

Healing of 56 segmental femoral shaft fractures after locked nailing

Poor results of dynamization

Chi-Chuan Wu and Wen-Jer Chen

We treated 56 consecutive acute segmental femoral shaft fractures with closed static locked nailing. 12 nails were dynamized after 6 (5–10) months due to slow fracture healing and 5 united after another 5 (3–8) months. The other 7 required cancellous bone

grafting and all healed uneventfully 6 (5–8) months after grafting. Since dynamization did not promote healing in most of our cases we suggest early cancellous bone grafting in cases of delayed union.

Department of Orthopedics, Chang Gung Memorial Hospital, 5, Fu-Hsin St. 333, Kweishan, Taoyuan, Taiwan, R.O.C.
Tel + 886 3-3281200, ext. 2163. Fax -3285818
Submitted 96-09-14. Accepted 97-06-24

Segmental femoral shaft fractures are uncommon and usually caused by high-energy violence (Winquist and Hansen 1978, Melis et al. 1990). The reported incidence is 1–5% of femoral shaft fractures (Church 1971, Wu et al. 1993). The commonest treatment at present is closed intramedullary nailing, usually with an interlocking nail. With this technique, a high union rate with few complications has been reported (Winquist and Hansen 1978, Wiss et al. 1990, Wu et al. 1993).

To promote fracture healing, static fixation is sometimes changed to a dynamic one (Wiss et al. 1990). The effect of this measure is not well known. We therefore made a retrospective study of segmental femoral shaft fractures treated with static locked nailing and dynamization because of slow fracture healing.

Patients and methods

From January 1989 to December 1992, 61 consecutive acute segmental femoral shaft fractures were treated with a static Grosse-Kempf interlocking nail (Howmedica, Kiel, Germany) at our hospital (Table). Patients aged from 19–81 years with a male-to-female ratio of 3:1. The causes of injury included 55 traffic accidents, 5 falls from heights, and 1 fall at ground level. There were 60 closed and 1 type I open fractures (Gustilo and Anderson 1976), with the femoral shaft divided into 5 equally long zones, X fractures were located in zones 2, 3 or 4 (Born et al. 1988, Wu and Shih 1991). Most patients had multiple associated

injuries, especially ipsilateral tibial fractures. 5 patients were lost to follow-up; 56 cases were included in our study.

A fracture table and an image intensifier were routinely used. The favored position was lateral decubitus. A supine position was used when the anesthesiologist preferred this or when there was an associated pulmonary or abdominal injury. After closed reduction and reaming, a static interlocking nail was inserted (Winquist and Hansen 1978, Wu et al. 1993). In 3 cases, the fracture was opened with a small incision to direct the flexible guide wire.

Postoperatively, patients were permitted to walk without weight bearing. Quadriceps and a knee range of motion-exercise was encouraged. They were followed-up with radiography in the outpatient department at 4–6 week intervals. Dynamization was performed by removal of the screws farthest away from the fracture when sparse callus formation was noted after 4 months (Klemm and Borner 1986, Brumback et al. 1988).

We considered the fracture to be united when there was no tenderness or pain during weight bearing and when there was radiographically bridging callus with cortical density connecting 3 fragments (Wiss et al. 1990, Wu et al. 1993). There was an indication for bone grafting if the fracture was not yet united about 1 year after the dynamization.

Results

44 / 56 cases healed without dynamization after 6 (4–

Clinical data for 61 segmental femoral shaft fractures treated with a static interlocking nail

A	B	C	D	E	F	G	H	I	J
1	42	2	2,4	—	—	6	—	—	46
2	31	2	2,4	—	—	6	—	—	45
3	23	1	2,3	—	—	6	—	—	44
4	44	2	2,4	—	—	5	—	—	44
5	26	1	2,3	P	D(7)	6	—	—	44
6	25	1	2,3	—	—	4	—	—	43
7	27	2	2,4	—	—	4	—	—	43
8	50	1	4,5	I	K	5	—	—	42
9	24	2	2,3	—	—	7	—	—	42
10	22	1	1,4	P	D(6)	N	B	5	42
11	58	1	2,4	—	—	5	—	—	41
12	20	1	2,4	—	—	6	—	—	41
13	23	1	2,3	—	—	7	—	—	41
14	45	2	1,4	P	D(6)	6	—	—	41
15	34	1	2,4	—	—	5	—	—	40
16	44	1	2,5	—	—	6	—	—	40
17	24	1	1,4	—	—	5	—	—	40
18	50	1	2,5	—	—	6	—	—	40
19	36	1	1,4	—	—	7	—	—	39
20	50	1	2,4	I	K	7	—	—	39
21	81	2	3,5	L	L	L	L	L	L
22	65	1	2,4	—	—	6	—	—	39
23	46	2	3,4	—	—	5	—	—	38
24	22	1	1,4	—	—	6	—	—	38
25	24	1	2,4	P	D(5)	5	—	—	38
26	20	1	2,4	—	—	7	—	—	36
27	26	2	2,3	P	D(6)	N	B	7	36
28	30	1	2,5	P	D(7)	N	B	8	35
29	29	1	1,4	L	L	L	L	L	L
30	19	1	2,4	—	—	6	—	—	35
31	55	1	2,4	—	—	5	—	—	34
32	28	1	3,4	—	—	6	—	—	34
33	24	1	1,4	—	—	6	—	—	32
34	61	2	2,4	—	—	6	—	—	32
35	39	1	1,3	L	L	L	L	L	L
36	31	1	1,3	—	—	5	—	—	30
37	50	2	2,3	—	—	6	—	—	30
38	21	2	2,4	—	—	8	—	—	30
39	25	2	2,5	P	D(6)	3	—	—	29
40	32	2	1,4	—	—	7	—	—	29
41	41	1	2,4	—	—	6	—	—	29
42	78	1	2,4	—	—	8	—	—	29
43	53	1	2,4	—	—	4	—	—	28
44	24	1	2,3	P	D(7)	8	—	—	28
45	39	1	2,4	P	D(10)	NB	5	28	
46	32	1	1,3	—	—	6	—	—	28
47	70	1	1,4	L	L	L	L	L	L
48	55	1	2,3	—	—	6	—	—	28
49	30	1	2,4	I	K	7	—	—	27
50	63	1	2,3	—	—	6	—	—	27
51	26	1	2,4	—	—	5	—	—	27
52	36	1	2,4	—	—	4	—	—	26
53	23	1	2,5	P	D(6)	N	B	6	26
54	24	1	2,4	—	—	6	—	—	26
55	68	1	2,4	P	D(7)	N	B	5	26
56	50	1	3,4	L	L	L	L	L	L
57	62	1	1,4	P	D(8)	N	B	8	25
58	28	1	2,4	—	—	5	—	—	25
59	26	1	2,3	—	—	6	—	—	25
60	30	1	2,4	—	—	6	—	—	24
61	38	1	2,4	—	—	7	—	—	24

- A Case number
- B Age, years
- C Sex
- D Zones of fracture location
- E Complications
 - I iatrogenic femoral neck fracture
 - P poor healing
 - without
 - L lost to follow-up
- F Management for complication
 - K closed Knowles' pinning
 - D dynamization, months
- G Results, months (healed) without or after dynamization
 - N nonunion
- H Management for nonunion: B bone graft
- I Results of bone graft, months, healed
- J Follow-up, months

8) months. The proximal fractures healed in all cases after 3 (3-4) months. However, in 12 cases the distal fractures healed slowly. The 12 fractures were dynamized after 6 (5-10) months. 5 united after another 5 (3-8) months (Figure 1). In the other 7 cases, the distal fracture had not healed x-y months after dynamization and cancellous bone grafting was performed. All healed 6 (5-8) months after the grafting (Figure 2). There was no deep infection, rotational (> 15°) or angular (> 15°) deformity or shortening (> 2 cm).

3/56 cases had an iatrogenic femoral neck fracture and closed reduction with Knowles' pinning was performed immediately postoperatively. All neck fractures healed without avascular necrosis (Figure 3).

Discussion

A segmental femoral shaft fracture is caused by high energy violence and there is always a substantial soft tissue injury (Rinaldi et al. 1989). With an intramedullary nail in place, the vascular supply to the distal fracture is most compromised (Rand et al. 1981, Olerud and Strömberg 1986, Bråten et al. 1990). Therefore, the healing of the distal fracture is usually slower.

Weight bearing has been widely used to promote fracture healing. Although several clinical and experimental studies, usually on tibia, have supported this view (Sarmiento et al. 1977, DeLee et al. 1981, Meadows et al. 1990, Richardson et al. 1995), some orthopedists still doubt that it is true (Riggins et al. 1985, Wu and Shih 1992). Dynamization of static interlocking nails in complex tibial fractures was successful in two thirds of the cases, but only in half of the cases of complex femoral fractures (Wu and Shih 1993). In the presence of delayed union early cancellous bone grafting should therefore be considered.

References

Born C T, Delong W G, Shaikh K A, Moskwa C A, Schwab C W. Early use of the Brooker-Wills interlocking intramedullary nail (BWIIN) for femoral shaft fractures in acute trauma. *J Trauma* 1988; 28 (11): 1515-22.

Bråten M, Terjesen T, Svenningsen S, Kibsgaard L. Effect of medullary reaming on fracture healing: Tibial osteotomies in rabbits. *Acta Orthop Scand* 1990; 61 (4): 327-9.

Brumback R J, Uwagie-Ero S, Lakatos R P, Poka A, Bathon G H, Burgess A R. Intramedullary nailing of femoral shaft fractures. part II: fracture-healing with static interlocking fixation. *J Bone Joint Surg (Am)* 1988; 70 (10): 1453-62.



Figure 1. Case 5. A 26-year-old man sustained a right segmental femoral shaft fracture and a closed static locked nail was inserted. Dynamization was done at 7 months, due to poor fracture healing process. Bony union ensued at 6 months.



Figure 2. Case 10. A 22-year-old man sustained a right segmental femoral shaft fracture and a closed static locked nail was inserted. Dynamization was done at 6 months, due to poor fracture healing. Nonunion still occurred and the fracture was bone grafted. Union ensued at 5 months.

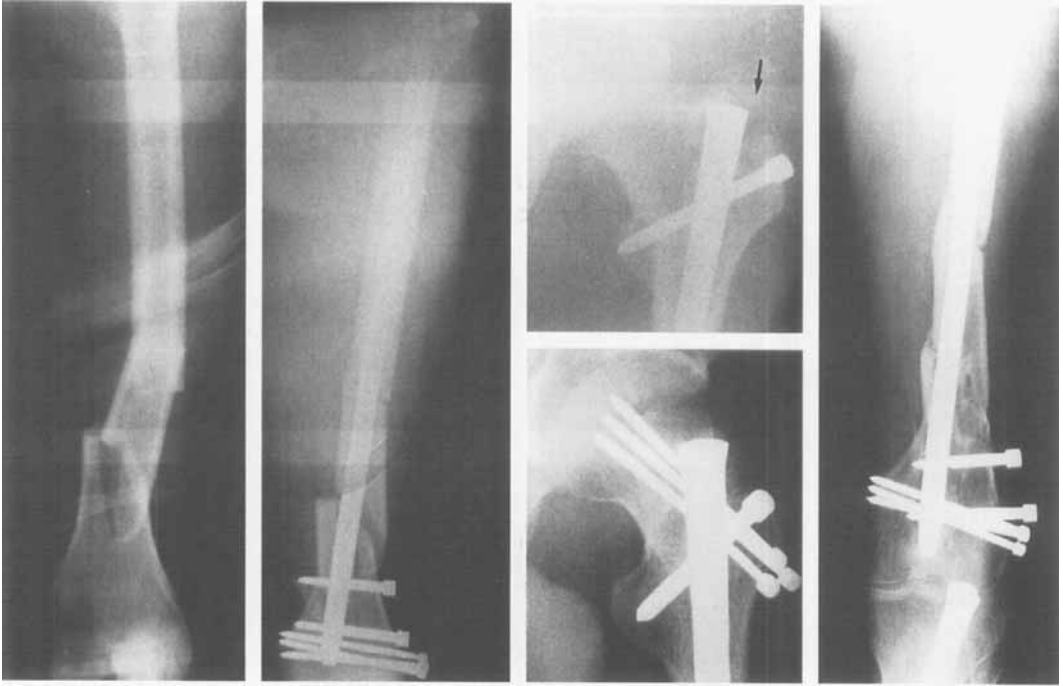


Figure 3. Case 8. A 50-year-old man sustained left segmental femoral shaft and intercondylar fractures. Closed multiple Knowles' pinning was done first for the intercondylar fracture and closed static locked nailing followed for the segmental shaft fracture. An iatrogenic femoral neck fracture was noted immediately postoperatively and closed multiple Knowles' pins were inserted. All fractures healed at 5 months. The femoral head was radiographically normal at 3-year follow-up.

- Church J C T. Segmental fractures of femur. *J Bone Joint Surg (Br)* 1971; 53 (2): 355.
- DeLee J C, Heckman J D, Lewis A G. Partial fibulectomy for ununited fractures of the tibia. *J Bone Joint Surg (Am)* 1981; 63 (9): 1390-5.
- Gustilo R B, Anderson J T. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones—retrospective and prospective analysis. *J Bone Joint Surg (Am)* 1976; 58 (4): 453-8.
- Klemm K W, Borner M. Interlocking nailing of complex fractures of the femur and tibia. *Clin Orthop* 1986; 212: 89-100.
- Meadows T H, Bronk J T, Chao E Y S, Kelly P J. Effect of weight-bearing on healing of cortical defects in the canine tibia. *J Bone Joint Surg (Am)* 1990; 72 (7): 1074-8.
- Melis G C, Guido P, Rossi F, Pinna P, Sotgiu F. Segmental femoral fractures: surgical strategies. *Ital J Orthop Traumatol* 1990; 16 (4): 515-26.
- Olerud S, Strömberg L. Intramedullary reaming and nailing: its early effects on cortical bone vascularization. *Orthopedics* 1986; 9 (9): 1204-8.
- Rand J A, An K N, Chao E Y S, Kelly P J. A comparison of the effect of open intramedullary nailing and compression—plate fixation on fracture-site blood flow and fracture union. *J Bone Joint Surg (Am)* 1981; 63 (3): 427-42.
- Richardson J B, Gardner T N, Hardy J R W, Evans M, Kuiper J, Kenwright J. Dynamisation of tibial fractures. *J Bone Joint Surg (Br)* 1995; 77 (3): 412-6.
- Riggins R S, Simanonok C, Lewis D W, Smith A H. Weight bearing: its lack of effect on fracture healing. *Int Orthop* 1985; 9: 199-203.
- Rinaldi E, Marengli P, Nurra A. Multifocal fractures of the femur. *Ital J Orthop Traumatol* 1989; 15 (4): 409-14.
- Sarmiento A, Schaeffer J F, Beckerman L, Latta L L, Enis T E. Fracture healing in rat femora as affected by functional weight-bearing. *J Bone Joint Surg (Am)* 1977; 59 (3): 369-75.
- Winqvist R A, Hansen S T. Segmental fractures of the femur treated by closed intramedullary nailing. *J Bone Joint Surg (Am)* 1978; 60 (7): 934-9.
- Wiss D A, Brien W W, Stetson W B. Interlocked nailing for treatment of segmental fractures of the femur. *J Bone Joint Surg (Am)* 1990; 72 (5): 724-8.
- Wu C C, Shih C H. Interlocking nailing of distal femoral fractures: 28 patients followed for 1-2 years. *Acta Orthop Scand* 1991; 62 (4): 342-5.
- Wu C C, Shih C H. A small effect of weight bearing in promoting fracture healing. *Arch Orthop Trauma Surg* 1992; 112 (1): 28-32.
- Wu C C, Shih C H. Effect of dynamization of a static interlocking nail on fracture healing. *Can J Surg* 1993; 36 (4): 302-6.
- Wu C C, Shih C H, Ueng W N, Chen Y J. Treatment of segmental femoral shaft fractures. *Clin Orthop* 1993; 287: 224-30.