Treatment of Tibial Nonunions and Bone Defects with the Ilizarov/Taylor Spatial Frame

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Purpose
The personality of a tibial nonunion is defined by patient factors, bone loss, radiographic appearance, deformity, leg length discrepancy (LLD), infection, and the soft-tissue envelope. These are complex and often limb threatening problems. We have used modern Ilizarov method to comprehensively approach these problems. The purpose of this study was to review the results of our experience to provide reconstructive trauma surgeons guidance for optimal treatment of these complex problems.

Methods
After obtaining IRB approval, our registry was used to identify the study population. Between 1999-2003, 38 patients with 38 tibial nonunions were treated with the Ilizarov/ Taylor Spatial Frame. There were 30 men and 8 women with an average age of 43 (range: 8-72). There were 10 smokers and 4 diabetics. The nonunions were the outcome of closed fractures in 10, open fractures in 26, bone defect following failed tumor reconstruction in one, and osteomyelitis and bone defect following a snake bite in one patient. Twelve patients had previous flaps and 17 patients presented with drainage. There were 23 mobile or atrophic, 6 partially mobile or normotrophic, and 6 stiff or hypertrophic nonunions. The tibial location of the nonunion was proximal in 6, middle in 12, and distal in 20. There were 23 patients with bone defects with an average size of 5.9 cm (range: 1.5-16).LLD was present in 22 patients with an average of 3.1 cm (range: 1-5.7). There was a history of infection in 23 patients treated previously with antibiotics. At the time of surgery, 19 (50%) nonunions were diagnosed as infected, and these patients were treated with 6 weeks of culture specific antibiotics. The average number of previous surgeries was 4 (range: 0-20). Bone grafting was performed in 25 (66%) patients. Distraction osteogenesis for bone transport or lengthening was performed in 19 (50%) patients with an average of 6.9 cm length (range 2.5-16). This was achieved at proximal tibia in 13, distal tibia in 2, both locations (trifocal technique) in 3, and the femur in one. Clinical follow-up was obtained consisting of physical examination, radiographs, SF-36 scores, AAOS lower limb module scores, and Association for the Study of the Method of Ilizarov (ASAMI) classification of results which scores a separate bone and functional outcome.

Results
The average follow-up was 28 months (range 8-51). The frame was used dynamically in distraction and/or compression for duration of 130 days (range: 15-480). The total time in

the frame averaged 289 days (range: 119-715). Bony union was achieved after the initial treatment in 28 (74%) patients. Nine of the ten of these initial failures were in the infected nonunion group. The 10 persistent nonunions were retreated with frame reapplication in 4, intramedullary rodding in 3, plate fixation in one, and amputation in 2 patients. This resulted in final bony union in 36 (95%) patients. The average LLD was 1.6 cm (range: 0-6.8). Alignment with deformity less than 5^0 was achieved in 32 patients and between 6^0 to 10^0 was achieved in 4 patients. SF-36 scores improved in 6 of 8 categories. AAOS lower limb module scores improved from 51 to 77. According to the ASAMI classification of results, there were 24 excellent, 12 good, and 2 poor bone outcomes and 20 excellent, 14 good, 2 fair, and 2 poor functional outcomes.

Conclusion/Significance
One can comprehensively approach tibial nonunions with the Ilizarov/ Taylor Spatial Frame. This is particularly useful in the setting of infection, bone loss, LLD, and poor soft-tissue envelope. Infected nonunions have a higher risk of failure than non-infected cases. Initial failure of bony union can be salvaged with additional treatment. We were able to successfully treat a complex group of tibial nonunions using the Ilizarov method with the occasional adjuvant use of internal fixation technique.

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