Original Article

Spiral and Oblique Fractures of Distal One-Third of Tibia-Fibula: Treatment Results with Circular External Fixator

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Abstract

<u>Introduction</u>: Spiral and oblique fractures of distal 1/3 of tibia-fibula are relatively common fractures of long bones. Due to their types, aetiology, limited coverage and blood supply, these fractures often lead to union and soft tissue problems. <u>Materials and Methods</u>: Twenty-seven patients with spiral and oblique fractures of distal 1/3 of tibia-fibula were treated with circular external fixator (CEF) between January 1997 and August 2000. All the fractures were closed. The type of fractures based on AO classification were A1 (n = 8), A2 (n = 6), B1 (n = 11) and C1 (n = 2). <u>Results</u>: The mean framing time was 14.1 ± 1.8 weeks (range, 12 to 19 weeks), and the mean treatment time was 18.8 ± 2.2 weeks (range, 15 to 24 weeks). The patients were followed up for 36 to 78 months (mean follow-up time: 51.9 ± 10.4 months). The results were evaluated for shortness, angulation, rotation, ankle stiffness, pain and infection. After removal of the frames, 11 patients had ankle pain and stiffness, and 3 patients had loss of range of motion in the ankle even after rehabilitation. None of the patients suffered any complications such as shortness, angulation, rotational deformity and infection, and none had loss of motion in the knee. <u>Conclusions</u>: CEF might be a preferable alternative treatment for distal tibia-fibula fractures due to its easy application, fewer major complications such as shortness and angulation, early mobilisation and shorter treatment time.

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Key words: Distal tibia, External fixation, Ilizarov, Oblique fractures

Introduction

Spiral and oblique fractures of distal 1/3 of tibia-fibula are relatively common fractures of long bones. Due to their types, aetiology, limited coverage and blood supply, these fractures often lead to union and soft tissue problems. Displacement, bone loss, soft tissue injury, infection and associated multiple injuries may negatively affect the prognosis of the treatment.[1-5] Delayed, insufficient union, or malunion is the most common problems in these fractures.

The advantage of Ilizarov circular fixation using tensioned transfixion wires is that in a small bone segment, multiple wires can be inserted and tightened, resulting in strong fixation of the bone.[1]

The aim of this study was to evaluate the results and effects of the external fixation technique in spiral and oblique fractures of distal 1/3 of tibia-fibula.

Materials and Methods

Twenty-seven patients (25 males, 2 females) with a mean age of 30.9 ± 13.9 years (range, 20 to 62) with spiral and oblique fractures of distal 1/3 of tibia-fibula were treated by circular external fixator between January 1997 and August 2000. The major indication for this technique was a 1/3 distal tibia fracture which is unsuitable for plating and intramedullary nailing. The aetiologies of the fractures were as follows: 12 cases, motor vehicle accident; 9 cases, sports injury; 6 cases, simple falls. All the fractures were closed. Based on AO classification, modified by Müller, 8 fractures were A1, 6 were A2, 11 were B1 and 2 were C1 (Table 1).[6]

The mean arrival time of the patients to our clinic was 4.3 ± 2.2 hours (range, 1 to 8) and the mean outset time for operation was 8 ± 1.7 hours (range, 6 to 12). The frames were constructed preoperatively depending on the fracture

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Table 1. Classification of the Fractures Based on AO

AO Classification	No.
A1 Spiral	8
A2 Oblique	6
B1 Spiral wedge	11
C1 Complex spiral	2

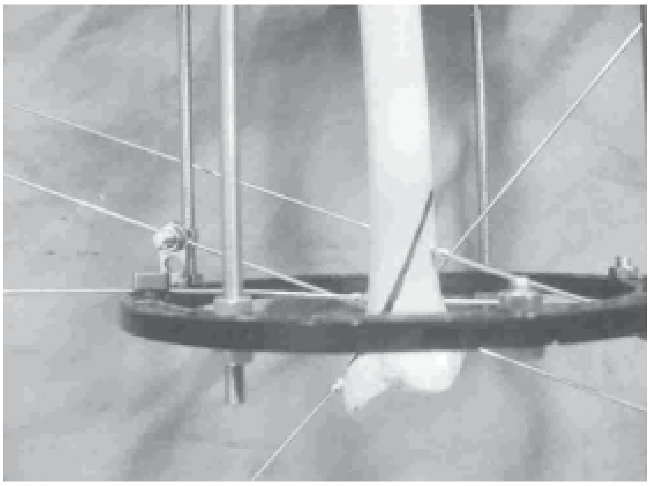

Fig. 1. Design of Ilizarov frame.

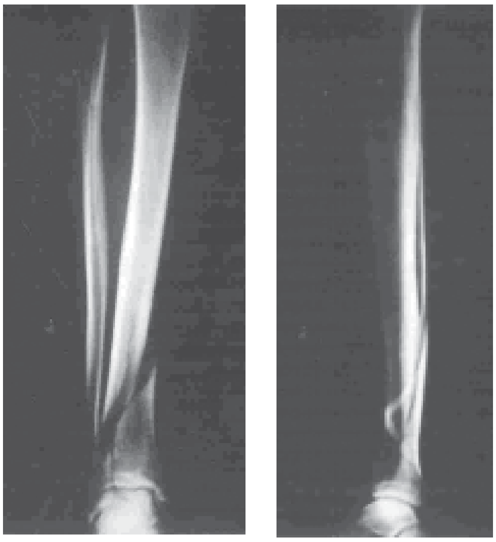

Fig. 2a. Fig. 2b.

Fig. 2a. Preoperative antero-posterior (AP) radiography of the 50-year-old patient.
Fig. 2b. Preoperative lateral (L) radiography of the 50-year-old patient.

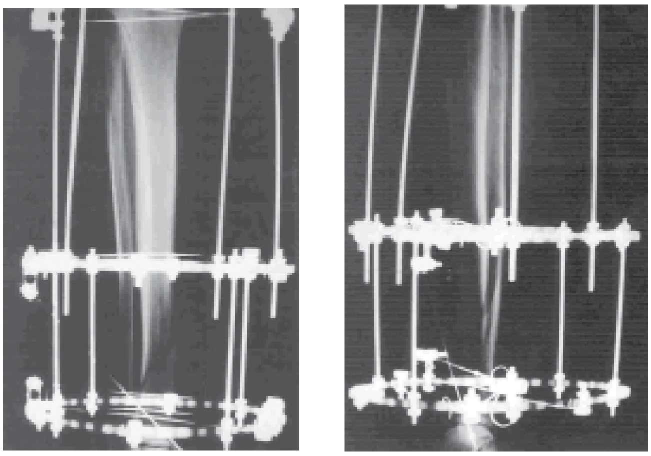

Fig. 2c. Fig. 2d.

Fig. 2c. Postoperative AP radiography of the 50-year-old patient.
Fig. 2d. Postoperative L radiography of the 50-year-old patient.

type. While preparing the circular external fixator (CEF), 2 rings were placed proximal to and 1 more ring was placed distal to the fracture line. The distal ring was fixed by multiple pins (Fig. 1). Under adequate anaesthesia, the patients were placed on the operation table. A tourniquet was not used. Four consultant orthopaedic surgeons from the Department of Orthopaedics performed the surgery.

The fracture line was not opened in any of the cases. Initially, fibular alignment was established by distraction of K wires applied to proximal and distal rings. In 7 cases where fibular length was not achieved by distraction, reduction was obtained by retrograde Steinmann pin. In all of the cases, 1.8-mm bayonet-pointed K wires were used in the diaphysis, and sharp-pointed K wires for the metaphyseal region. Olive K wires were used for the reduction whenever it was necessary. In 1 case, subcutaneous fasciotomy was performed with CEF because of compartment syndrome. The mean operation time was 68 ± 11.8 minutes (range, 55 to 90) (Figs. 2a to 2d).

In all of the cases, antibiotic prophylaxis (first generation cephalosporin, 2 x 1 g/day) was started preoperatively and continued until the third postoperative day. The patients exercised the ankle and knee starting from the first postoperative day. They were mobilised with controlled load on the fourth postoperative day (2 to 7), and with full load on the tenth postoperative day. Follow-up radiographs were obtained on the postoperative seventh, 14th, 28th days and monthly thereafter.

Results

The mean follow-up time was 51.9 ± 10.4 months (range, 36 to 78). CEF frames were removed whenever sufficient union was observed radiographically during the follow-up. The mean framing time was 14.1 ± 1.8 weeks (range, 12 to 19). After removal of the frame, an ankle-foot orthesis (AFO) was used for full weight bearing to encourage the patient. The mean treatment time was 18.8 ± 2.2 weeks (range, 15 to 24).

Table 2. Data of Cases

No.	Name	Age (y)	Type of injury	Classification	Mean framing time (wks)	Mean treatment time (wks)	Mean follow-up time (mo)	Complication
1	SB	27	MVA	A2	12	18	78	Pin tract infection
2	SB	20	SI	A1	14	18	74	
3	EE	20	SI	A2	12	17	66	
4	FS	20	SF	A1	16	22	65	Limitation of ankle movement
5	ET	31	MVA	B1	13	18	65	
6	AY	26	MVA	B1	15	19	56	
7	GG	20	SF	A1	12	18	55	
8	MÖ	22	MVA	B1	14	20	54	Limitation of ankle movement, pin tract infection
9	VU	23	SI	A1	13	17	54	
10	AS	24	MVA	A2	12	15	53	
11	YD	20	SI	C1	15	19	53	Pin tract infection
12	YK	38	SI	B1	14	18	52	
13	VA	30	MVA	A2	12	15	52	
14	EÖ	58	SF	B1	12	17	51	
15	EÜ	33	SI	B1	15	20	50	
16	ME	20	SI	B1	14	19	50	
17	NG	57	SF	A1	19	24	49	Limitation of ankle movement
18	NA	59	MVA	A1	16	21	47	Pin tract infection
19	AG	62	SF	A1	17	22	46	
20	TY	20	MVA	B1	14	19	46	
21	TA	21	MVA	B1	14	18	45	
22	FG	22	MVA	A2	12	15	44	
23	FN	37	SI	A2	13	19	43	
24	FC	22	MVA	A1	16	22	42	Pin tract infection
25	ST	27	SF	B1	14	20	38	
26	DÇ	24	SI	C1	15	20	38	
27	IB	51	MVA	B1	14	18	36	

mo: months; MVA: motor vehicle accident; SF: simple fall; SI: sports injury; wks: weeks

Shortness, angulation and rotation were not observed in any of the cases. In 5 cases, pin tract infection developed, which were treated by oral antibiotics. In 11 cases, loss of range of ankle motion and pain were observed after the removal of the frame. Although pain was resolved in all cases after rehabilitation, 3 patients had loss of mean 5-degree dorsiflexion and mean 10-degree plantar-flexion. All the patients had full knee function. No soft tissue infection or osteomyelitis developed in any of the cases (Table 2). After treatment, all the patients could return to their daily activities and participate in sports activities 8 months after the treatment, except 1 patient who had limited ankle motion (Table 3).

Discussion

Spiral and oblique fractures of distal 1/3 of tibia-fibula, which are accepted as unstable fractures, have a wide range of treatment modalities from closed reduction to external fixator. The objectives in the treatment of these fractures are rapid and ideal healing, minimisation of loss of function and prevention of any deformity.[5] To this end, many studies have used intramedullary nail as the treatment of choice for transverse, short oblique, segmented diaphyseal tibia-fibula fractures; intramedullary nail, plate fixation, or percutaneous plating system for distal fractures.[3-5,7-9] Shortness, angulation, non-union, infection, loss of ankle range of motion (ROM) and delayed weight bearing have been

Table 3. Preoperative and Postoperative Shortening, Rotational, Angular and Axial Malalignment and also Range of Ankle Motion on Both Ankles of the Patients

		Shortness (mm)		Varus ang. (^{0})		Valgus ang. (^{0})		Rotation (^{0})		Axial ang. (^{0})		Ankle stiff. (df^{0}-pf^{0})	Pin tract infection (Grade*)
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post		
1	SB	10	3	10	1	-	-	E15	-	A10	P1	-	2nd
2	SB	8	2	8	-	-	-	E10	-	A9	A1	-	
3	EE	7	-	14	1	-	-	I6	-	A5	-	-	
4	FS	9	1	12	1	-	-	E8	-	A8	-	5-12	
5	ET	11	1	13	2	-	-	I9	-	P5	-	-	
6	AY	12	2	14	2	-	-	E4	-	P9	-	-	
7	GG	6	-	10	-	-	-	E7	-	A10	A2	-	
8	MÖ	8	1	-	-	8	-	E7	-	A11	A1	5-10	3rd
9	VU	9	1	9	-	-	-	E7	-	P12	P2	-	
10	AS	5	-	-	-	9	-	E10	-	A6	-	-	
11	YD	6	-	11	1	-	-	E13	-	A12	A1	-	3rd
12	YK	7	-	10	1	-	-	E14	-	A10	A1	-	
13	VA	5	-	5	-	-	-	E13	-	P9	-	-	
14	EÖ	8	-	6	-	-	-	E15	-	P9	-	-	
15	EÜ	9	1	-	-	8	-	E9	-	P6	-	-	
16	ME	3	-	3	-	-	-	I5	-	A8	-	-	
17	NG	7	-	10	-	-	-	I4	-	A4	-	5-8	
18	NA	-	-	11	-	-	-	I7	-	A9	-	-	2nd
19	AG	5	-	12	2	-	-	E12	-	A7	-	-	
20	TY	7	-	10	1	-	-	E8	-	P10	-	-	
21	TA	3	-	-	-	9	-	E4	-	P11	A1	-	
22	FG	6	-	9	-	-	-	E10	-	A7	-	-	
23	FN	5	-	10	-	-	-	E11	-	A8	-	-	
24	FC	9	2	12	-	-	-	I9	-	A5	-	-	3rd
25	ST	7	1	11	-	-	-	I6	-	P9	-	-	
26	DÇ	6	-	10	-	-	-	I9	-	P10	A1	-	
27	IB	5	-	-	-	5	-	E7	-	P7	-	-	
Total		183	15	220	12	39		E184 I 55		A 129 P 97	A 8 P 3		
Mean		6.77	0.55	8.14	0.44	1.44		E 6.81 I 5.74		A 4.77 P 3.59	A 0.29 P 0.11		

ang: angle; A: anterior; E: external rotation; I: internal rotation; P: posterior

reported as the most common complications of internal fixation.

Shortness up to 2 cm is acceptable after treatment of spiral and oblique fractures of distal 1/3 of tibia-fibula.[4,5,8,10] Risk of alignment loss is higher in the distal 1/3 of tibia fractures than in any other part of tibia.[11] Five degrees of varus-valgus and 10 degrees of procurvatum-recurvatum deformities are usually considered acceptable.[5,8] Angulation deformities mostly due to inadequate fixation and implant failure are less commonly reported in the plate fixation.[10] Angulation is also reported to be common in the intramedullary nail method, especially if the fixation is inadequate in the distal fractures, where the medulla is somewhat larger.[11]

One of the most important reasons of delayed union and non-union is inadequate stabilisation of the fracture. The most important reason of delayed union or non-union in plate fixation is deterioration of the already damaged distal tibial circulation even with the use of bone graft[10,12] and in intramedullary nailing, the relatively large medullary size in the distal tibia where the nail cannot provide adequate stabilisation.[13,14]

Distal tibia has less vascular and soft tissue support than any other part of the tibia.[6] Infection has been a more common complication, particularly in open tibia fractures treated by plate fixation.[13,15,16] It is known that open reduction and plate fixation of the traumatised extremity will further increase soft tissue damage and risk of compartment syndrome.[5,12] Application of an intramedullary nail may also increase intramedullary pressure and therefore the risk for a fasciotomy.

It is possible to correct any angular deformity in CEF method, either intraoperatively by stop wires or postoperatively by hinge systems.[3] Minimal additional dramatisations, minimal effect on periosteal, endosteal and bone marrow circulations, complete stabilisation of distal fragment and accurate reduction of spiral fractures by stop wires are the major advantages of CEF system. Besides, axial compression by early weight bearing minimises the delayed union and non-union.[1,17] We have achieved union within 18 months and had no union problems. The closed manipulation of fracture and minimal soft tissue trauma also minimises the risk of infection in CEF.[5] The correct application of wires, proper fixation to the rings and regular pin care will prevent possible pin tract infection.[17] It is possible to allow early weight bearing even on the second postoperative day in CEF systems because of its inherent mechanic structure and stability.[5,17] External fixation, especially CEF with its thin wires with minimal traumatic effect, will not increase risk of compartment syndrome.[5]

Conclusion

Plating, intramedullary nailing, circular external fixator and percutaneous plating are methods that can be used in the treatment of distal tibia-fibula fractures. Plating and intramedullary nailing have some disadvantages. Recently, percutaneous plating has been a popular method, preferred by many orthopaedic surgeons. It has been recommended as an alternative method that minimises the risk of infection and soft tissue problems for unstable tibial fractures.[2,15,18-20] However, based on our previous experiences with the CEF method,[21-23] we preferred CEF method to percutaneous plating technique in the treatment of spiral and oblique fractures of distal 1/3 of tibia-fibula.

In light of the results of this study, we believe that CEF may be used as an alternative method in the treatment of distal tibia-fibula fractures.

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