Nonunion and shortening after femoral fracture treated with one-stage lengthening using locked nailing technique

Good results in 48/51 patients

Chi-Chuan Wu, Chun-Hsiung Shih and Wen-Jer Chen

We report on 56 consecutive aseptic femoral shaft nonunions with shortening, which were treated with local debridement, skeletal traction, a spine-spreader aiding lengthening, static locked nail stabilization and corticocancellous bone grafting. 51 patients were followed for 2 (1–4) years and 48 achieved a solid union. The median period to bony union was 4 (3–8) months and lengthening achieved was 2.8 (1.5–4.5) cm. 3 patients had nonunion, 2 without implant failure and 1 with implant failure. However, all 3 healed after reoperation. There was no neurovascular injury or deep infection.

Department of Orthopedic Surgery, Chang Gung Memorial Hospital, 5, Fu-Hsin St., 333, Kweishan, Taoyuan, Taiwan, R.O.C. Tel + 886 3-3281200 ext. 2163. Fax -3278113
Submitted 98-04-24. Accepted 98-09-17

In femoral shaft nonunions, lengthening can be executed with one-stage, repeated one-stage or gradual technique and each has individual indications (Herron et al. 1978, Siffert 1987). Although gradual lengthening with Ilizarov technique has been developed during recent years (Paterson 1990, Paley et al. 1997), a bulky frame, surrounding muscle penetration and pin tract infection have restricted its widespread application (Paley 1990). Articles on one-stage femoral lengthening are rare (Cauchoix and Morel 1978, Herron et al. 1978, Wu et al. 1992). We have treated patients with femoral nonunion and shortening with locked nailing and bone grafting. We report our experience of 51 patients.

Patients and methods

In December 1986, we began to use a fracture table for femoral lengthening (Wu et al. 1992) and intramedullary nailing. Lengthening was by femoral condylar skeletal traction. However, in a femur with a thin cortex which was osteoporotic (Wu and Shih 1991), the traction pin sometimes cut out and the lengthening failed.

From June 1989 to May 1994, we treated 56 consecutive patients with shortening due to femoral shaft aseptic nonunion with an improved lengthening technique. Patients were aged 34 (17–58) years with a male-to-female ratio of 3 to 1. Most fractures were due to motorcycle accidents. Previous operations included plates, Küntscher nails or locked nails. The preoperative shortening, as measured on scanograms, was 3 (1.5–5) cm. The median period from injury to our operation was 2.2 (0.6–4.5) years.

At admission, erythrocyte sedimentation rate, C-reactive protein, and white blood cell count were routinely checked to rule out latent deep infection. Potential infection was considered a contraindication and in such cases other techniques were chosen, such as the Ilizarov technique or Wagner apparatus.

Surgical technique

Under general anesthesia, patients were placed on the fracture table in the lateral decubitus position. A 2.4 mm Kirschner wire was used for femoral condylar skeletal traction. First, corticocancellous bone grafts were harvested from the posterior iliac crest.

The fracture site was opened laterally and implants were removed. The local area was thoroughly debrided. The femur was lengthened by gradual spreading with a spine-spreader and pulling with the fracture table (Figure 1). The desired lengthening was measured as the distance between the bony fragments. After maximal reaming, a slotted static locked nail (Howmedica, Kiel, Germany) was inserted antegradely, under the guidance of an image intensifier. The bone grafts were placed in the space.

Postoperatively, the patients were permitted to ambulate with partial weight bearing as soon as possible.

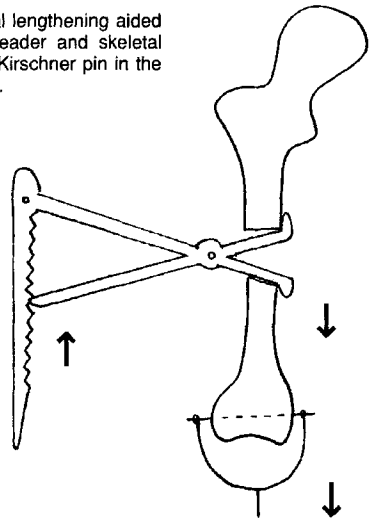


Figure 1. Femoral lengthening aided by the spine-spreader and skeletal traction, using a Kirschner pin in the distal metaphysis.

Knee and ankle range of motion exercises were encouraged. They were followed up in the outpatient department at 4–6-week intervals. Crutches were discontinued only when the fracture had united.

Bony union was defined as: clinically, no pain, no tenderness, and walking without aids; radiographically, solid callus of cortical density bridging the bony fragments. Nonunion was defined as: lack of union at the 1-year follow-up or requirement of additional operations to achieve bony union (Wu et al. 1991). Rotational deformity was evaluated by comparing internal and external hip rotation of the injured and uninjured leg. Residual shortening was checked by scanogram after bony union. 51 patients were followed for 2 (1–4) years and 5 were lost to follow-up.

Results

The lengthening achieved was 2.8 (1.5–4.5) cm. 48 fractures healed with a union period of 4 (3–8) months (Table, Figure 2). Complications included 3 nonunions: 2 without and 1 with implant failure. The 2 nonunions without implant failure were treated with a cancellous bone graft (10 and 11 months, respectively) from the ipsilateral tibial condyle and healed uneventfully (at 4 and 5 months, respectively). The nonunion with implant failure occurred 6 months postoperatively and was treated with closed exchange of a locked nail of dynamic mode. It healed after 4 months (Figure 3).

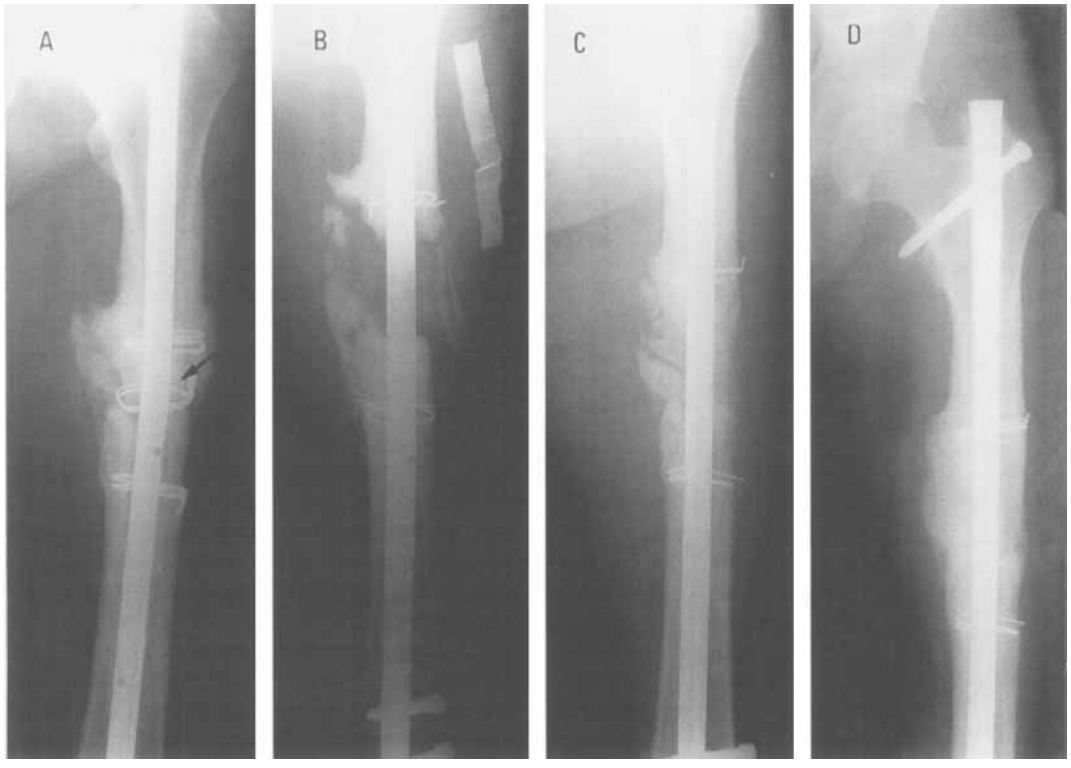
All the patients had return of preoperative knee movement within 1 month. There were no wound infections, vascular or peripheral nerve injury, rotational (> 10°) or angular (> 10°) deformity or residual shortening (> 2 cm).

Clinical and radiographic data for 51 femoral shaft nonunions associated with shortening

A	B	C	D	E	F	G	H	I	J	K	L
1	35	1	1	2	2.5	1.2	1	2	13	4	2.5
2	21	2	1	2	3.2	2.3	2	2	12	4	3.2
3	32	1	1	2	3.1	2.4	2	2	12	3	3.0
4	28	1	1	2	3.1	2.6	2	2	13	5	3.0
5	26	1	1	2	5.0	2.4	3	2	13	4	4.5
6	34	1	1	2	2.4	1.3	1	2	13	4	2.4
7	24	2	1	2	3.2	2.4	2	2	12	4	3.0
8	29	1	1	2	3.5	1.2	1	2	13	4	3.5
9	55	1	2	2	1.5	1.2	2	2	13	4	1.5
10	24	1	1	2	2.0	1.0	1	2	13	4	3.0
11	22	1	1	2	3.4	0.8	2	2	13	7	3.0
12	22	1	1	1	1.8	2.4	3	3	13	4	1.8
13	54	2	1	2	1.9	4.5	5	2	12	4	2.0
14	26	1	1	2	2.8	3.2	3	2	13	3	2.8
15	53	1	2	3	2.6	2.4	2	3	12	6	2.5
16	39	1	1	2	1.6	4.2	3	2	12	8	1.5
17	28	1	2	3	3.3	1.6	3	1	13	4	3.0
18	53	2	1	2	1.6	1.8	2	2	12	4	1.8
19	38	1	1	3	3.8	3.2	3	1	13	3	3.5
20	37	1	1	2	3.2	2.0	1	2	13	3	3.2
21	35	1	1	3	3.2	3.0	3	1	13	3	3.0
22	49	1	1	2	3.5	3.0	2	2	13	4	3.5
23	24	1	1	2	3.5	1.8	1	2	12	4	2.8
24	19	2	1	2	4.5	1.7	1	2	13	4	4.0
25	42	1	1	2	3.4	2.5	1	2	13	6	3.0
26	23	1	1	2	3.2	2.7	2	2	13	N	2.8
27	55	1	1	2	2.1	3.2	2	2	13	4	2.0
28	40	1	2	2	2.0	1.4	1	2	12	4	2.0
29	48	1	1	2	3.1	1.2	2	2	13	5	3.0
30	18	1	1	2	2.5	2.7	2	2	13	3	2.5
31	27	2	1	2	2.5	2.2	1	2	12	3	2.5
32	58	1	2	1	2.3	2.4	2	3	13	4	3.0
33	34	2	1	2	2.6	2.4	2	2	13	7	2.5
34	19	1	1	2	3.4	2.8	3	2	13	5	2.8
35	45	1	1	2	3.2	1.7	1	2	12	4	2.8
36	48	1	1	3	3.6	1.9	1	3	13	4	3.5
37	25	2	1	2	2.4	2.5	2	2	12	3	2.5
38	54	1	1	2	2.9	2.4	2	2	13	N	2.5
39	47	1	1	2	3.0	2.1	3	2	12	6	2.0
40	19	1	1	2	3.6	2.0	2	2	13	8	2.6
41	26	2	2	2	2.8	2.3	2	2	12	4	2.0
42	17	1	1	3	1.5	0.6	1	1	12	N	1.5
43	41	1	1	2	2.2	2.4	1	2	12	6	2.0
44	27	1	1	2	3.8	2.8	2	2	13	5	3.0
45	24	2	1	2	2.4	1.6	1	2	13	3	2.0
46	52	1	1	2	3.2	1.6	1	2	12	4	2.8
47	42	1	1	3	2.4	2.5	3	1	13	4	2.5
48	44	1	1	2	2.4	1.4	2	2	13	3	2.4
49	29	2	2	2	2.7	1.2	2	2	12	4	2.5
50	28	1	1	3	2.5	1.2	2	1	13	3	2.5
51	37	1	1	2	2.8	1.8	1	2	13	4	2.5

A Case number
B Age, years
C Sex
  1 male
  2 female
D Cause of fracture
  1 motorcycle
  2 automobile
  3 fall from height
E Fracture level
  1 proximal third
  2 middle third
  3 distalt third
F Preoperative shortening (leg-length discrepancy), cm
G Period from injury to the present operation, years
H Number of previous operations
I Previous inserted implants
  1 plate
  2 Küntscher nail
  3 locked nail
J Nail size, diameter, mm
K Bony union, months
  N nonunion
L Lengthening achieved, cm

Figure 2. Case 5. A 26-year-old man, who sustained a left femoral nonunion.



Küntscher nail breakage (arrow), and shortening of 5 cm after 2.4 years.

Lengthening and bone grafting were done

Nonunion healed at 4 months and lengthening achieved was 4.5 cm.

Good remodeling was noted at 2.5 years.

Discussion

A maximal one-stage lengthening of a femur can gain 15% (about 6 cm) length (Cauchoix and Morel 1978). Nevertheless, peripheral nerve injury has been reported, with only a 4 cm lengthening (Cauchoix and Morel 1978, Herron et al. 1978). Therefore, one-stage femoral lengthening of less than 4 cm should be safe. Because most femoral nonunions shortened less than 5 cm, one-stage lengthening is often appropriate (Wu et al. 1992).

Various techniques for one-stage femoral lengthening have been reported. Because the nonunion site usually has severe scarring, simple femoral condylar skeletal traction is difficult in a femur with a thin cortex and osteoporotic bony stock (Wu and Shih 1991). On the other hand, with a distractor inserted at both metaphyses of a femur, a locked nail could not be inserted.

Our technique has several advantages. The lateral decubitus position makes it easy to harvest massive corticocancellous bone graft from the posterior iliac crest. A spine-spreader reduces the stress of the femoral condylar traction pin. Thorough debridement of the fracture site provides sufficient space for the cancellous bone graft. Direct measurement of the lengthening can be done in the wound. With the fracture table traction, distal locked screws can be inserted easily.

Cauchoix J, Morel G. One-stage femoral lengthening. Clin Orthop 1978; 136: 66-73.

Herron L D, Amstutz H C, Sakai D N. One-stage femoral lengthening in the adult. Clin Orthop 1978; 136: 74-82.

Paley D. Problems, obstacles, and complications of limb lengthening by the Ilizarov technique. Clin Orthop 1990; 250: 81-104.

Paley D, Herzenberg J E, Paremain G, Bhave A. Femoral lengthening over an intramedullary nail: a matched-case comparison with Ilizarov femoral lengthening. J Bone Joint Surg (Am) 1997; 79 (10): 1464-80.

Paterson D. Leg-lengthening procedures: a historic review. Clin Orthop 1990; 250: 27-33.

Siffert R S. Current concepts review: lower limb-length discrepancy. J Bone Joint Surg (Am) 1987; 69 (7): 1100-6.

Figure 3. Case 42. A 17-year-old man, who sustained a right femoral nonunion.

Plate loosening and shortening of 1.5 cm after 7 months.

Lengthening and bone grafting were performed.

Double-level locked nail (diameter, 12mm) breakage (arrows) was noted at 6 months.

It was treated with closed exchange of locked nailing (diameter, 14 mm). The nonunion healed uneventfully at 4 months.

Wu C C, Shih C H. Distal femoral nonunion treated with interlocking nailing. J Trauma 1991; 31 (12): 1659-62.

Wu C C, Shih C H, Lee Z L. Subtrochanteric fractures treated with interlocking nailing. J Trauma 1991; 31 (3): 326-33.

Wu C C, Shih C H, Lee Z L. A simpler surgical technique to treat aseptic nonunion–associated femoral length discrepancy. Arch Orthop Trauma Surg 1992; 111 (3): 160-4.