TRIPLANE FRACTURE OF THE DISTAL TIBIA WITH IPSILATERAL TIBIAL SHAFT FRACTURE: A Case Report

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Triplane fractures were first described by Johnson and Fahl in 1957.[1] In 1970, Marmor[2] identified three distinct fragments that result after these injuries: an anterolateral epiphyseal fragment, a posterior metaphyseal fragment that was attached to the remainder of the epiphysis, and the tibial shaft. Lynn[3] coined the term triplane fracture in 1972. The fracture line between the anterolateral epiphyseal fragment and the remainder of the epiphysis lies in the sagittal plane, the fracture line between the posterior metaphyseal fracture and the tibial shaft occurs in the frontal plane, and the fracture line which crosses through the epiphyseal plate courses in the transverse plane. On anteroposterior radiographs of the ankle joint the injury resembles a Salter-Harris type 3 fracture, and on the lateral radiograph the injury appears as a Salter-Harris type 2 fracture. Therefore, the injury is a Salter-Harris type 4 fracture.[3]

Kleiger and Mankin[4] attributed the configuration of Salter-Harris 3 injuries of the ankle to the asymmetry of closure of the distal tibial physis at the time of injury. The entire process occurs over a period of 18 months beginning with the central portion and progressing in a medial and then posterior direction, with the last portion to fuse being the anterolateral portion. They described an external rotation force through which the anterior inferior tibiofibular ligament avulses the anterolateral fragment from the epiphysis.

Dias and Tachdjian[5] proposed a classification scheme in 1978, that combined the Lauge-Hansen and the Salter-Harris classifications. Triplane fractures were compared to the juvenile Tillaux fracture. Both were described as external rotation and plantarflexion injuries and a classification system based on increasing forces was created. An isolated Salter-Harris 3 fracture of the distal tibial epiphysis was a Grade 1 injury, the triplane fracture was a Grade 2 injury, and a triplane fracture with an ipsilateral transverse high fibula fracture was a Grade 3 injury. The classification was created to assist with closed reduction of the deformity through reversal of the mechanism of injury. Later, Dias and Giegrich[6] modified this staging as follows: Grade 1 injuries include initially the anterolateral Salter-Harris 3 fracture and, with increasing pure external rotation force, the remainder of the epiphysis separates from the growth plate with an attached posteromedial metaphyseal fragment that varies in size, and Grade 2 injuries include an oblique fibular fracture in addition to the Grade 1 injury.

Also in 1978, Cooperman et al[7] found that a two-fragment configuration occurred more commonly than the previously described three-fragment configuration. One fragment consisted of the tibial shaft, medial malleolus, and the anteromedial portion of the epiphysis. The second fragment consisted of the remainder of the epiphysis and the posterior metaphyseal spike with the attached fibula. They used computed axial tomography (CT) to accurately assess these complex injuries. In 1981, Peiro et al[8] noticed 5 of 6 injuries were consistent with the two-fragment configuration. In 1985, Von Laer[9] noticed two different types of triplane fractures, those in which the fracture line stopped in the epiphyseal plate and those that continued through the epiphysis and into the ankle joint. They also used computed tomography (CT) to differentiate these two types. Feldman et al[10] studied the comparison of radiographs and CT for diagnosis of triplane fractures and found that CT was far superior over radiographs for determining fracture patterns. In 1988, Ertl et al[11] also supported the use of CT to diagnose this complex fracture. They were unable to predict the number and orientation of fragments using plain films only.

Of 200 triplane fractures reviewed in the English literature,[1-3,6-21] only 4 occurred with an ipsilateral tibial shaft fracture. Peiro et al[8] reported one case in their series that was treated conservatively, and Rapariz et al[12] noted three cases in their series in which only one was treated operatively with a uniplanar external fixator. Neither study mentioned the mechanism responsible for the double injury. The following case report describes our approach to this even more complex injury.

CASE REPORT

A 14-year-old boy was seen in the emergency room at Northlake Regional Medical Center immediately after sustaining an injury to the right leg and ankle from falling 8 feet from a tree. The patient related falling onto an

Figure 1. Initial anteroposterior radiograph of the leg taken in emergency room.

Figure 2A. Initial anteroposterior ankle radiograph.

Figure 2B. Initial lateral ankle radiograph.

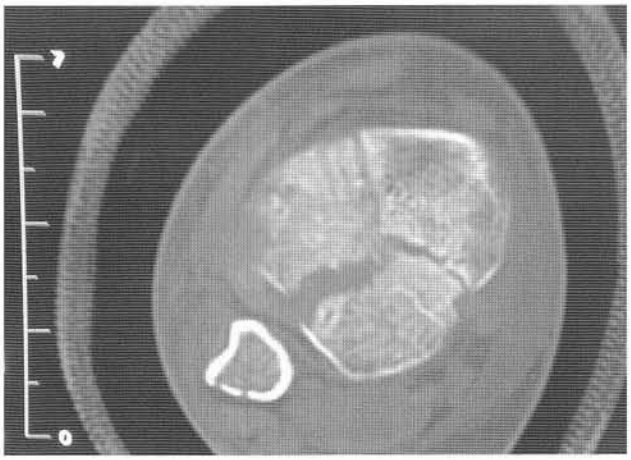

Figure 3. Computed tomography of the distal tibial physis.

externally rotated foot that bent back behind him upon landing. The patient had an unremarkable past medical history and denied pain at any other location. Physical exam revealed an edematous ankle and lower leg. Dorsalis pedis and posterior tibial pulses were easily palpable. Epicritic sensations were intact to the digits. No open lesions were noted. Mild valgus and recurvatum deformities were noted at the lower leg. The distal third of the leg and the ankle were painful on palpation. Severe pain was elicited with range of motion of the ankle.

An oblique fracture of the tibial shaft with mild anterior and medial angulation and 5 millimeters of shortening was seen on radiographs (Figure 1). A distal tibial physeal injury with a linear fracture line in the central aspect of the epiphysis extending into the ankle joint was seen on the anteroposterior ankle film (Figure 2A), and a posterior metaphyseal fragment was seen on the lateral ankle film (Figure 2B). A minimally comminuted oblique fracture of the fibula beginning at the level of the distal tibiofibular syndesmosis was also noted. The diagnoses of a tibial fracture, triplane fracture, and fibular fracture were made. Closed reduction was attempted under intravenous sedation; however, the tibial shaft fracture was unstable and would not maintain correction due to its oblique nature. The patient was placed into an above knee Jones compression cast. The treatment

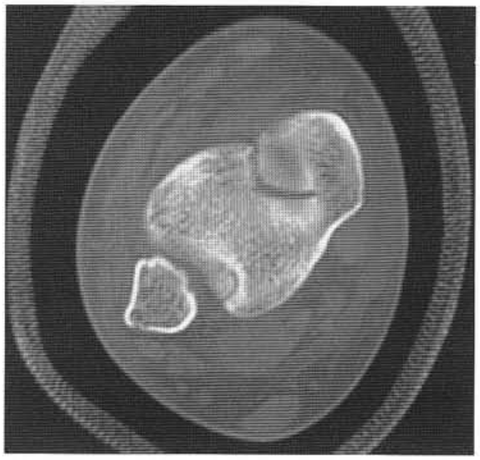

Figure 4. Computed tomography of the articular surface of the tibial plafond.

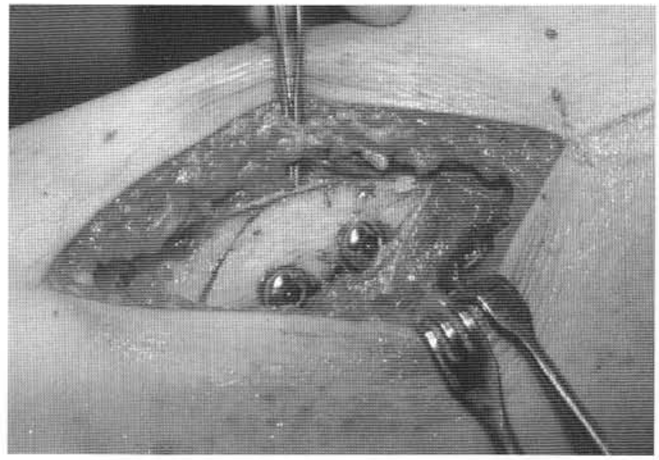

Figure 5. Intra-operative photo after internal fixation of the oblique tibial shaft fracture.

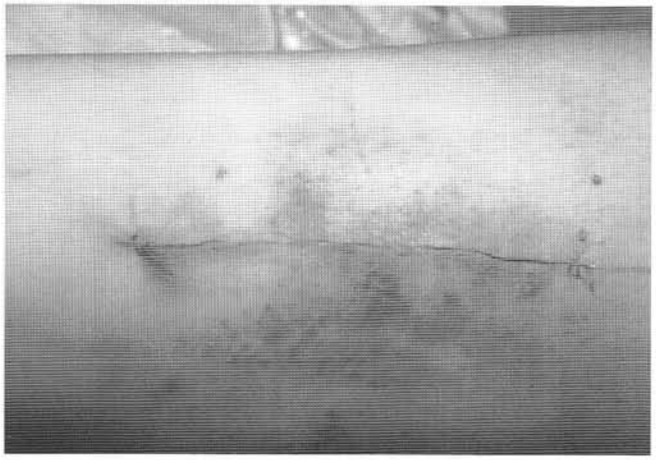

Figure 6. Incision after closure.

Figure 7. Above knee compression cast.

options were discussed with the patient's parents, and operative treatment was chosen.

The next morning, a CT was taken of the distal tibia and ankle (Figures 3, 4). A three fragment triplane fracture was seen with a fracture line exiting extra-articular from the medial malleolus. There were 8 millimeters displacement between the posterior and anterolateral fragments above the level of the joint. There was less than 2 mm displacement between the anterolateral and medial epiphyseal fragments. The patient was taken to the operating room and a second attempt at closed reduction was attempted under general anesthesia using miniature C-arm fluoroscopy. The oblique nature of the tibial shaft fracture complicated this attempt as well. The tibial shaft was then open reduced and fixated with two 4.5 millimeter cortical screws in anatomic alignment (Figure 5). The incision was closed in anatomic layers (Figure 6). The ankle was visualized under fluoroscopy and the fibula was distracted out to normal length and the triplane fracture was reduced to within less than one millimeter of displacement at the ankle joint. The ankle was placed through passive dorsiflexion and plantarflexion range of motion without crepitation. The leg was dressed with a sterile dressing, the foot was internally rotated, and an above knee cast was applied (Figure 7). Postoperative radiographs showed excellent reduction of all three fractures (Figures 8, 9). The postoperative hospital course was uneventful with the exception of a 102°F fever on the evening of postoperative day one. The patient's temperature was normal prior to discharge on the second day after surgery.

The patient was followed on an outpatient basis. The above-knee cast was changed to a below-knee cast after 6 weeks, with 25% weight bearing allowed with gradual increase. At 10 weeks, the patient was taken out of the cast and placed into an ambulatory cast boot. At 12 weeks, the patient was placed in an air cast ankle support. The patient was experiencing a decrease in pain in the

Figure 8. Postoperative mortise radiograph.

Figure 9. Postoperative lateral radiograph.

Figure 10. Five month follow-up lateral radiograph.

Figure 11. Five month follow-up anteroposterior radiograph.

ankle. At 5 months after surgery, the patient's only complaints were an occasional slight limp and discomfort with extreme activity and running. The ankle had full and pain-free range of motion with no crepitation. No evidence of limb length inequality was noticed. The patient began strengthening exercises for posterior muscle cast atrophy. Radiographs taken at this time showed excellent position with consolidation of the fractures (Figures 10-12). The epiphyseal plate was near complete closure. The patient was last examined 10 months after the injury and reported no symptoms. He was active in motorcross and running activities without any limitations. Ankle motion was unrestricted compared to the contralateral limb. There was no evidence of pain or crepitation with ankle motion. Repeat radiographs (Figures 13, 14) and CT scans (Figures 15, 16) showed

Figure 11. Five month follow-up anteroposterior radiograph.

Figure 12. Five month follow-up oblique radiograph.

Figure 13. Ten month follow-up lateral radiograph.

Figure 14. Ten month follow-up anteroposterior radiograph.

complete union of the tibial and fibular fractures. The triplane fracture also was well united with no disruption of the tibial plafond. There was only a 3 millimeter limb length shortage on the involved extremity (Figure 17).

DISCUSSION

Of the two articles[8,12] that mentioned this combination of triplane and ipsilateral tibial shaft fractures, only Rapariz et al[8] mention the use of external fixation for the treatment of the shaft fracture. They failed to discuss how they maintained the reduction of the triplane fracture with a uniplanar external fixation device on the tibia. In fact, neither paper described how they were able to achieve closed reduction of the shaft fracture and triplane fracture or suggested the mechanism responsible for these associated fractures.

It is widely accepted that the mechanism of injury

Figure 15. Ten month follow-up computed tomography axial view.

Figure 16. Ten month follow-up computed tomography coronal view of the ankle with no evidence of arthritis.

Figure 17. Ten month follow-up computed tomography scout film.

in the majority of triplane fractures is through external rotation forces. Dias and Tachdjian[5] developed a staging system for these injuries that was later modified by Dias and Giegrich.[6] External rotation forces the talus against the fibula placing the anterior inferior tibiofibular ligament under tension resulting in an avulsion fracture of the anterolateral epiphysis or triplane fracture depending on age of patient (Stage 1). Further external rotation forces are then transmitted through the fibula causing a spiral oblique fracture of the fibula (Stage 2). We propose a third stage to this classification in which continued external rotation is transmitted through the tibia because of the closure of the central and medial portions of the epiphyseal plate, resulting in an oblique fracture of the tibial shaft. We believe this particular injury occurred in our patient because after he landed on his foot and sustained a triplane ankle injury, his leg was caught behind his body as he rolled over on his side. Therefore, a continuous, high-level, external rotation force is needed to cause this rare injury pattern in patients with closed central and medial physeal portions.

Positive results following closed reduction of mildly displaced triplane fractures with internal rotation and casting have been reported throughout the literature1.[3,6-9,11,12,15-17,20-23] Closed reduction of physeal fractures is successful if there is no more than 2 millimeters of displacement.[24] The presence of an oblique tibial shaft fracture complicated the attempts at closed reduction in this patient. It was determined at the time of surgery that the proximal fracture should be stabilized in order to allow gentle manipulation of the triplane fracture. Following the open reduction of the tibial shaft fracture with internal fixation, restoration of the length of the fibula and reduction of the triplane fracture within one millimeter of anatomic alignment were observed. By reducing the major fracture, the remaining injuries were distracted out and pulled together by associated soft tissue attachments, thus avoiding further surgery in this particular patient.

CONCLUSION

The combination injury of triplane fracture of the distal tibia with ipsilateral tibial shaft fracture is a rare occurrence. With continuation of the extreme external rotation force following triplane fracture, a tibial shaft fracture could develop. Thus, we have proposed a third stage to Dias and Giegrich's classification of triplane fractures. Closed reduction of the mildly displaced triplane fracture can still be achieved after stabilizing the proximal fracture through open reduction with internal fixation as demonstrated in this case study. Despite the severe nature of this double injury, the patient healed with no complications.

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