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Salvage of infected non-union of the tibia with an Ilizarov ring fixator

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ABSTRACT

Purpose. To review outcomes of 24 patients who underwent Ilizarov ring fixation for infected non-union of the tibia.

Methods. Medical records of 21 men and 3 women aged 13 to 74 (mean, 38) years who underwent Ilizarov ring fixation for infected non-union of the tibia were reviewed. The mean bone defect was 3.3 (range, 2–5) cm. The mean time from injury to presentation was 11.9 (range, 1–36) months. The mean number of previous surgeries was 2 (range, 0–14). A local flap was used in 2 patients and a free flap was used in one patient. Nine of the patients underwent Ilizarov ring fixation without soft tissue and bony resection, as inadequate stability was the reason for non-union. Patients were assessed using the Association for the Study and Application of the Method of Ilizarov criteria.

Results. Patients were followed up for a mean of 11 (range, 8–46) months. Functional outcome was excellent in 8 patients, good in 12, fair in 2, and failure

in one, whereas bone union outcome was excellent in 6 patients, good in 14, fair in one, and poor in 2. The mean time to union was 8 (range, 3–31) months. The mean external fixation index was 4.2 (range, 1.5–15.7) cm/month. Complications encountered were pin tract infection (n=5), re-fracture (n=2), soft tissue impingement by Ilizarov rings (n=2), recurrence of wound infection (n=1), mal-union (n=1), and mortality (n=1).

Conclusion. Ilizarov ring fixation is a viable option for infected non-union of the tibia. Adequate assessment of bone union is crucial before removal of fixator to prevent re-fracture.

Key words: Ilizarov technique; pseudarthrosis; tibial fractures

INTRODUCTION

Infected non-union of the tibia is usually associated with deformity, bone loss, leg-length discrepancy, and soft-tissue coverage.¹ The goals are to achieve bony union, eradication of infection, and functional use of the extremity through radical debridement, coverage

of soft tissue defects with flaps or skin grafts, use of antibiotic beads, cancellous bone grafting, and free tissue transfer including bone transplants.²⁻⁴ These procedures are usually staged and cannot correct limb length and deformity, and thus prevent early rehabilitation and prolong recovery.¹

The Ilizarov technique of distraction osteogenesis enables regeneration of large bone defects and eradication of infected non-union simultaneously, as well as early weightbearing.⁴⁻⁶ This study reviewed outcomes of 24 patients who underwent Ilizarov ring fixation for infected non-union of the tibia.

MATERIALS AND METHODS

Medical records of 21 men and 3 women aged 13 to 74 (mean, 38) years who underwent Ilizarov ring fixation for infected non-union of the tibia between 2005 and 2010 were reviewed (Table 1). Infected non-union was defined as positive tissue cultures, previous

multiple surgeries with discharging sinus, elevated C-reactive protein and erythrocyte sedimentation rate, and exposed bony ends.⁷ Patients with multiple fractures and unsalvageable proximal or distal joints were excluded.

According to the Paley classification,⁸ the non-union was type A in 16 patients and type B in 8 patients. The mean bone defect was 3.3 (range, 2–5) cm. The mean time from injury to presentation was 11.9 (range, 1–36) months. The mean number of previous surgeries was 2 (range, 0–14).

A local flap was used in 2 patients and a free flap was used in one patient. Nine of the patients underwent Ilizarov ring fixation without soft tissue and bony resection, as inadequate stability was the reason for non-union.

Patients were assessed using the Association for the Study and Application of the Method of Ilizarov criteria.⁸ Three-dimensional computed tomography was used to assess bone union with a metal frame surrounding.⁹

Table 1
Patient characteristics and outcomes

Sex/age (years)	Initial fracture	No. of previous surgeries	Treatment	Union time (months)	Association for the Study and Application of the Method of Ilizarov score		Complications
					Functional	Bone union	
M/74	Closed	3	Bone transport (4.2 cm)	18	Failure	Poor	Recurrence of infection, trans-knee amputation
M/55	Open	1	Bone transport (2.3 cm)	31	Fair	Poor	Pin track infection, mal-union (11° varus)
M/45	Closed	3	Compression distraction	8	Excellent	Excellent	-
M/45	Closed	3	Bone transport (1.9 cm)	30	Good	Good	Reapplication of Ilizarov fixator for soft tissue impingement
F/49	Closed	2	Compression distraction	15	Good	Good	Re-fracture
M/40	Open	2	Compression distraction	9	Good	Good	Reapplication of Ilizarov fixator for soft tissue impingement
M/37	Closed	2	Compression distraction	5	Good	Good	Re-fracture
M/40	Open	2	Compression distraction	3	Excellent	Excellent	-
M/65	Closed	4	Compression distraction	5	Fair	Fair	Pin track infection requiring pin removal
M/20	Open	1	Compression distraction	4	Excellent	Excellent	-
M/19	Open	3	Segment transport (4.3 cm)	8	Excellent	Good	Pin track infection
M/20	Closed	2	Compression distraction	6	Excellent	Excellent	-
M/17	Open	0	Compression distraction	4	Excellent	Excellent	-
M/26	Open	2	Compression distraction	9	Excellent	Excellent	-
M/33	Open	1	Compression distraction	10	Good	Good	Pin track infection
F/13	Open	1	Bone transport (3.3 cm)	4	Good	Good	-
M/52	Closed	2	Bone transport (2.4 cm)	8	Good	Good	-
M/35	Open	4	Compression distraction	6	Good	Good	-
M/32	Open	1	Bone transport (3.2 cm)	14	Good	Good	Pin track infection
M/46	Open	2	Compression distraction	11	Good	Good	-
M/40	Closed	2	Bone transport (4.7 cm)	-	-	-	Death
F/34	Open	2	Compression distraction	4	Excellent	Good	-
M/39	Open	3	Compression distraction	4	Good	Good	-
M/45	Closed	2	Compression distraction	6	Good	Good	-

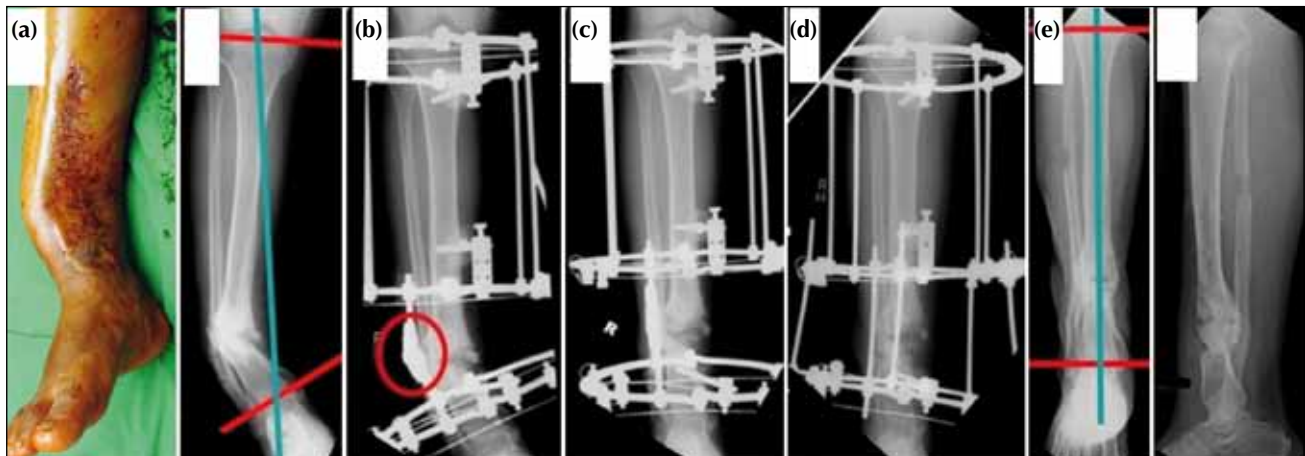


Figure A 40-year-old man with non-union of a tibial fracture: (a) mobile non-union 9 months after injury; (b) fixation using an Ilizarov ring fixator; (c) gradual correction of the deformity; (d) re-adjustment of the fixator 4 months later secondary to soft tissue impingement; and (e) bone union at 9 months.

RESULTS

Patients were followed up for a mean of 11 (range, 8–46) months. Functional outcome was excellent in 8 patients, good in 12, fair in 2, and failure in one, whereas bone union outcome was excellent in 6 patients, good in 14, fair in one, and poor in 2 (Table 1). The mean time to union was 8 (range, 3–31) months. The mean external fixation index was 4.2 (range, 1.5–15.7) cm/month.

Five patients developed pin tract infection; 4 of them were treated with Pyodine solution and oral antibiotics, and one underwent pin removal, debridement, and reapplication of pins elsewhere. Two patients had re-fracture (secondary to premature removal of the fixator), which was resolved with reapplication of the fixator. Two patients had soft tissue impingement, which necessitated re-adjustment of the fixator (Fig.). One patient had mal-union of 11° varus, which was tolerated by the patient.

There was one treatment failure in a patient with multiple co-morbidities (including chronic renal failure) who had undergone open reduction and internal fixation with a dynamic compression plate elsewhere for a low-energy, closed distal tibial fracture. He developed infection and underwent implant removal, multiple debridement, and use of a local flap elsewhere. Five months after injury, he was referred to our hospital and underwent debridement, excision of necrotic bone and tissue, and insertion of antibiotic beads, followed by Ilizarov ring fixation. Cultures grew *Pseudomonas aeruginosa*, *Enterobacter*, and *Klebsiella pneumoniae* (Table 2). The patient underwent further debridement twice, as the infection

did not resolve. 20 months after Ilizarov fixation, the patient underwent trans-knee amputation.

One patient died from advanced liver disease. He underwent open reduction and internal fixation for closed tibial fracture elsewhere. He developed infection and underwent implant removal, followed by Ilizarov ring fixation in our hospital.

DISCUSSION

There is no consensus in the definition of non-union and delayed union. We used a definition of non-union as a fracture that, according to the treating physician, has no possibility of healing without further intervention.¹⁰ Exposed bone that has been devoid of vascularised periosteal coverage for >6 weeks and purulent drainage were indicators of infected non-union.^{5,11}

The Ilizarov ring fixator enables stabilisation even

Table 2
Micro-organisms identified

Bacteriology	No. of patients
Methicillin-resistant <i>Staphylococcus aureus</i> (MRSA)	4
Methicillin-sensitive <i>Staphylococcus aureus</i>	2
<i>Escherichia coli</i>	1
Multiple organisms including MRSA	2
Multiple organisms excluding MRSA	7
No micro-organism found	4
No culture/missing	4

after resection of the infected bone; joint movement and functional loading can be started within the first few days after application of the fixator to minimise loss of working hours and income associated with staged procedures and prolonged recovery.⁵ Nonetheless, Ilizarov fixation has disadvantages of a prolonged and intensive treatment period and potential major complications.⁶ Amputation is the last resort. Improvement in wiring of the fixator enables greater patient comfort; proper soft tissue handling during wire insertion decreases the risk of infection.

Most complications after Ilizarov ring fixation are associated with the docking sites such as non-union, delayed union, mal-alignment, low cross-sectional area, and soft tissue invagination.^{8,12,13} Bone grafting should also be performed, because the bone ends lose their viability and potential for union secondary to atrophy following resection.¹²⁻¹⁴

In 27 patients treated with an Ilizarov fixator for infected non-union of the tibia, the mean time to union was 6.3 months; 24 patients achieved excellent-to-good functional outcome; 2 patients had a residual deformity and one had non-union.¹⁵ In 25 patients with tibial non-union treated with an Ilizarov fixator, bone union was excellent in 18 patients, good in 5, and

fair in 2, whereas functional outcome was excellent in 16 patients, good in 7, fair in one, and poor in one; complications included persistent infection (n=3), deformity (n=4), limb shortening (n=1), limp (n=4), equinus (n=5), dystrophy (n=4), pain (n=4), and neurogenic pain requiring amputation (n=1).⁸ In 58 patients treated with an Ilizarov fixator for tibial non-union, radiological outcome was excellent in 33 patients, good in 12, fair in 8, and poor in 5, whereas clinical outcome was excellent in 33 patients, good in 18, fair in 4, and poor in 3.¹⁶ Outcomes of our patients were comparable to these studies.

CONCLUSION

Ilizarov ring fixation is a viable option for infected non-union of the tibia. Adequate assessment of bone union is crucial before removal of the fixator to prevent re-fracture.

DISCLOSURE

No conflicts of interest were declared by the authors.

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