Intramedullary Nailing of an Anterior Tibial Stress Fracture in a Football Player

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STRESS FRACTURES ACCOUNT for as much as 10% of all sports injuries.¹ They are most common in the leg’s weight-bearing bones,² and in athletes, the tibial diaphysis.³ Anterior tibial-cortex fractures are difficult to treat because they are recalcitrant to conservative treatment and can progress to complete fracture.² With treatment of immobilization or rest, fractures in this region require prolonged healing time.⁴ For athletes who have defined limited playing time and eligibility like the athlete in this report, dynamic intramedullary nailing is a viable treatment option.³

History and Mechanism of Injury

A Division I freshman football player started preseason football and began complaining of bilateral shin pain that he had had since the preceding spring, when he participated in long jump and high jump on an asphalt track. He said the pain had subsided, but with the demands of preseason football, it had begun to recur. The pain intensified during weight-bearing activities and then diminished with rest. His symptoms were worse on the right than on the left side.

Evaluation and Assessment

Physical examination by the ATC revealed an obvious raised prominence with localized swelling at the mid- to distal third of each tibia. On palpation, the athlete’s right tibia was more point tender and warm at the prominence than at the same location on his left tibia. He had a slight antalgic gait with a noticeable limp on the right. Strength and range of motion for both ankles and knees were within normal limits. The team orthopedist ordered bilateral anteroposterior and lateral X-rays of both tibiae, which revealed stress fractures of the anterior cortex of the mid- to distal third of both tibiae. The “dreaded black line” indicated that the anterior tibial cortex of each was compromised, more prominently on the right (Figures 1 and 2).
Initial Treatment

The athlete’s left leg was placed in an Aircast Air-Stirrup (Aircast, Summit, NJ), and the right leg in both an Air-Stirrup and a High Tide walker (dj Orthopedics, Inc., Vista, CA). He was withheld from all activity and treated with an Exogen 2000 bone stimulator (Memphis, TN) once a day for 20 min bilaterally. After 1 week, he had no pain with activity. He was cleared for full practice while continuing the bone-stimulator treatments.

Two and a half weeks into the football season, the athlete became symptomatic again on the right tibia. A triple-phase bone scan revealed bilateral uptake in the anterior cortex of both right and left legs, with the right tibia demonstrating a more intense reaction than the left. Based on these findings and the fact that the athlete would be eligible for a medical hardship because he had only played in 20% of the team’s games, he and the sports-medicine team decided to have intramedullary nailing performed on his right tibia.

Surgical Procedure

A 3-cm incision was made on the lateral aspect of the patellar tendon, and a smaller incision was made lateral to the patellar tendon to identify the proximal aspect of the tibia. A starting hole was drilled and then a guide wire placed across the tibial stress fracture and distally to just above the physeal scar. The hole was reamed with a 12.5-mm reamer. When it was complete, a 10- by 340-mm intramedullary nail was placed across the tibial stress fracture and distally. A proximal interlocking screw was inserted after fluoroscopy confirmed the appropriate placement of the nail. Because the fracture site was stable, no distal interlocking screw was placed in the tibia.

Rehabilitation

After surgery, the athlete was given a lower leg Cryo-Cuff (Aircast) and instructions to rest, keep his leg elevated, and bear weight as tolerated using crutches if necessary. Because the surgeon had to go through the knee to insert the rod in the tibia, the rehabilitation plan was designed like one for a knee arthroscopy. Postoperatively, the athlete presented with significant effusion of his knee, quad atrophy and inhibition, and a noticeable limp. His initial range of knee motion, as compared with his left leg, showed a 39° deficit for flexion and a 4° deficit for extension.

The long-term goal of rehabilitation was to return the athlete to full sport activity in time for winter football-conditioning drills, approximately 3 and a half months postsurgery. The goals of Weeks 1 and 2 were to prevent stiffness and patellofemoral problems; decrease knee swelling; increase quadriceps activation and girth; strengthen the hip, thigh, and lower leg muscles; and progress toward full weight bearing. Daily treatment began with an ice compression boot for 20 min followed by ankle pumps with rubber tubing for 10 min to decrease the swelling. Patellar mobilizations were performed to decrease patellofemoral-joint stiffness. Seated active heel slides were performed to increase knee flexion, and an extension board with straps (10 min) and terminal knee extensions with rubber tubing (5 × fatigue) were used to return the knee to 0° of extension. Electrical muscle stimulated quadriceps sets were performed (10 s on, 10 s off) for 15 min to increase quadriceps activity and girth. Gait training was incorporated to teach the athlete how to walk without a limp. As the patient progressed, lower extremity strengthening was incorporated. Hip-strengthening exercises included four-way hip machine (2 × 15 all four ways), ball squats with medicine-ball knee squeezes (3 × 15), and wall sits with medicine-ball knee squeezes (5 × 30 s). Hamstring strengthening was done with the curl machine (3 × 10), and quadriceps strengthening, with controlled short-arc 0–30° step-downs (5 × 25) and terminal knee extensions (5 × fatigue). Calf strengthening was performed using...
cycling calf raises off of a step (3 × 20) and calf raises on a wobble board (3 × 20). Balance training was performed with barefoot single-leg stance on a foam pad (5 × 30 s). The treatment ended with 20 min in the ice compression boot. By the end of Week 2, the patient had achieved full range of knee motion; showed decreased swelling, increased quadriceps activation, and good patellar mobility; and was fully weight bearing (Tables 1 and 2).

At 3 weeks postsurgery, the patient had his stitches removed and was instructed to start using the bone stimulator again on both legs and to perform deep friction massage on the scar. The goals were to continue strengthening his lower body, return his quadriceps to normal girth, and progress through functional exercises in the rehabilitation pool five times per week. Tables 1 and 2 show the progression in girth and strength from Weeks 3 to 6. During this time, the athlete alternated between two protocols. The first started with a pool workout for 25 min and included running, back-pedaling, shuffling, acceleration/deceleration, and sport-specific drills. The athlete then performed circuit training including four exercises (30 s on, 30 s off): one-leg hamstring curls, hip flexion on the four-way hip machine, short-arc single-leg squats on a foam pad, and calf raises on a wobble board. The second protocol started with the stair-stepper (10 min, progressing to 14 min by Week 6). After that, the athlete performed single-leg press (5 × 10), lunges with dumbbells (eight trips back and forth [~72 ft] in the training room), stool scoots for the hamstrings (five trips [~150 ft] around the island in the training room), rubber-tubing sideways walking (five trips down and back in the training room), calf raises off a step (5 × 20), and single-leg squats on a trampoline (4 × 25). He made great progress during this phase and had no setbacks. He had equal girth of both thighs and almost equal strength of his quadriceps and hamstrings. During Week 5 we discontinued ice after exercise and started using continuous ultrasound and massage on his infrapatellar fat pad to reduce the scar tissue.

Six weeks postsurgery, an X-ray of the right tibia showed good callous and healing (Figure 3). The team orthopedist suggested adding squats and leg extensions to the workout. Quadriceps and hamstring strength were measured with an isokinetic dynamometer. The patient’s quadriceps and hamstrings were equal bilaterally at 60°/s and also proportional to his body weight. Because of his outstanding progress, his rehabilitation in the athletic training room was reduced to 3 days per week: 2 days of 30 min of pool cardiovascular training and 1 day of isokinetic velocity spectrum exercise on the isokinetic dynamometer. On nontreatment days he did lower body weight training, avoiding high-load exercises such as the power clean. He continued to use the bone stimulator during the week. At 3 months postsurgery bilateral X-rays showed significant healing. The athlete began mainstreaming into running activities with the team and was released to full activity 4 months postsurgery. At 6 months postsurgery, he had no complaints or further problems.

### Discussion

Anterior tibial-cortex fractures were first reported by Burrows in 1956 in 5 ballet dancers. In contrast to a postero-medial stress fracture, an anterior stress fracture occurs on the tension side of

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**Table 1. Thigh-Girth Measurements Throughout the Rehabilitation Process**

<table>
<thead>
<tr>
<th>Time of Measurement</th>
<th>Distance From Suprapatellar Apex (in.)</th>
<th>Injured Right Thigh</th>
<th>Noninjured Left Thigh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 2</td>
<td>3</td>
<td>15 7/8</td>
<td>16 1/2</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>20</td>
<td>20 7/8</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>22 3/8</td>
<td>22 3/4</td>
</tr>
<tr>
<td>Week 4</td>
<td>3</td>
<td>18 1/2</td>
<td>18 1/8</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>21 1/2</td>
<td>22 1/8</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>22 3/4</td>
<td>23 1/4</td>
</tr>
<tr>
<td>Week 6</td>
<td>3</td>
<td>18 5/8</td>
<td>18 5/8</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>22 3/8</td>
<td>22 3/8</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>23 1/8</td>
<td>23 1/8</td>
</tr>
</tbody>
</table>

**Table 2. Quadriceps and Hamstring Strength Measurements (lb)**

<table>
<thead>
<tr>
<th></th>
<th>Injured Quadriceps</th>
<th>Uninjured Quadriceps</th>
<th>Deficit</th>
<th>Injured Hamstring</th>
<th>Uninjured Hamstring</th>
<th>Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 2</td>
<td>33.5</td>
<td>51.2</td>
<td>27%</td>
<td>41.8</td>
<td>52.6</td>
<td>22%</td>
</tr>
<tr>
<td>Week 3</td>
<td>65.8</td>
<td>85.5</td>
<td>24%</td>
<td>54.6</td>
<td>57.3</td>
<td>8%</td>
</tr>
<tr>
<td>Week 5</td>
<td>73.3</td>
<td>71.6</td>
<td>2%</td>
<td>56.6</td>
<td>56.2</td>
<td>1%</td>
</tr>
</tbody>
</table>

*Note: Strength was measured with a J-Tech handheld dynamometer (Salt Lake City, UT). Each strength measurement is an average of three trials.*
the tibia in an area of minimal soft-tissue coverage and relative hypovascularity. These fractures are associated with prolonged healing times, can progress to complete fractures, and often require surgical intervention.

Nonoperative treatment of anterior tibial-cortex stress fractures entails prolonged healing time. Rettig et al. studied 8 athletes with such fractures, 1 of which progressed to complete fracture. The other 7 were treated conservatively with immobilization or rest with electrical stimulation and healed an average of 8.7 months after onset of treatment. The average time from onset of symptoms to complete return to symptom-free sports activities was 12.5 months. We also recommend initial treatment of rest and electrical stimulation for a minimum of 3–6 months before considering surgical intervention. In this case, the athlete was able to return to full activity in 4 months, demonstrating the benefit of surgery.

Other studies report that operative treatment of this type of fracture is the best method for healing and decreasing recovery time. Chang et al. reviewed the records of 6 military patients who underwent intramedullary nailing for chronic midanterior tibial stress fractures. One left the service and was lost to follow-up. All were treated with nonoperative therapy for 1 year or more before the surgery. After the surgery, 2 of the patients reported excellent results, indicating that they were completely symptom-free and were able to perform unlimited running, and the other 3 reported good results, indicating that they had occasional minor pain with vigorous activity and could perform limited pain-free running.

Brukner et al. reported on a patient with bilateral stress fractures. One was treated with intramedullary nailing and healed at 5 months postsurgery, and the other, treated conservatively, remained symptomatic for over a year. Gardiner et al. reported on a patient with bilateral anterior tibial stress fractures who had intramedullary nailing on both tibiae and was pain free with no tenderness at 4 weeks postsurgery. Six months postsurgery, X-rays showed no fracture line, and she returned to competition without restriction.

**Conclusion**

Anterior tibial-cortex stress fractures are uncommon and difficult to treat. Most are treated nonoperatively, which means the patient has a prolonged healing time. Surgical treatment with intramedullary nailing provides the athlete the best opportunity to return to play sooner and with minimal symptoms. In this case report, intramedullary nailing allowed full recovery and return to activity at 4 months postsurgery.

**References**


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