

Recurrent Fracture After Anterior Tension Band Plating With Bilateral Tibial Stress Fracture in a Basketball Player

A Case Report

Hiroyuki Hattori,^{*†} MD, and Toshiyuki Ito,[†] MD

Investigation performed at the Department of Orthopedic Surgery, Japan Community Health Care Organization, Tokyo Kamata Medical Center, Tokyo, Japan

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The tibial shaft is the most common location of stress fractures in athletes. Tibial stress fractures are divided into 2 groups, anterior and posterior, based on location. Posterior tibial cortex fractures are more common and respond well to conservative treatment. Fractures in the anterior cortex are less common, accounting for only 4.6% of stress fractures,¹⁴ and they often heal poorly because of relatively poor vascularity and constant tension exerted by posterior muscle forces. In the absence of operative treatment, a persistently painful stress fracture may result in delayed union, nonunion, or even complete fracture.

Different surgical treatment procedures have been described, but there is no consensus on the best approach for anterior tibial stress fractures. Intramedullary nailing is an established technique for treating delayed or nonunion tibial stress fractures.¹⁰ Recently, several authors have reported that anterior tension band plating offers a number of advantages over intramedullary nailing for anterior tibial stress fractures in athletes.^{3,7,13,20}

We report on the surgical treatment, via exchange intramedullary nailing, of a new stress fracture that developed after anterior tension band plating treatment of an existing stress fracture.

CASE REPORT

A 15-year-old male junior high school basketball player presented with severe pain of the left lower leg after feeling a “pop” at the same site while attempting a layup. The patient could not bear weight on the left leg. Six months previously, he had been diagnosed with bilateral anterior tibial stress fractures at another orthopaedic clinic. He had been managed conservatively with temporary activity modification and low-intensity pulsed ultrasound bone stimulation. After a 3-month period of rest, he resumed regular basketball practice with resultant mild bilateral leg pain.

The patient’s weight and height were 67 kg and 180 cm, respectively; his body mass index (BMI) was 20.7 kg/m². Clinical examination revealed diffuse swelling and severe tenderness over the mid-left tibia. Left leg compartments were firm. A focal, firm, warm fullness in the right midanterior tibia was mildly painful to palpation. The arches of his feet appeared normal. The subtalar and ankle joints had a normal range of motion. Routine laboratory blood tests were unremarkable. Measurements were made using standard radiographs in another orthopaedic clinic; however, tibial widths in the bilateral mediolateral planes were narrow (right tibia, 23.8 mm; left tibia, 24.5 mm at 8 cm above the ankle joint).⁹ Radiographs of the left leg showed a

*Address correspondence to Hiroyuki Hattori, MD, Department of Orthopedic Surgery, Japan Community Health Care Organization, Tokyo Kamata Medical Center, 2-19-2 Minamikamata, Ohta-ku, Tokyo, 144-0035, Japan (email: hiroyuki.hattori@jcom.home.ne.jp).

[†]Department of Orthopedic Surgery, Japan Community Health Care Organization, Tokyo Kamata Medical Center, Ohta-ku, Tokyo, Japan.

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Figure 1. Injury radiographs. (A) Anteroposterior and (B) lateral radiographs of the right tibia show a clearly transverse lucency (arrow), the “dreaded black line” in the midtibial diaphysis, as well as a thickened anterior cortex and narrowed medullary canal. (C) Anteroposterior and (D) lateral radiographs of the left tibia show an oblique midtibial shaft fracture through stress fracture nonunion.

complete oblique fracture through the anterior tibial stress fracture nonunion. Radiographs of the right leg revealed a linear cortical defect with thickened periosteal bone deposition at the midanterior tibia (the “dreaded black line”), which was diagnosed as a tibial stress fracture nonunion (Figure 1).

After discussion with the patient, the decision was made to surgically treat the bilateral tibial fractures because of a quicker return to activity. We performed intramedullary nailing for the left complete tibial fracture and anterior tension band plating for the right tibial stress fracture nonunion. The left tibial canal was reamed with progressively larger reamers (2-mm intervals) to allow insertion of an 8.5-mm-diameter tibial nail (Trigen Meta-Nail Tibial Nail System; Smith & Nephew). The nail was locked with screws both distally and proximally. We also collected cancellous bone in the left tibial canal for an autogenous bone graft at the right tibial stress fracture nonunion. C-arm fluoroscopy was used to identify the right tibial fracture site. A longitudinal incision was made slightly lateral to the anterior tibial crest and was centered over the fracture site. The fracture site was directly visualized and carefully debrided using a small curette and high-speed bur. Next, transverse drilling to create a normal

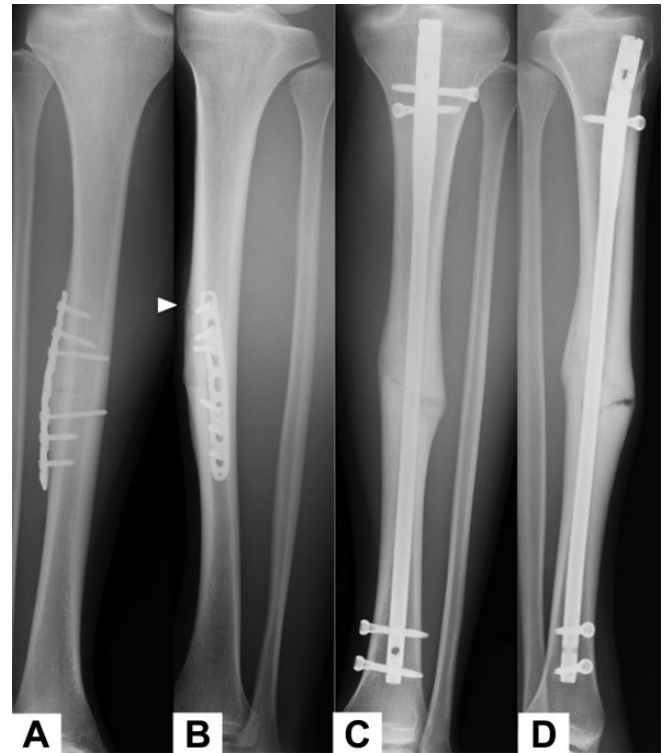


Figure 2. Four-month postoperative radiographs. (A) Anteroposterior and (B) lateral radiographs of the right tibia show a healed fracture line but focal lucency (arrowhead) around the proximal locking screw. (C) Anteroposterior and (D) lateral radiographs of the left tibia show a persistent transverse lucency around significant callus formations.

intramedullary canal was performed using a 2.0-mm drill. Autogenous cancellous bone was placed in the fracture site, and the site was fixed with a 3.5-mm, 7-hole locking compression plate (LCP) (Synthes) at the anterolateral aspect of the tibia. Three screws were used on each side of the fracture. One of these screws was a cortical screw, and dynamic compression was first provided across the fracture by eccentrically positioning the screw on the plate hole near the fracture site. Next, 2 bicortical locked screws were used on each side of the fracture. The wound was closed without drains.

Postoperatively, the patient progressed to weightbearing on the left leg as tolerated over a 2-week period. He was prohibited from weightbearing on the right leg for a 4-week period, after which partial weightbearing was permitted. The patient could walk without assistance by 6 weeks, and he began light jogging without symptoms at 13 weeks. Four months after surgical treatment, he returned to playing basketball and was symptom free. Radiographs of the bilateral legs showed that the left complete tibial fracture had a persistence of the “dreaded black line” around significant callus formation, and the right tibial stress fracture nonunion appeared healed. However, the focal lucency around the proximal locking screw could be seen if observed carefully (Figure 2).

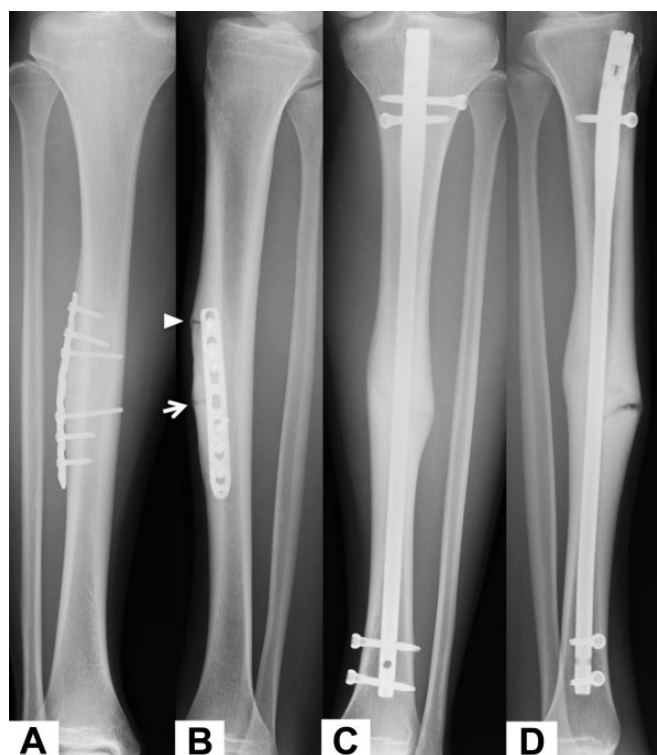


Figure 3. Seven-month postoperative radiographs (3 months after returning to basketball). (A) Anteroposterior and (B) lateral radiographs of the right tibia show a clearer transverse lucency (arrow) in the midtibial diaphysis proximal to the site of the tibial stress fracture (arrowhead). (C) Anteroposterior and (D) lateral radiographs of the left tibia still show the transverse lucency.

Seven months after surgery, the patient gradually noted pain in the right leg while he ran during basketball. On physical examination, he had a normal gait without pain, but there was a localized area of swelling and tenderness proximal to the area of his previously treated stress fracture. Radiographs of the right leg showed a more clearly linear cortical defect of the midanterior tibia proximal to the site of his previously treated stress fracture nonunion, which had still appeared on radiographs postoperatively. Radiographs of the left leg still demonstrated persistence of the dreaded black line at the midanterior tibia (Figure 3).

The patient underwent surgery utilizing the previous incision for removal of the plate and intramedullary nailing. We found that his previously treated stress fracture had healed successfully, but a new lesion was present near the proximal screw hole. After reaming with progressively larger reamers, an 8.5 mm–diameter tibial nail, locked proximally but not distally to allow for compression, was inserted into the right tibia without difficulty. We used a 2.0-mm drill to pass transversely from the fracture site to the adjacent screw hole. The screw hole was grafted with cancellous bone from the tibial reaming. We also removed the distal interlocking screw of the left intramedullary nail to allow for compression at the persistent fracture site.

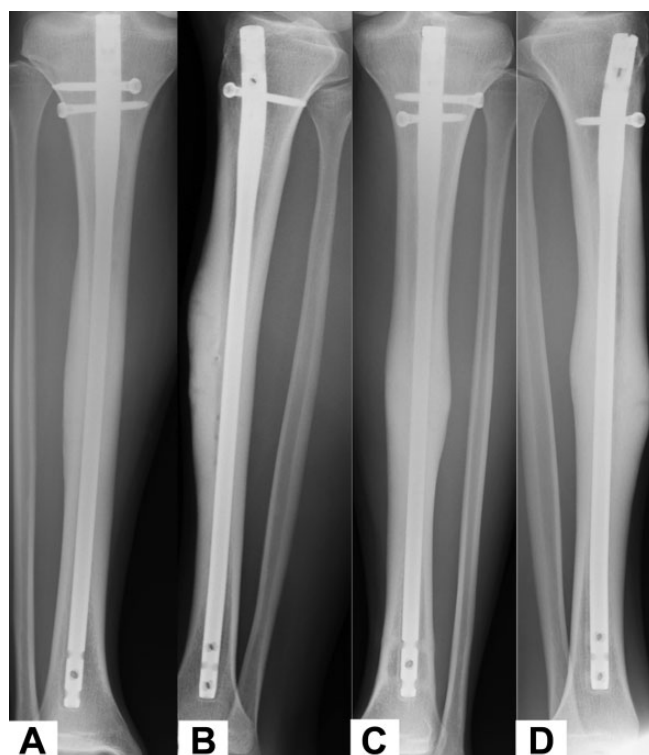


Figure 4. Twelve-month post-second surgery radiographs. (A) Anteroposterior and (B) lateral radiographs of the right tibia show a new and old healed tibial stress fracture. (C) Anteroposterior and (D) lateral radiographs of the left tibia show the diminished transverse lucency.

Postoperatively, the patient was able to bear weight on the right leg without assistance by 2 weeks. He began light jogging and nonstrenuous basketball drills without jumps at 6 weeks. By 3 months after revision surgery, he could return to full basketball activity without pain. At most recent follow-up (12 months), radiographs of the bilateral legs showed that the right tibial stress fracture nonunion had healed successfully, and the dreaded black line in the left leg had diminished (Figure 4).

DISCUSSION

Stress fractures are classified as high or low risk based on their prognosis and the biomechanical environment in which they are located. Anterior tibial stress fractures are considered to be high risk.^{8,10} With delays in diagnosis or with less aggressive treatment, high-risk stress fractures tend to progress to nonunion or complete fracture, requiring surgical treatment, or to never heal in the same location. Therefore, the decision of whether to manage a high-risk stress fracture operatively should be based on radiographic findings independent of symptoms.¹⁰ The dreaded black line in an anterior tibial stress fracture is predictive of delayed healing and nonunion. If the fracture line is well established or the athlete has failed conservative treatment, surgical treatment is often recommended.

In our patient, unfortunately, the complete left tibial fracture occurred due to failed conservative management of the anterior tibial stress fracture. The patient should not have returned to playing basketball without undergoing radiographic examination for signs of stress fracture healing.

Conservative treatment for anterior tibial stress fracture includes rest, ultrasound therapy, extracorporeal shock wave therapy, and recently, the use of a pneumatic lower leg brace. Batt et al¹ reported on 4 cases with delayed union stress fractures of the anterior tibia treated with rest and a pneumatic leg brace. All 4 patients returned to full unrestricted activity at a mean of 12 months after presentation. Radiologically assessed healing was complete in 3 of the fractures at a mean of 8 months.¹ The effect of low-intensity ultrasound treatment for anterior tibial stress fractures is controversial. Uchiyama et al¹⁸ examined the effects of low-intensity pulsed ultrasound treatments in 5 delayed and nonunion anterior tibial stress fractures in athletes. Patients returned to full sports activity at an average of 3 months, and absence of pain was achieved at an average of 3.8 months. However, disappearance of the fracture line was achieved at a mean 11 months. For athletes, the duration of conservative treatment for anterior tibial stress fracture may be too long if "healing time" is defined as radiographic union. Anterior tibial stress fractures should be treated more aggressively with surgical fixation, with the goal of fracture healing and minimizing risk of complete fracture or refracture. Moreover, surgical treatment may speed healing of the fracture and may allow earlier return to play.

Intramedullary nailing, as previously mentioned, has been advocated for the treatment of chronic tibial stress fractures. Several case reports supporting this technique have shown healing of anterior tibial stress fractures in athletes, with a low complication rate.^{5,6,19} In the largest published series, clinical and radiographic union occurred at 2.7 and 3 months, respectively, and the mean time to return to sports was 4 months.¹⁹ Several recent case reports have described the complications after intramedullary nailing for chronic anterior tibial stress fractures, such as complete fracture and new fracture around the existing nail.^{2,12,15} A few of these patients required exchange intramedullary nailing because of failed conservative treatment or nail breakage.^{12,15}

Several authors have reported good clinical and radiological outcomes of anterior tension band plating for anterior tibial stress fractures in athletes. They used a 3.5-mm or 4.5-mm, 6-hole LCP at the anterior aspect of tibia to provide compression near the cortex. This plate is different from the plate typically used for tibial osteosynthesis. However, Cruz et al⁷ proposed that a 3.5-mm plate is sufficient for converting the tension forces into compression forces because anterior tibial stress fractures are incomplete fractures and there are no rotational or shear forces across the fracture. This technique has 2 theoretical advantages over the use of an intramedullary nail for anterior tibial stress fractures: One is that it allows for compression at the fracture site and thus neutralizes fracture micromovements. The other is that the plating does not violate the extensor

mechanism, thus preventing anterior knee pain.^{3,7,13,20} Anterior knee pain is the most common complication of intramedullary nailing for tibial shaft fracture; however, its incidence after tibial nailing for anterior tibial stress fracture is still unknown. In a literature review, Katsoulis et al¹¹ reported a 47.4% mean incidence of anterior knee pain in 1460 patients treated with intramedullary nailing for tibial shaft fracture. However, Varner et al¹⁹ reported only 1 patient who developed bursitis at the tibial nail insertion site in 11 patients treated with intramedullary nailing for anterior tibial stress fracture. In the largest published series, there were 13 chronic anterior tibial stress fractures in 12 patients who underwent anterior tension band plating. Osseous union occurred at a mean 9.6 weeks, and the mean time to return to sports was 11.1 weeks.²⁰ We found no reports of recurrent tibial stress fractures stabilized with anterior tension band plating in athletes.

In our patient, the construct may have induced new fracture around the proximal locking screw. We have recognized 2 problems with our construct: One is that a 3.5-mm, 7-hole LCP may have been too short to fix an anterior tibial stress fracture. The other is that we used 2 bicortical screws on each side of the fracture. A stress injury of the bone is the result of either excessive strain or bone strain with the accumulation of microdamage and the inability to keep up with appropriate skeletal repair. There may be a component of reperfusion injury following prolonged strenuous exercise that results in bone tissue ischemia.¹⁶ The choice of the appropriate length of the LCP is one of the most important steps in internal fixation using plates. We should keep the plate and screw loading as low as possible to avoid fatigue failure due to cyclic loading. The ideal length of the LCP for anterior tibial stress fracture may be longer than the overall cortical thickness area. The previous surgical interventions for anterior tension band plating using the LCP have been described: inserting 1 or 2 cortical screws on each side of the fracture to achieve dynamic compression and unicortical locking screws in the remaining holes.^{3,7,13,20} Locking plates transmit load through fixed-angle locking screws instead of relying on plate-to-bone compression. A locked end screw induces greater stress concentration than a conventional end screw. Theoretically, locked plating constructs for fractures occurring in poor-quality bone may cause a greater periprosthetic fracture risk than do conventional plates.⁴ We had concerns about putting 2 bicortical locking screws on each side of the fracture into bone in this condition. However, we considered that bicortical screws needed to gain good anchorage because of the eccentric plate position. Locking screws will not have optimal fixation if the plate is not sitting over the middle of the bone surface,¹⁷ such as with anterior tension band plating. A 3.5-mm or 4.5-mm 6-hole LCP for anterior tension band plating technique in the tibial shaft should be used with caution.

Anterior tibial stress fractures in athletes present a difficult challenge to clinicians. We should be aware of the substantial risk for delayed union, nonunion, and complete fracture, particularly if conservative treatment is continued. We also highly recommend aggressive surgical treatments. Two surgical interventions, including

intramedullary nailing and tension band plating, are attractive options for treating problematic anterior stress fractures. In treating intramedullary nailing, however, we should carefully insert the nail to avoid anterior knee pain. Moreover, we also need to examine recurrent fracture around the implant after surgery. In treating anterior tension band plating, we would recommend the longer LCP plate rather than the previously reported surgical interventions from our failed construct point of view. We propose that return to full activity after anterior tibial stress fractures should be permitted after confirming radiographic union in both conservative and surgical treatments.

This is the first report of a recurrent anterior tibial stress fracture after anterior tension band plating. The optimal management of anterior tibial stress fractures is unclear. Conservative treatment may be successful, but it can also be prolonged and unpredictable. Surgical treatments result in earlier union and return to play if one can avoid complication. However, the known possibility of fracture after stabilization may justify a more cautious approach regarding return to activity.

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