Intramalleolar Triplane Fracture With Osteochondral Talar Defect

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Triplane fracture of the ankle is an uncommon injury that presents in adolescents after partial closure of the distal tibial physis. Ehalt[1] and Titze,[2] in the 1960s, first described triplane fractures as "transitional fractures" of the distal tibia. Marmor,[3] in 1970, described a fracture of the distal tibia as consisting of 3 separate fracture fragments—a free anterolateral epiphyseal fragment, a posterior metaphyseal fragment (including the remainder of the epiphysis), and the tibial shaft. Lynn[4] then introduced the term triplane fracture to describe this fracture in 1972. In 1978, Cooperman and colleagues[5] reported that a 2-fragment configuration was more common than a 3-fragment configuration and emphasized the importance of obtaining a computed tomography (CT) scan to evaluate these fractures.

Von Laer,[6] who also emphasized the importance of CT scans for evaluating complex triplane fractures, described 2 types of intramalleolar triplane fractures—one extending outside the weight-bearing surface and the other extending into the tibial plafond at the junction of the medial malleolus. Feldman and colleagues[7] and O'Connor and Mulligan[8] described case reports of extra-articular, intramalleolar triplane fractures. These intramalleolar fractures were treated nonoperatively (with acceptable results) because of the extra-articular fracture pattern. Shin and colleagues,[9] in 1997, proposed 3 types of intramalleolar triplane fractures: I (intra-articular, within the weight-bearing zone), II (intra-articular, outside the weight-bearing zone), and III (extra-articular).

Osteochondral fractures of the talus are more common than triplane fractures. Osteochondral lesions are injuries to the dome of the talus where the cartilaginous fragments separate from the talar dome with or without the subchondral bone. Many terms, including talar dome lesion, osteochondritis dissecans, transchondral fracture, and osteochondral defect, have been used to describe these lesions.[10]

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In reviewing the literature, we found several reports of direct correlations between talar dome lesions and ankle injuries and fractures but did not find any reports of osteochondral lesions of the talus occurring with a triplane fracture of the distal tibia in adolescents. Sorrento and Mlodzienski[11] found that 38% of supination–external rotation stage IV fractures of the ankle were associated with lateral talar dome lesions (mean age, 44 years). Ferkel and Orwin[12] similarly reported that, of 288 ankle fractures, 79% had articular lesions.

In this article, we report the case of a 14-year-old boy who sustained an intramalleolar triplane fracture with an osteochondral defect of the talus and then present the results of our literature review.

Case Report

A 14-year-old boy presented to the office for evaluation of an ankle injury. Eight days before evaluation, he was lifting weights when he lost his balance and "rolled" his left ankle. He was examined in the emergency room and underwent closed reduction and received a cast. A CT scan of the ankle showed a triplane fracture of the distal tibia with an osteochondral defect of the medial talus. The patient was referred to a pediatric orthopedic surgeon for definitive treatment.

Physical Examination

The patient presented to the office for evaluation 8 days after his original injury. He looked to be a healthy 14-year-old boy. His left lower extremity was in a short leg cast (in good condition) and was neurovascularly intact. The knee had full range of motion.

Radiographic Examination

The emergency room radiographs showed a triplane fracture of the distal tibia (Figures 1A, 1B). An irregularity of the medial talar dome was also noted. Prior radiographs, which would have shown whether the defect had been present before the injury, were not available. The CT scan of the left ankle showed a fracture of the distal tibia extending from the posterior metaphysis of the tibia, anteriorly through the epiphyseal plate and medial malleolus (Figure 2). At the medial malleolus, the fracture entered the non–weight-bearing surface of the tibiotalar joint. There was minimal articular step-off. An osteochondral defect of the posteromedial talar dome was also noted. The fragment was detached without intra-articular displacement, corresponding to a Berndt and Harty stage III osteochondral fracture.

Figure 1. Obtained before closed reduction, initial emergency room anteroposterior (A) and lateral (B) radiographs of 14-year-old boy's left ankle show a triplane fracture of the distal tibia.

Operative Findings

The patient presented for surgery the next day, 9 days postinjury. A medial approach was made to the ankle, and then a medial malleolar osteotomy was performed to gain access to the medial talar dome. Intraoperative fluoroscopy was used to ensure that the osteotomy did not extend into the fracture site at the medial malleolus. Two holes (for cannulated screws) were drilled in the medial malleolus before completion of the osteotomy. The osteotomy site was made distal in the medial malleolus to avoid the open distal tibial epiphysis. The medial malleolar fragment was folded back to reveal the medial aspect of the talar dome. A 1×2-cm osteochondral lesion was noted on the medial weight-bearing surface of the talus. The cartilage was intact, but the fragment was depressed. The fragment was secured with 2 bioabsorbable nails (Smart Nails, Bionix Implants, Tampere, Finland). Solid fixation of the fragment was obtained.

Figure 2. Computed tomography scan shows the triplane fracture of the distal tibia with medial talar dome osteochondritis dissecans lesion. The fracture extends into the non–weight-bearing surface at the junction of the medial malleolus and the tibial plafond.

Figure 3. Immediate postoperative radiograph shows the cannulated screws from the medial malleolus osteotomy and the reduced ankle mortise.

Attention was then directed to the distal tibial triplane fracture. The articular surface of the distal tibia was clearly visible and intact throughout, except for a slight, 2-mm diastasis where the fracture entered the tibiotalar joint at the medial malleolus. This was in the non–weight-bearing area of the joint. An attempt at closed reduction was made, but, as the fracture was 9 days postinjury, it did not move. We decided to treat the triplane fracture in a closed manner rather than undo the healing that had occurred at the site. The medial malleolar piece was reduced and fixed with two 4.0 cannulated partially threaded screws through drilled holes; care was taken not to penetrate the distal tibial epiphysis (Figure 3). Intraoperative fluoroscopic images showed the ankle mortise reduced and the articular surface intact. The wounds were closed, and a short leg, univalve, non–weight-bearing cast was applied (the triplane fracture was stable intraoperatively).

Postoperative Course

One month postoperatively, the patient began progressive weight-bearing in the cast. Radiographs showed healing of the triplane fracture and incorporation of the osteochondral fracture (Figure 4). Use of the cast was discontinued, and the patient began increasing activity with physical therapy. At 3 months, the left ankle had almost full range of motion with only mild swelling over the medial malleolus. Radiographs showed a healed triplane fracture with closed distal tibia and fibula physes. The osteochondral fracture was healing. The patient was released to activities as tolerated.

One year later, the patient presented with complaints of swelling and pain in the left ankle. Apparently he had been doing well and had played sports that year. A few weeks before presentation, he noticed swelling and pain in the left ankle after strenuous uphill climbing. He denied injury. He had improved significantly with rest. Radiographs showed an intact ankle mortise and a healed medial malleolus (Figure 5). There was a small, bony ossicle in the anterior ankle at the anterior lip of the tibia. The osteochondral fracture was well healed and had only a subtle irregularity at the medial talus. We thought that the patient's pain was from impingement with strenuous hiking, given its acute onset and his lack of complaints after earlier, normal activity. The patient was treated conservatively, with rest and avoidance of pain-producing activities. His symptoms resolved, and he returned to activities as tolerated.

The patient returned for follow-up 4 years after his original injury. He said that he had occasional pain in the ankle but that it did not limit his activities. He denied locking, catching, or giving way of the ankle. Radiographs showed a residual irregularity of the medial talar dome (Figures 6A, 6B).

Discussion

Konig,[13] in 1888, was the first to describe osteochondritis dissecans (OCD) of the knee joint. He believed that the process was due to necrosis of the bone. Kappis[14]

Figure 4. One-month follow-up radiograph shows healing of the triplane fracture and incorporation of the osteochondritis dissecans lesion.

Figure 5. One-year follow-up radiograph shows the healed distal tibia without deformity and with subtle irregularity at the medial talus at the site of the osteochondritis dissecans lesion.

Figure 6. Anteroposterior (A) and lateral (B) radiographs at four-year follow-up.

described OCD of the ankle joint in 1922. Berndt and Harty,[15] in 1959, presented evidence that the etiology of the osteochondral fracture was more likely trauma than ischemic necrosis, as previously believed. Their cadaveric work showed that lateral lesions occur more commonly in the anterolateral talar dome and are produced by inversion and dorsiflexion of the ankle and that medial lesions occur posteromedially and are produced by inversion and plantarflexion of the ankle.

Classification Systems for Osteochondral Lesions

Berndt and Harty[15] also presented a radiographically based classification system of osteochondral fractures—the system most commonly used today. There are 4 stages in their system: I (compression of articular cartilage and subchondral bone), II (partially detached fragment without displacement), III (completely detached fragment without displacement), and IV (completely detached fragment with intra-articular displacement).

Other classification systems are based on magnetic resonance imaging (MRI) and arthroscopic inspection. These systems help in determining lesion stability, prognosis, and treatment options.

Nelson and colleagues[16] developed a classification system that uses MRI findings to address stage and stability of osteochondral lesions. There are 5 stages in their system: 0 (normal), 1 (signal changes consistent with articular cartilage injury with normal subchondral bone), 2 (high-signal-intensity disruption of articular cartilage with stable subchondral fragment), 3 (partial chondral attachment with thin high-signal rim behind fragment), and 4 (loose body or complete detachment of fragment in osteochondral bed). MRI can be used to evaluate articular cartilage, presence of fluid between fragment and bone, and fragment viability,[17] which can help in determining treatment and possibly in identifying which lesions to stabilize surgically.

Arthroscopy can also be used to evaluate and classify osteochondral lesions. It provides a more direct evaluation, although it is also more invasive. Guhl's original arthroscopic classification of OCD[18] has been modified by others.[19] In this system, stages progress from I (softening of cartilage) to IV (presence of a loose body).

Etiology and Incidence

Many authors[20–22] have supported the Berndt and Harty[15] theory that osteochondral fractures are most commonly caused by trauma. Reviewing the literature, Flick and Gould[20] found that 98% of lateral talar lesions and 70% of medial lesions were associated with a history of trauma. Canale and Belding[21] reported similar findings for 31 talar dome lesions: All the lateral lesions and 64% of the medial lesions were associated with trauma. Similarly, Pritsch and colleagues,[23] studying 24 patients with osteochondral lesions, found that 75% of both medial and lateral lesions were associated with trauma. Lateral lesions are more commonly associated with trauma than are medial lesions.[20–22] Results from these studies support the theory that trauma is the most common etiology of osteochondral fractures of the talus.

The incidence of osteochondral lesions of the talar dome with ankle injury has ranged from 38% to 79%, but little has been reported on osteochondral lesions of the talus associated with triplane fractures in adolescents.[11,12] Trauma has been found to be the most likely cause of osteochondral lesions of the talus, with lateral lesions (vs medial lesions) more commonly associated with trauma.[15,20–22] In addition, most articular cartilage lesions in children have a traumatic etiology.[24] The mechanism of inversion-type injuries in this patient population is consistent with the mechanism described by Berndt and Harty[15] for talar articular dome lesions.

Evaluation and Treatment

The Box at top right discusses the choice of imaging studies for evaluating triplane fractures and osteochondral lesions.

Optimal treatment of osteochondral lesions can be determined by integrating thorough history taking and physical examination with a combination of radiographic or arthroscopic diagnostic studies and classification systems.

Treatment of triplane fractures depends partially on displacement amount, articular involvement, and amount of residual articular displacement after reduction. Conservative treatment (closed reduction, restricted weight-bearing, casting) has been advocated for some triplane fractures, including extra-articular fractures, intra-articular fractures outside the primary weight-bearing area of the ankle, and fractures with less than 2 mm of articular incongruity.[7–9,26] Distal tibial articular surface displacement of 2 mm or more, after closed reduction, has been found to lead to less than optimal results and a high incidence of late symptoms.[26] Our patient's fracture was an intramalleolar triplane fracture at the junction of the medial malleolus and the tibial plafond and, most important, outside the primary weight-bearing surface. Lack of articular involvement of the weight-bearing dome and the presence of only 2 mm of incongruity, found at surgery, allowed for conservative treatment of this fracture—as opposed to the open reduction and internal fixation often required for more common triplane fractures.

Our patient's osteochondral defect, however, was treated with internal fixation. Indications for operative treatment of OCD lesions range from failed conservative treatment for more than 3 months to surgery for symptomatic lesions or loose fragments.[27] A trial of conservative management, including restricted weight-bearing and immobilization, is indicated for Berndt and Harty stage I, II, and medial stage III lesions. Surgical treatment is advocated for lateral stage III and all stage IV lesions.[28] Internal fixation of OCD lesions is usually indicated for large fragments associated with acute trauma in younger patients.[28] Our patient's OCD lesion was on the posteromedial talus and corresponded to a stage III lesion. Because of the acute nature of the ankle trauma, the size of the lesion, and the patient's young age, the fragment was stabilized with internal fixation.

Recommendations

Intraoperative inspection of the talar dome should be a routine part of open ankle fracture repair.[11] Also, if a child sustains a trauma that leads to a triplane fracture, a talar dome lesion should be suspected, given the association of trauma with talar osteochondral lesions. If lesions are suspected and not detected on plain radiographs, a CT scan should be used to assess not only the amount of articular involvement of the fracture but also the possibility of talar osteochondral lesion. In staging, assessing, and determining treatment for osteochondral lesion stability, MRI and perhaps arthroscopy may be useful. If an adolescent's triplane fracture requires operative stabilization, the possibility of osteochondral injury should be considered, and the talar dome articular surface should be inspected at the time of surgery.

Radiographic Evaluation of Triplane Fractures and Osteochondral Lesions

Triplane fractures can be diagnosed with plain radiographs, but the value of a CT scan in evaluating the complex nature of these fractures is well documented.[5,6,8] OCD lesions, on the other hand, can be difficult to diagnose using only plain radiographs. In one study, the diagnosis of OCD lesions was missed on plain radiographs in 43% of cases.[20]

CT scans or MRIs can be used to evaluate the articular surface if an osteochondral lesion is suspected in an ankle injury, especially in an ankle injury with an inversion component.[20,25,26] In the case of our patient, we used a CT scan to gain better understanding of the fracture pattern of the distal tibia as well as the extent of articular damage.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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