The Use of a Transyndesmotic Bolt in the Treatment of Tibiofibular Diastasis: Two Case Studies

The authors present a brief overview of tibiofibular diastasis and the mechanisms of injury associated with it. This type of injury is frequently misdiagnosed or improperly treated. Two case studies are presented with specific emphasis placed on the use of a transyndesmotic bolt in the reduction of the tibiofibular diastasis. The authors have found this to be more beneficial in the treatment of this condition, as opposed to the traditional use of a transmalleolar screw.

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When treating ankle injuries, one must consider the congruity of the joint in order to restore the extremity to its appropriate function. If the joint is not congruent, the articular surfaces become abraded with range of motion, resulting in an increase in symptoms and arthritic changes over time (1). Not only should malleolar function and congruity be assessed, but also the presence or absence of a diastasis of the distal tibiofibular syndesmosis should be evaluated. The primary goal in treatment of ankle injuries is the restoration of full function to the injured extremity (1).

A diastasis, in relation to the ankle, is defined as a splaying of the fibula away from the tibia beyond the elastic yield allowed by the fibrous structure binding the distal ends of these two bones together (2). It commonly occurs in more severe types of ankle injuries, and rarely occurs as a single entity. Anatomically, the distal tibiofibular syndesmosis is formed by the distal tibiofibular articulation, and is supported by four ligaments: the anterior inferior tibiofibular, the posterior inferior tibiofibular, the transverse tibiofibular and the interosseous ligament. The primary stabilizers are the anterior and posterior inferior tibiofibular ligaments (3). The relative stiffness of the syndesmotic ligaments plays an important role in the contribution of the stability of the ankle in tibiotalar rotation (4). Although the syndesmosis bears little load, it is an important stabilizer of the fibula, and disruption of the syndesmotic ligaments can lead to widening of the ankle joint and instability.

A diastasis of the distal tibiofibular syndesmosis occurs with the rupture of the syndesmotic ligaments. This results in a separation of the tibia and fibula. As a consequence, the tibial articulation with the talus is affected, resulting in instability of the ankle joint. This can occur with injuries such as Danis-Weber types B and C fractures, or Lauge-Hansen stages II, III, or IV injuries, both supination external rotation injuries and pronation external rotation injuries. In addition, other injuries such as supination-adduction and pronation-abduction may lead to a diastasis.

Diagnosis

Diagnosis of a diastasis is made by clinical and radiographic evaluation. Palpation of the ligaments and evidence of possible instability of the ankle joint are useful, but associated injuries frequently make examination difficult because of the presence of edema and/or pain experienced by the patient. Radiographically, a normal distal tibiofibular space is defined as one less than 4 mm. A 5-mm. or greater clear space or separation between the tibia and fibula, on an anteroposterior or oblique view, indicates an obvious diastasis (5). A lateral view will demonstrate asymmetry of the talotibial articulation. Stress films and arthrography may also be utilized in the diagnosis. In addition, a fibular fracture is often present above the tibial plafond, indicating damage to the syndesmotic ligaments. A fibular fracture typically occurs with a diastasis and is located 2.5 cm. to 8 cm. above the tibiotalar joint (6).

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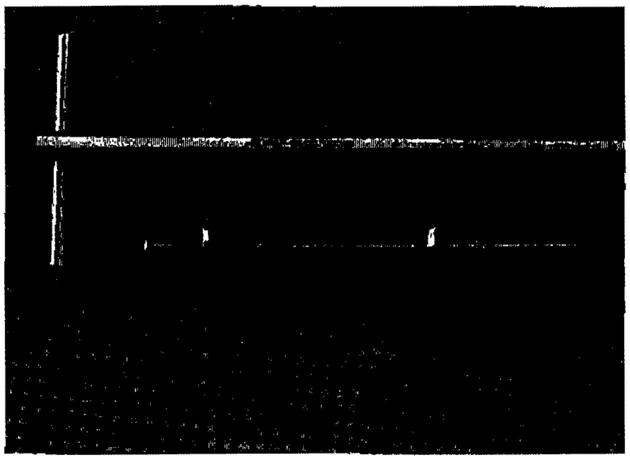

Figure 1. The transyndesmotic bolt and accompanying wrench for tightening.

Treatment

Conservative treatment of a diastasis is difficult because of the inability to prevent widening of the ankle mortise secondary to an unstable diastasis, which widens with dorsiflexion of the ankle joint (6). Cast therapy may be utilized, providing no other significant injuries are present, but most often is ineffective in preventing long-term degenerative changes within the ankle joint. When surgical reduction of the diastasis is performed, biomechanic factors must be considered. The superior surface of the talus is wider anteriorly than posteriorly. Because of this, the intramalleolar distance is widened with ankle joint dorsiflexion. The syndesmotic bolt is inserted while the ankle joint is in maximal dorsiflexion. The bolt fixes the fibula to the tibia and maintains the ankle mortise in its widened state (4). If fixation were performed with the ankle plantarflexed, the intramalleolar distance would decrease, which can lead to a long-term decrease in ankle joint dorsiflexion (4).

Various forms of fixation have been utilized in the treatment of a diastasis. Such devices include a transmalleolar screw, staples, Steinmann pins, and transyndesmotic bolts. The authors believe that the utilization of a transyndesmotic bolt for fixation allows for better reduction of the diastasis. In this type of fixation procedure, a pilot hole is made in the fibula superior to the tibial plafond. A transyndesmotic bolt (Fig. 1), which is self-tapping, is inserted lateral to medial through the fibula and tibia. A nut and washer are placed medially. The diastasis is reduced by tightening the bolt on the nut. This allows for excellent coaptation of the diastasis. Reduction is confirmed by the use of intraoperative fluoroscopy. The bolt is then cut flush with the nut to avoid soft tissue irritation. There are varying theories as to how long a transyndesmotic bolt is retained in place. Segal (7) and Kaye (8) suggest that 6 weeks is sufficient to allow healing of the syndesmosis, while Roberts (9) indicates that the practice of early removal of the syndesmotic fixation prior to weightbearing is responsible for the loss of diastasis reduction.

Complications of diastasis fixation include calcification of the interosseous ligaments. Many authors have discussed synostosis secondary to the injury (10, 11). Syndesmosis calcification occurs most frequently at the level of the fibular fracture (8). Kaye believes that this is due more to the extent of the soft tissue and bony damage, and not related to the use of syndesmotic fixation (8). Skarba and Greenwald state that clinical symptoms of synostosis are rare, however, despite disruption of normal biomechanical function (12). In addition, such factors as overcorrection, screw breakage, loosening of the bolt, and inadequate reduction must be considered.

Case Study 1

A 65-year-old white male presented to the office with complaints of having slipped and fallen on the ice 3 days earlier. Since that time, his left ankle had become swollen, painful, and discolored. He had been unable to bear weight on his foot, and also felt it was distorted in appearance. He was unable to describe the way his ankle turned when he fell.

Initial examination showed a healthy male with no significant medical history. His left ankle was erythematous and edematous, most notably laterally. A detailed examination was difficult to perform because of the extreme tenderness the patient was experiencing, and the muscle splinting that was occurring secondary to the injury. There was no evidence of vascular or neurological compromise. X-rays (Fig. 2) revealed a fibular fracture that was displaced posteriorly, and diffuse soft tissue swelling. In addition, a significant tibiofibular diastasis of 7 mm. was noted. From clinical examination and x-ray evaluation, it was determined that this patient had a stage III supination external rotation injury. At this time, it was felt that open reduction with internal fixation would be necessary because of the extreme instability, significant diastasis, and displacement of the fibular fracture.

A 15-cm. linear incision was placed over the lateral aspect of the fibula. Great care was taken to identify and retract the lateral dorsal cutaneous and sural nerves. Deep dissection exposed a large, degenerated hematoma in the fracture area, which was then evacuated. The fibular fracture was 3 cm. proximal to the tibial plafond. It was noted that the fracture had attenuated the tendon of the peroneus longus and caused a partial rupture at the proximal aspect of the fracture site, and was appropriately repaired. Next, attention focused on

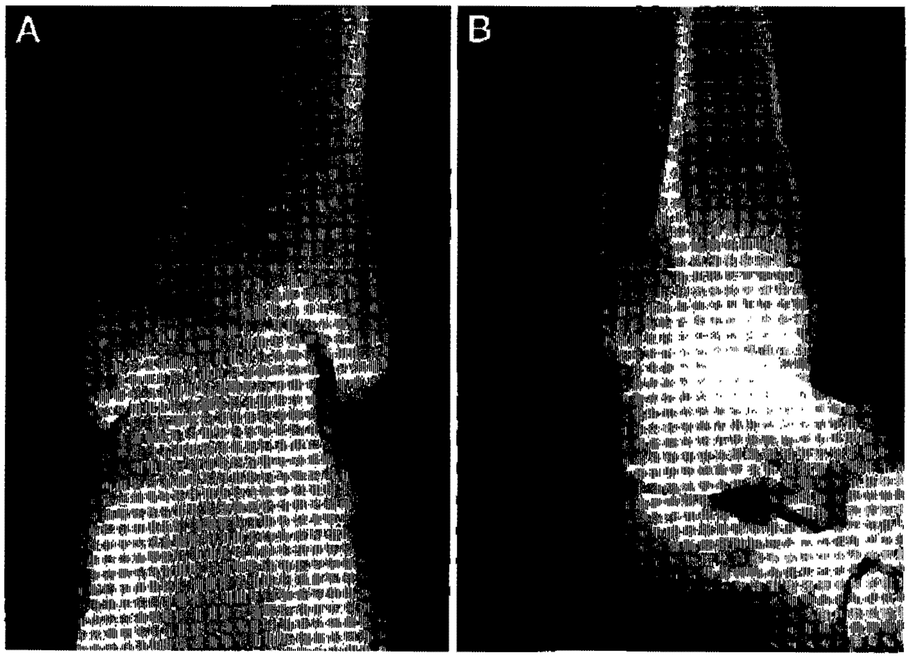

Figure 2. Case study 1. Anteroposterior *(A)* and oblique *(B)* radiographs of ankle show displacement of fibular fracture and diastasis of the tibia-fibula.

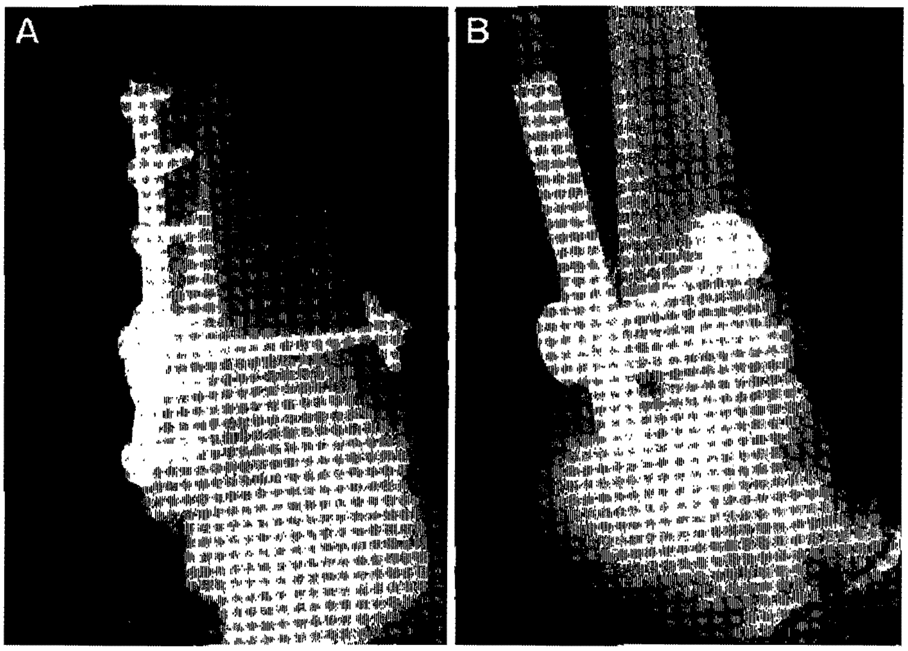

Figure 3. Case study 1. Oblique *(A)* and lateral *(B)* radiographs show postoperative reduction of fibular fracture and transyndesmotic bolt placement for treatment of diastasis.

the fracture, which was noted to be displaced posteriorly and laterally. The hematoma across the fracture line was evacuated, which allowed the fracture to be reduced. This was initially fixated with a bone clamp, allowing the authors to focus attention on the distal tibiofibular diastasis. A transyndesmotic bolt was incorporated. The bolt was inserted lateral to medial through the fibula-tibia, 3.5 cm. above the apex of the lateral malleolus. A washer and nut were placed on the bolt medially and then tightened, which allowed excellent coaptations of the diastasis (Fig. 3). Intraoperative fluoroscopy was used to ensure adequate reduction. Following this, the fibular fracture was fixated with a seven-hole screw plate that was formed to fit the fibula. The plate was fixed with cancellous screws and the bone clamps were removed. Fluoroscopy scans revealed good compression and excellent reduction. Postoperative radiographs revealed the distal tibiofibular space to be 2 mm., with anatomical reduction of the fibular fracture. The surgical area was closed appropriately, and a posterior splint was applied. This was retained for 10 days, and the patient was maintained nonweightbearing. A nonweightbearing,

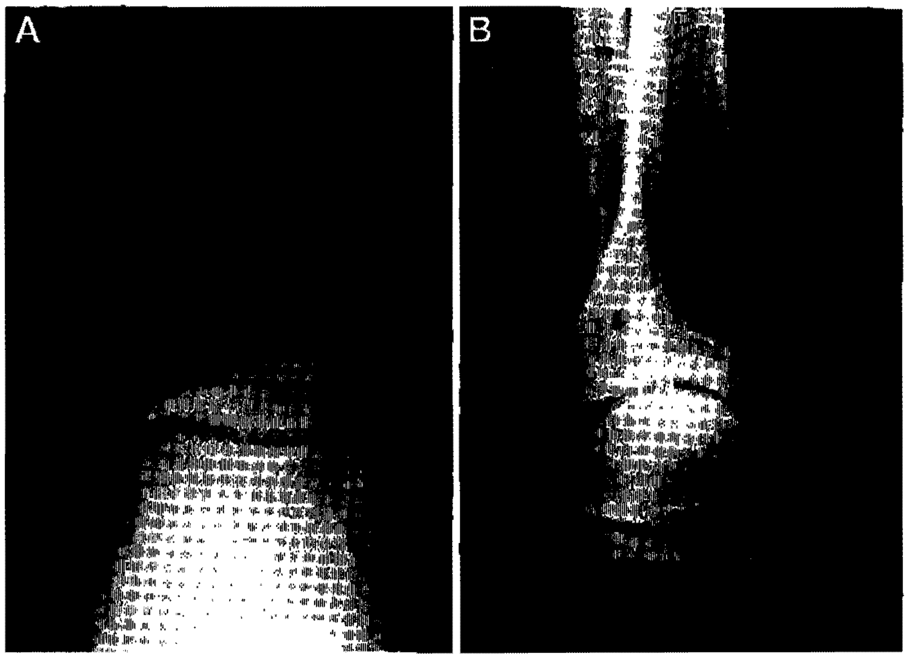

Figure 4. Case study 1. Anteroposterior *(A)* and lateral *(B)* radiographs after removal of internal fixation devices show good reduction of fibular fracture and diastasis.

below-the-knee fiberglass cast was then applied and maintained for 3 weeks, followed by a partial weightbearing cast, thus enabling the amount of pressure on the transyndesmotic bolt to be decreased. Four weeks later, the patient was placed in a full weightbearing cast and maintained for 2 weeks, followed by use of a removable walker. Physical therapy followed, consisting of range-of-motion and strengthening exercises, and the patient is currently back to full activity. The bolt was removed approximately 4 months after the initial surgery (Fig. 4). The patient is now 15 months postoperative, has progressed well, and has returned to full activity.

Case Study 2

A 37-year-old white female presented to the office complaining of an extremely painful ankle. She related that she had slipped on the ice approximately 1 hour before presenting to the office. She described a supination inversion injury and was unable to bear any weight on the ankle. She also stated that her ankle had begun to swell almost immediately after the injury.

Upon examination, the patient was an apparently healthy, active woman with a history of asthma. Her left ankle was extremely edematous surrounding the ankle joint and over the fibula, both above and below the level of the talar dome. There was generalized erythema noted, with ecchymoses present along the lateral aspect of the foot. Muscle and range-of-motion testing were unable to be performed because of the pain the patient was experiencing. Palpation of the ankle joint revealed localized tenderness along the length of the fibula and all lateral ankle ligaments. There was no break in the skin and no evidence of vascular or neurological compromise. Radiographic examination showed a spiral oblique fracture of the fibula 3 mm. superior to the tibial plafond that was displaced posteriorly, and a 5-mm. diastasis of the tibiofibular syndesmosis (Fig. 5). There was a generalized increase in soft tissue density consistent with soft tissue trauma. From clinical examination and radiographic evaluation, a diagnosis was made of a left ankle fracture with diastasis secondary to Lauge-Hansen supination external rotation III injury. Because of the nature of the injury, and the clinical and radiographic evaluation of the patient, it was determined that open reduction and fixation of the fracture was indicated. The patient was immediately admitted for surgical reduction.

A 20-cm. linear incision was performed over the lateral aspect of the ankle joint. The sural nerve was identified and gently retracted. Deep dissection revealed a spiral oblique fracture of the fibula 3 cm. above the tibial plafond, and the fracture was noted to be displaced posteriorly and laterally. A large hematoma was identified and evacuated. This allowed for reduction of the fracture, which was initially reduced with two bone clamps. Attention was then focused on the tibiofibular diastasis, where a Steinmann pin was initially placed across the transmalleolar area, approximately 2 cm. proximal to the tibial plafond. The pin was directed lateral to medial. The transyndesmotic bolt was hand-drilled from lateral to medial, and a washer and nut were placed over the medial aspect of the bolt and tightened. This allowed for reduction of the diastasis, which was confirmed intraoperatively with fluoroscopy. The re-

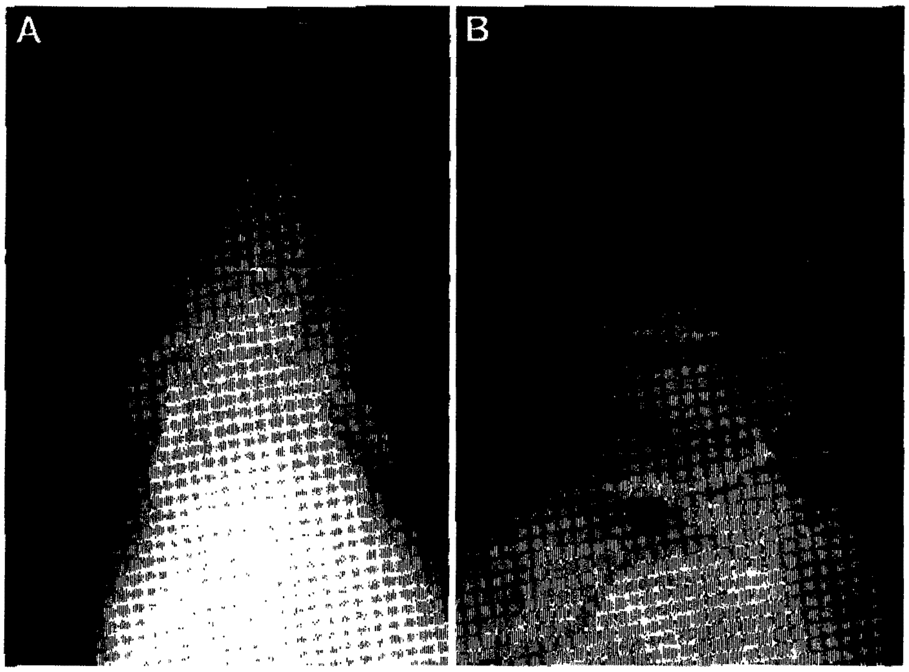

Figure 5. Case study 2. Anteroposterior *(A)* and oblique *(B)* radiographs of ankle demonstrating spiral oblique fracture with diastasis.

maining portion of the screw was cut flush with the bolt to eliminate cutaneous irritation. Returning to the fibular fracture, a seven-hole neutralization plate was placed over the fibula, and molded distally to accommodate the distolateral aspect of the fibula. Cancellous screws were used to fixate the fracture. Intraoperative fluoroscopy revealed good anatomical alignment, and the bone clamps were removed. The surgical area was closed appropriately and a posterior splint was applied. Postoperative radiographs demonstrated that the tibiofibular space now measured 2 mm. with anatomical reduction of the fibular fracture (Fig. 6). The patient was nonweightbearing for 12 days. A below-the-knee cast was then applied, and the patient remained nonweightbearing for a total of 6 weeks. She was placed and maintained in a full weightbearing cast for 2 more weeks. Following cast removal, she began physical therapy, consisting of strengthening and range-of-motion exercises, and has progressed well. The bolt was removed 6 months after the initial surgery, and the patient had an uneventful

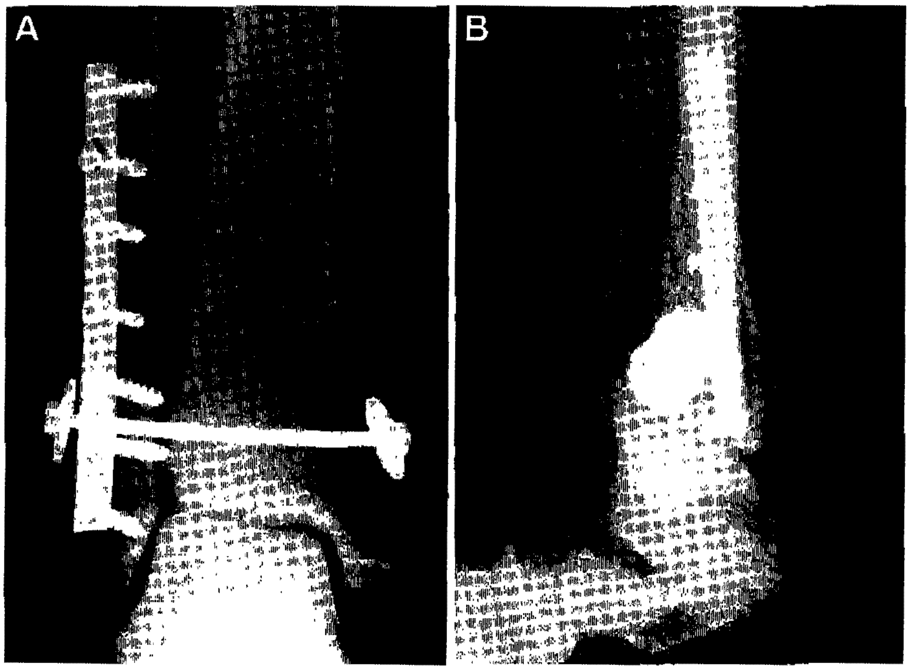

Figure 6. Case study 2. Anteroposterior *(A)* and lateral *(B)* radiographs of ankle demonstrating placement of transyndesmotic bolt for diastasis and neutralization plate for the fibular fracture.

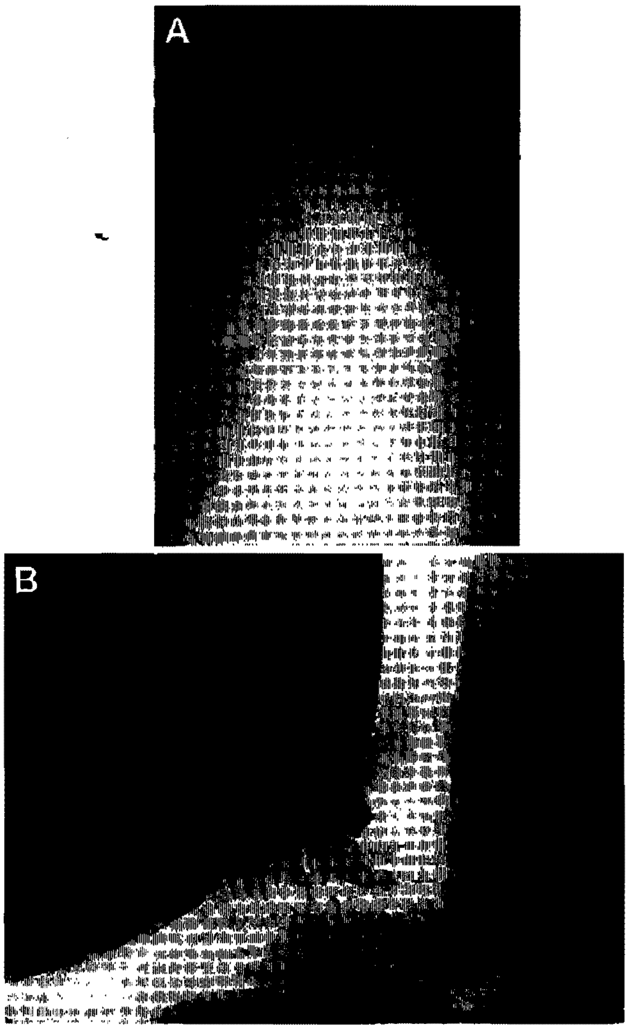

Figure 7. Case study 2. Anteroposterior *(A)* and lateral *(B)* radiographs taken after removal of internal fixation devices demonstrating reduction of fibular fracture and diastasis.

recovery (Fig. 7). The patient is now one year postoperative and is fully active, with exercises including stair-step activity and jogging. She has normal muscular examination and good ankle range of motion with no erythema, edema, or pain in the area.

Conclusion

The use of a transyndesmotic bolt in the treatment of a distal tibiofibular diastasis has proven to be more successful for the authors than the use of transmalleolar screw. The authors have employed both methods of fixation in their work, but it has been their experience that the transyndesmotic bolt allows for better coaptation of a diastasis. It is, however, technically more difficult to use, most notably with the use of an adjoining fixation device. The authors have utilized the transyndesmotic bolt in eight additional cases, with no complications to date. The transmalleolar screw cannot provide the same type of compression that a bolt can, but can easily be fitted in a neutralization plate if that type of fixation is also required.

Postoperatively, the patient is placed in a nonweightbearing cast for approximately 4 weeks, followed by a weightbearing cast for 4 weeks. This is followed by physical therapy consisting of active and passive range-of-motion exercise of the ankle joint, compression to reduce swelling, and gradual strengthening exercises. This allows for a gradual return to full weightbearing so as not to put too much pressure on the bolt.

Frequently, a diastasis is not identified, or if it is, not properly treated. Untreated, this can result in ankle joint instability and long-term degenerative changes within the joint. Also, pain and stiffness may occur along with synostosis of the interosseous ligament. Proper diagnosis and treatment are essential to prevent this from occurring.

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