CHAPTER **28**

MID-SHAFT TIBIA FRACTURE WITH CIRCULAR EXTERNAL FIXATOR, IMMEDIATE WEIGHTBEARING AND PRIMARY BONE HEALING: A Case Study

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INTRODUCTION

Fractures of the tibial shaft are one of the most common long bone fractures in the body (1). The incidence of tibial shaft fractures ranges from 17-22 per 100,000 patient years. The most common mechanisms for tibial shaft fractures include falls, sporting accidents and high-energy mechanisms, such as soccer and motorcycle collisions (2). While these injuries are extremely common, there is still some debate in the literature about the optimal treatment for these fractures. Some physicians advocate nonoperative treatment with casting, while others advocate surgical intervention as optimal (3). Among surgical treatment options, the three most common methods for fixation are plating, intramedullary nailing, and external fixation. Of these surgical options, the literature suggests that intramedullary nails are most commonly indicated for mid-shaft fractures, while external fixation is generally indicated for damage control with open fractures or compromised soft tissues (2). Each of these methods of fixation requires different periods of non-weightbearing, which may influence the surgeon's surgical decision making. The case presented in this study demonstrates the indication for external fixation as the primary fixation method for a closed mid-tibial shaft fracture without soft tissue compromise. This case also demonstrates the load-bearing capabilities of external fixations for immediate weightbearing.

CASE PRESENTATION

The patient is a 50-year-old female who was seen in the emergency department after sustaining a slip and fall accident on a wet floor. The patient felt instant excruciating pain and was unable to bear weight to her left lower extremity. The patient was transported to the hospital by an ambulance. The patient's past medical and surgical history was non-contributory. The patient denied any drug allergies, but admitted to some type of reaction from morphine. Her social history was positive only for social alcohol consumption.

Upon physical examination of the left lower extremity, no open wounds were noted. No bowing of the tibia was noted and the soft tissue envelope was preserved. Only some bruising was noted to the anterior aspect of the leg. The pedal pulses were palpable and non-pitting edema was noted. The neurological examination was unremarkable. The patient experienced pain on palpation to the anterior aspect of the leg along the mid-shaft of the tibia and with active and passive range of motion of the ankle. Radiographic evaluation revealed a minimally displaced mid-shaft fracture of the left tibia without comminution or joint involvement (Figures 1, 2).

After clinical examination and radiographic evaluation, all conservative and surgical options were discussed with the patient in great detail. We discussed referral to an orthopedic doctor for the application of an intramedullary nail versus the application of a ring external fixator by podiatry. After discussing the advantages and disadvantages of each option, the patient opted for the application of an external fixator. The surgical procedure was performed that same day.

SURGICAL PROCEDURE

A circular ring fixator was applied to the left lower extremity, which consisted of two rings proximal to the fracture, two rings distal to the fracture, and a floating middle ring at the fracture site. No foot plate was attached to the construct to allow for weightbearing without limitation to the ankle range of motion. The most proximal and distal rings were fixated with two olive wires, each for stabilization of the extremity. One olive wire was fixated to the middle floating ring and tensioned under fluoroscopy to visualized compression of the fracture. Once we were satisfied with the correction achieved, the remaining rings were fixated and stabilized with smooth wires (Figures 3, 4, 5).

Following surgery and the application of the external fixator device with a posterior splint, the patient was given instructions to be non-weightbearing until her first

Figure 1. Initial presentation, anterior-posterior radiograph of the left tibia-fibula demonstrating the displaced mid-shaft tibial fracture.

Figure 2. Lateral radiograph of left tibia-fibula demonstrating the displaced mid-shaft tibial fracture at initial presentation.

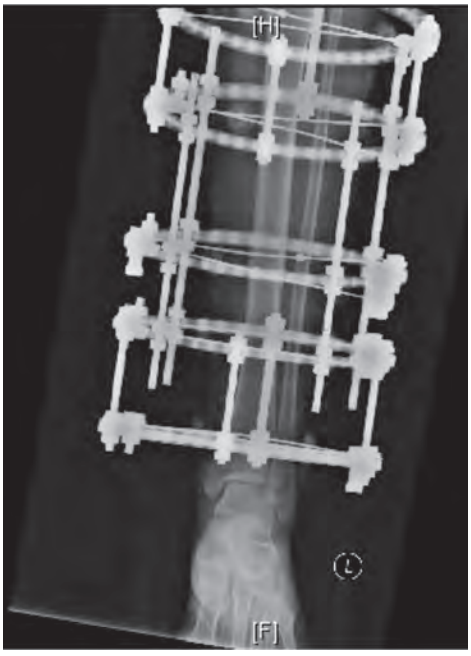

Figure 3. Anterior-posterior radiograph of left tibia-fibula demonstrating configuration of external fixator device taken immediately after surgery.

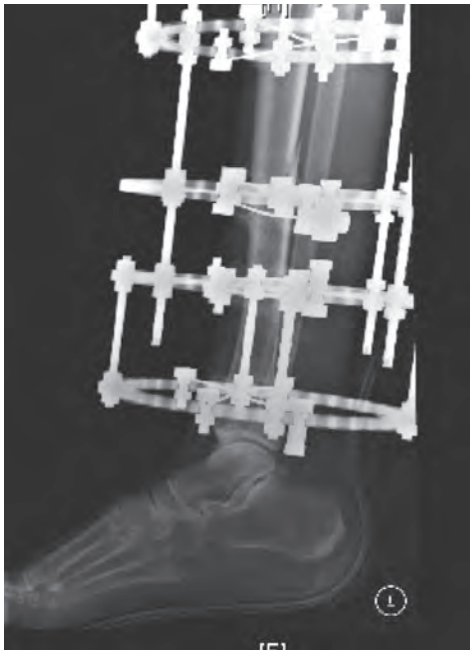

Figure 4. Lateral radiograph of left tibia-fibula demonstrating configuration of external fixator device taken immediately following surgery.

postoperative visit. During her first postoperative visit, 5 days after surgery, the patient was given permission to begin weightbearing as tolerated. The patient began to gradually increase her weightbearing load, and by 4 weeks following surgery; the patient presented to our office weightbearing in comfortable shoes bilaterally and using a walker only to aid with stabilization (Figure 6). The patient was instructed that she could walk without assistive devices, however, the patient was concerned about tripping and falling, therefore, she felt more confident using the walker.

In between weeks 5 and 9 postoperatively, the patient became more confident, and by week 10 postoperatively, the patient was ambulating with the external fixator and without any assistive devices. Radiographs taken during this visit revealed complete union of the fracture with good anatomical alignment of the tibia, and the external fixator was removed at 12 weeks postoperatively (Figures 7, 8). At 16 weeks, postoperatively, the patient had already undergone 3 weeks of physical therapy and was walking pain

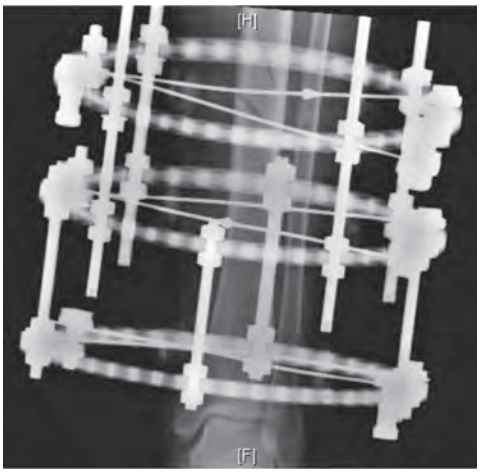

Figure 5. Anterior-posterior radiograph demonstrating the corrected alignment of the left tibia fracture.

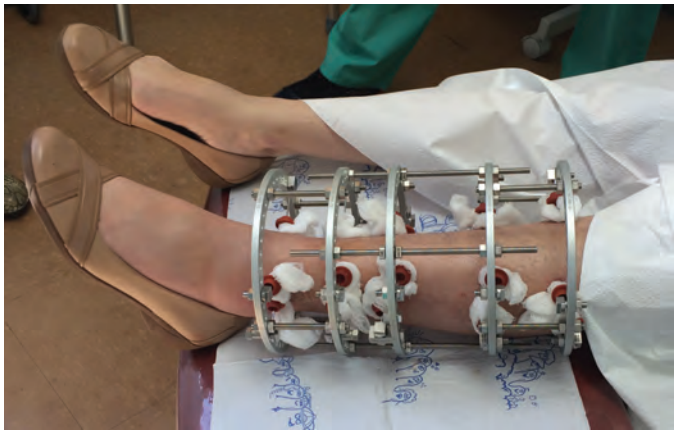

Figure 6. Clinical view of the patient demonstrating external fixator device with comfortable shoe gear. This configuration allows for full weightbearing 4 weeks after surgery.

Figure 7. Anterior-posterior radiograph after external fixator removal demonstrating complete union of left tibia fracture at 12 weeks following injury.

Figure 8. Lateral radiograph after external fixator removal demonstrating complete union of left tibia fracture at 12 weeks following injury.

free in high heels. The patient was last-followed up at 26 weeks postoperatively, and stated that she was getting back to her regular routine.

DISCUSSION

Internal and external fixation are the two most common approaches for fixating tibial fractures. A meta-analysis of external fixation versus intramedullary nails states that postoperative outcomes such as infection, malunion, disunion and healing time improve with intramedullary nailing as opposed to external fixation. It also states the unreamed nails offer better stability and anatomic alignment. Conversely, fracture reduction with plate fixation is associated with a high number of revisional surgeries ranging from 8-69% and 11% deep infection rate (4). However, this case study demonstrates the effectiveness of external fixation for tibial fractures. Some benefits of external fixation include early weight-bearing, faster functional recovery, correction of the tibial deformity, adequate reduction to appropriate limb length and ability to facilitate wound coverage. External fixation offers ease of application, limited effect on blood supply to the tibia, preservation of microvascular structures of the tibia, preservation of the periosteum and

periosteal blood supply, allows for outpatient adjustment if necessary and is lastly associated with a high union rate (5). External fixation allows for bone healing and stabilization of fractures via the "trampoline effect." This effect suggests that increasing loads on the external fixator continually tightens the wires and their ability to stretch, so that resultant axial deformation exponentially decreases. Thus, increased load is advantageous to callus formation and bone healing (6). Another consideration for the application of external fixation is the presence of a visible apparatus, which may psychologically affect the patient. Some of the most common complications seen with external fixation are pin tract infection and nonunion (4).

The advantages of external fixation noted above are in direct opposition to the disadvantages of intramedullary nailing and internal fixation with plates. Literature suggests that reamed intra-medullary nailing can cause elevation of compartment pressures, disturbance of cortical bone circulation and thermal injury to cortical bone (7). Intramedullary nailing also provides variability in the postoperative weightbearing protocol. With reamed nails, patients may begin protected weightbearing at 2 to 4 weeks postoperatively. However, with unreamed nails, patients may need to be non-weightbearing for 6 weeks (3). Thus, in attempting to preserve the cortical bone by using an unreamed nail, the physician sacrifices strength and stability of the nail. Additionally, if there is still a noticeable bone gap noted at 6 weeks, the surgeon must go back surgically and dynamize the nail (3). In regards to plating, the literature suggests that the periosteal blood supply to the bone is disturbed when plate to bone contact occurs (8). With compression plating, the literature suggests that patients may be partially weightbearing with crutches for the first 6 weeks following surgery. However, partial weightbearing in this case implies a maximum of 15-20 kilograms (9).

In this case, our patient had a displaced closed tibial fracture that was fixated with a circular external fixator. She began weightbearing with assistance within 1 week of surgical intervention. While the patient was tentative to walk without assistance initially due to pain and uncertainty about stability, it was possible for her to do so because the external fixator is designed to absorb the weightbearing load. Thus, as opposed to intramedullary nailing or plate fixation, there is no maximum limit to the amount of weight that can be applied with postoperative weightbearing. The patient progressed to weightbearing with minimal assistance at 1 month. She had no complications and no pin-tract infections. The patient healed uneventfully and the external fixation was removed 12 weeks after the tibial fracture.

This case demonstrates how external fixation can effectively be used as the primary means of fixation for tibial shaft fractures, and it also demonstrates certain advantages that external fixation can provide over internal fixation. Specifically, the patient was able to ambulate within 1 week of surgery. The patient has no hardware remaining, no residual knee pain, which is sometimes seen with intramedullary nailing, and psychologically the patient was happy that she had no remaining hardware inside her body. She began physical therapy 3 days after removal of external fixation. The patient returned to normal knee and ankle range of motion and began exercising 4 months postoperatively with minimal pain and mild ankle stiffness. Thus, it can be seen that external fixation is an effective method to treat displaced open or closed tibial fractures.

In conclusion, tibial shaft fractures are extremely common injuries seen in the trauma setting. While the current literature suggests that internal fixation with intramedullary nails or compression plates are the preferred treatment options; these forms of fixation require extended periods of non-weightbearing and can cause considerable bone damage. The damage caused to the bone can limit the osseous healing potential. External fixation as a means of primary fixation for tibial fractures allows for stabilization and reduction of the fracture while also preserving the integrity of the osseous vascular supply. The mechanics of the external fixator also allow for full weightbearing in the immediate postoperative period. The outcome of this case demonstrates how external fixation can be used as the primary means of fixation for isolated tibial shaft fractures.

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