Tension Band Plating of a Nonunion Anterior Tibial Stress Fracture in an Athlete

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Abstract: The authors present a rare technique of tension band plating of the anterior tibia in the setting of a nonunion stress fracture. Surgical management with an intramedullary nail is a viable and proven option for treating such injuries. However, in treating elite athletes, legitimate concerns exist regarding the surgical disruption of the extensor mechanism and the risk of anterior knee pain associated with intramedullary nail use. The described surgical technique demonstrates the use of tension band plating as an effective treatment of delayed union and nonunion anterior tibial stress fractures in athletes without the potential risks of intramedullary nail insertion.

Tibial stress fractures occur in individuals who participate in rigorous activity and present a formidable challenge to clinicians with respect to treatment and the facilitation of a prompt return to action. Commonly described in high-performance athletes and military personnel, the reported incidences are 8% to 21% and 2.4% to 13.4%, respectively. The most common bone in which stress fractures occur is the tibia, and the prognosis of the injury is dependent on the location of the fracture. Posterior tibial cortex fractures are the most common and favorable in terms of treatment and speed in return to sport. Fractures of the anterior cortex are less likely to occur, accounting for 2.7% to 4.6% of stress fractures.

Treatment is often dependent on the broad classification of the fracture as either low or high risk. Low-risk stress fractures are often diagnosed with a thorough history and physical, supported with radiographic evidence, and require rest with limited weight bearing for up to 6 weeks. High-risk stress fractures, such as those in the anterior tibial cortex, are persistent and have a predilection for complete fracture, delayed union, or nonunion and require a more aggressive approach.

Two surgical interventions have been described by Chang and Harris and Borens et al and include intramedullary nailing and tension band plating, respectively. The most frequently reported complication of tibial nailing is chronic anterior knee pain. This can be devastating to a jumping athlete who is already predisposed to anterior knee pain as a result of forceful quadriceps contraction with concurrent knee flexion that increases pressure on the posterior kneecap.

The authors present a surgical technique for tension band plating supplemented with drilling of the fracture site and bone morphogenic protein pads for a delayed union or nonunion anterior tibial stress fracture in an elite athlete.

Materials and Methods

The indication for surgery is failed nonoperative management of an anterior tibial cortex stress fracture in an elite-level athlete. The senior author (G.F.R.H.) begins treatment with rest, CAM walker boot immobilization, and physical therapy modalities, including ultrasound. If the patient is pain free at 3 months after onset of treatment, then the patient can return to play. If pain persists, then surgical intervention is considered. Time of season (in- vs off-season) factors into decision making for advancing to surgical treatment after the initial 3 months of conservative treatment.

Surgical Technique

The patient is placed in the supine position on the operat-
Intraoperative photograph of the right lower extremity showing the markings for an 8-cm longitudinal incision that is 1 cm lateral to the anterior tibial crest and centered over the fracture site.

Postoperatively, the patient is placed in a CAM boot and told not to bear weight for 6 weeks postoperatively. The patient is advanced to bearing weight as tolerated at the end of 6 weeks postoperatively, he began running on the AlterG anti-gravity treadmill (AlterG, Fremont, California); 14 weeks postoperatively, he began underwater running and jumping; and 18 weeks postoperatively, he began traditional agility and plyometric exercises. Radiographs taken 8 months postoperatively were void of any visible black line, indicating a healed fracture site (Figure 2).
Anterior tibial stress fractures in athletes present a difficult challenge to clinicians. Immobilization and rest are often inadequate and can extensively delay the return to competition. Previous studies evaluating nonoperative treatment of tibia stress fractures found a mean of 12 months for return to former level of play. This lengthy period of inactivity can have significant psychological effects on athletes and even represent financial loss in terms of potential earnings for professional athletes. In the case of nonunion or delayed union, surgical intervention must be explored. The technique presented in this article is advised for use in elite athletes with a delayed union or nonunion of an anterior tibial stress fracture.

Stress fractures of the anterior tibia are most commonly related to overuse and are derived from an imbalance in host injury and repair. The injury is commonly derived from excessive tensile forces from posterior muscle activity that, under circumstances of attenuated bone strength from intensive exercise, can result in microfractures. Stress fractures in recreational athletes who suddenly elevate the force of exertion have a predilection for healing because the metabolic equilibrium is intact. High-level athletes who constantly train create an asymmetry in osteoclast and osteoblast activity, thus producing an unfavorable environment for healing. 

Although healing may be less likely in an athlete, rest and immobilization are the recommended initial treatment. Once imaging reveals hypertrophic tibial cortex and a widening fissure, the self-curative capacity is minimal and surgical intervention is likely warranted. 

Intramedullary nailing of tibial shaft fractures has been described extensively, yet the most common complication is anterior knee pain. Vaisto et al noted that 21 (75%) of 28 patients who underwent intramedullary nailing of tibial shaft fractures had chronic anterior knee pain at 8-year follow-up. Borens et al used an anterior tension band plating technique in 4 athletes. They postulated that the plate offers a biomechanical advantage secondary to its distance from the central axis of the bone that alleviates tensile forces and fracture motion. In addition, intramedullary nail insertion site pain is avoided, thus abstaining from possibly contributing to the likelihood of debilitating anterior knee pain. All 4 athletes returned to competition at 10 weeks postoperatively. The 3 patients who solely underwent tension band plating were symptom free with respect to anterior knee pain at 1-year follow-up.

Gaining absolute stability is critical for healing in nonunion, transverse tibial stress fractures. To gain rigid fixation at the fracture site, the current authors used compression plating on the anterolateral aspect of the tibia (Figure 4B). Additional stability was obtained by using locking screws to support the initial reduction and compression. Combining locking and nonlocking compression screws also minimizes absolute compression of the periosteum that may be detrimental to blood supply in an area where vascular compromise already exists.

Bone healing involves biological and mechanical components. Previous studies have demonstrated the effectiveness of proper fracture site debridement and supplemental translational drilling for delayed-union or nonunion tibial stress fractures. Bone morphogenic proteins are regarded as a key regulator in skeletal repair. Swiontkowski et al noted that rhBMP-2 reduced the frequency of bone grafting.

**Figure 4**: Intraoperative anteroposterior (A) and lateral oblique (B) photographs of the right tibia showing a 6-hole, 4.5-mm locking compression plate centered over the fracture site with recombinant human bone morphogenic protein-2 supplementation.

**Figure 5**: Postoperative anteroposterior (A) and lateral (B) radiographs of the right tibia showing hardware placement.
procedures and secondary procedures in patients with severe tibial fractures. The current authors used rhBMP-2 to supplement the biologic response of fracture healing to improve the likelihood of union.

**CONCLUSION**

Anterior tension band plating of chronic anterior tibial stress fractures can dramatically accelerate recovery and return to play for patients. It also offers several advantages over intramedullary nailing, with no violation of the extensor mechanism and no associated risk of anterior knee pain. This technique should be reserved for those who have failed initial conservative treatment and, due to involvement in high-level athletics, cannot accept a prolonged period of activity restriction.

**REFERENCES**


