of the femoral neck fracture after all.

Even though the procedure was technically difficult,[3] the proximal locked screw could be achieved easily. But we did have more problems with the distal locked screws, particularly in our early cases. In an obese or muscular patient, the universal rod mounted distal target device seemed to be impractical. Later on the C-arm mounted target device had been used with more convenient.[13]

Regarding the malalignment which had been reported by other,[3,10] we did not have any of that problem. But relatively, the range of motion of the hip and knee were less in our series that may be due to the delay of the operations. But they seemed to improve considerbly after the nail was removed and gentle manipulation was performed postoperatively.

In conclusion we treated sixteen femoral shaft fractures in fifteen male patients with the Grosse Kempf interlocking intramedullary nail. All of the

fractures caused by higher energy injuries mostly from motorcycle accidents. The stable internal fixation could be achieved in every one of them, even in a severe comminuted one at the distal or proximal of the shaft. In two cases of ipsilateral fracture neck and the shaft, hip pinning anteriorly and posteriorly could stabilize the fractures satisfactorily. The interlocking principle allowed extension of the use of intramedullary nailing to both ends of the femur. In a doubtful case such as in the severe comminuted one, the static nailing was preferable. The postoperative physical rehabilitation especially the range of motion of the joints could be commenced immediately. The malalignment and the stiffness of the joints could be eliminated in most of our cases.

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