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Treatment of Type III Tibial Intercondylar Eminence Fractures in Skeletally Immature Athletes

Brett D. Owens, MD, Gilbert K. Crane, MD, Troilus Plante, BS, and Brian D. Busconi, MD

Abstract

Our retrospective study of 12 skeletally immature athletes with type III intercondylar eminence fractures showed that arthroscopic evaluation with mini–open arthrotomy and repair of the tibial intercondylar eminence fracture with absorbable suture can be successful in repairing anterior cruciate ligament avulsion fractures and in helping such patients return to their athletic endeavors.

Fracture of the intercondylar eminence of the tibia is fairly common in children. This injury, which has been well described in the literature, is thought to be equivalent to rupture of the anterior cruciate ligament (ACL) in adults.[1–3] With stress, the incompletely ossified tibial eminence in the child fails before the ligament fails. This failure occurs through the cancellous bone beneath the subchondral plate.[4] In addition to disrupting ACL integrity, the fracture also can affect a variable portion of the articular surface of the tibia. This fracture rarely occurs before a child is 7 years old; it usually occurs between ages 8 and 14. Approximately half of children's tibial eminence fractures are caused by a fall from a bicycle. Mechanism of injury is thought to be forceful hyperextension of the knee or a direct blow on the distal end of the femur with the knee flexed.[5]

Meyers and McKeever[1,2] classified tibial eminence fractures into 3 basic patterns—type I (nondisplaced), type II (anterior third to half is elevated; posterior hinge is intact), and type III (avulsed fragment is completely displaced) (Figure 1). Zaricznyj[6] added type IV (fracture with comminution). Management of type I and type II fractures is generally straightforward and conservative. Management of type III fractures, however, is somewhat controversial, and various modes for reduction and fixation have been proposed.[1–3,5–7] There is also some dispute about amount of residual knee laxity and long-term outcome with type III fractures.

At our institution, we recently treated several young athletes who had sustained completely displaced ACL avulsion fractures, many of which occurred during a sporting event. In this article, we present our methods for treating and rehabilitating type III tibial eminence fractures in immature athletes.

Methods

We retrospectively studied 12 skeletally immature athletes (5 girls, 7 boys) who had undergone treatment for type III tibial eminence fractures between January 1994 and November 1998. Mean age of the patients was 11 years (range, 10–12.5 years). For 10 of the 12 patients, mechanism of injury was related to a sporting activity; for the other 2 patients, mechanism of injury was the more classical fall from a bicycle. Five of the 12 patients had associated knee injuries—2 medial collateral ligament (MCL) injuries, 2 lateral meniscal tears, 1 medial meniscal tear, and 1 patellar tendon avulsion. All 12 patients had knee pain, decreased range of motion, and hemarthrosis and were unable to bear weight on the injured leg immediately after injury.

Dr. Busconi used the same operative technique on all patients, and all patients received clinical and radiographic follow-up evaluations.

Each patient had diagnostic radiographs and then knee joint aspiration and attempted closed reduction. After failure of the closed reduction, a splint was applied, and the patient was scheduled for surgery. During surgery and with the patient under anesthesia, a thorough arthroscopic knee examination was performed using the standard anteromedial and anterolateral portals. Copious irrigation and a probe were used to remove hemarthrosis, and aggressive débridement of the fat pad was performed with a standard shaver for visualization purposes. At this point, the fracture fragment was visualized, and reduction was attempted (usually not possible with only 2 portals). Thorough arthroscopic examination of the knee joint was conducted, and any associated meniscal injuries were repaired. A mini-arthrotomy open repair was then performed through a small (~3 cm) vertical incision along the medial half of the patellar tendon. A medial parapatellar capsular incision was made, and the patellar tendon and remaining fat pad were retracted lat-

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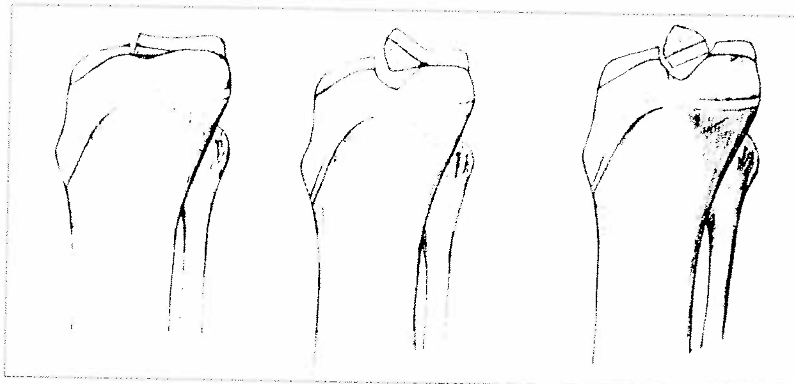

Figure 1. Meyers and McKeever classification.

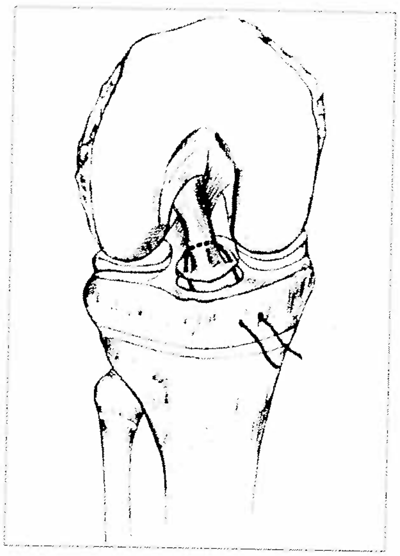

Figure 2. Diagram of technique as described.

erally. The fracture bed was then completely cleaned of clot and debris. A lacing or whip 0 polydioxanone suture (PDS) was placed through the base of the ACL at its attached bony fragment. Two small holes were then drilled in the proximal anteromedial epiphysis above the physis from a distal to proximal direction, exiting into the fracture defect. After the PDS was passed through these holes, the fragment was reduced snugly down into its bed, and the PDS was tied under tension over a bony bridge (Figure 2).

Postoperatively, 11 of the 12 patients underwent the same rehabilitation protocol: The knee was immobilized in a long leg-cast in extension for 4 weeks. The 12th patient, who had an associated patellar tendon avulsion, was casted for 6 weeks. At 4 weeks, a removable knee brace was applied to all patients, who then started motion from 0° to 90° and patella mobility exercises. The standard ACL rehabilitation protocol was undertaken after 8 weeks.

At final follow-up examination, patients were asked for details about any residual symptoms of pain, discomfort, loss of range of motion, weakness, or instability. As all these patients were active in sporting activities before injury, we sought specific information regarding when they were able to return to sports and at what level. A radiograph was taken at this follow-up examination. For both knees, range of motion was evaluated, and a complete clinical examination was conducted—including varus/valgus test at 20°, Lachman examination, pivot shift, anteroposterior drawer, and KT-1000 knee laxity comparison testing at 20° using the standard protocol. Postoperative and nonoperative knees were compared for loss of motion and instability.

Results

Mean time between injury and surgical repair was 3.1 days. All patients had positive Lachman and pivot-shift results. In addition, 2 of the 12 patients had grade II MCL injuries that were treated nonoperatively. For all patients, arthroscopy showed a completely displaced intercondylar eminence fracture, and mean size of fragments was 1.7 × 1.0 cm. For 5 of the 12 patients, the anterior horn of the lateral meniscus was trapped beneath the osteochondral fragment, and thus reduction was not possible.

All patients returned for follow-up examination; mean time to final follow-up examination was 36.3 months. Mean loss of flexion was 4°, and mean loss of extension was 1°. All fractures healed in a reduced position, as seen on radiographs. No patient had varus/valgus instability. Three patients had 1+ Lachman results. No patient had a pivot shift. On KT-1000 comparison testing, the operative side showed a mean increase of 1.1 mm in anterior laxity. The 3 patients with 1+ Lachman results showed a mean increase of 2 to 3 mm in anterior laxity on KT-1000 comparison testing. The 2 patients with 3 mm of laxity were the 2 patients who had sustained associated MCL injuries. The other patients had less than 1 mm of increased laxity. No patient complained of pain, decreased function, or instability. The patient with the associated patellar tendon avulsion and lateral meniscal repair complained of occasional aching in the knee after prolonged activity but was back to full sporting activity without limitation. All patients returned to athletics; mean time to return was 8.0 months. There were no postoperative infections, no deep vein thrombosis, no avascular necrosis, no neurovascular compromise, and no changes within the tibial growth plate.

Discussion

Although several articles have been written on tibial eminence fractures, there is no consensus regarding appropriate management of these injuries, and results are often confusing. Most of the studies involve results reviewed retrospectively over several years and both adult and pediatric fractures treated with various means of fixation. Although the number of patients included in our study is relatively small (12), these patients represent a well-defined group of young (10- to 12.5-year-old) athletes, all with type III intercondylar eminence fractures treated by a single surgeon using the same technique and essentially the same rehabilitation protocol. By comparison, of the 70 fractures reported by Meyers and McKeever,[2] only 10 of these were type III fractures in children, and 7 of these 10 fractures were treated with open reduction and suture fixation.

All 12 of our patients were athletes involved in a regular team sport—which accounts for why 10 of them were injured during a sporting event and only 2 had the more classical mechanism of injury of a fall from a bicycle. At our institution, we are seeing an increase in incidence of these fractures among children in the age group reported here. We believe that this increase is related to increases in participation and competition in various team sports.

In the literature, there is some disagreement regarding expected outcomes for intercondylar eminence fractures. Many earlier studies found that these fractures caused no instability and seldom any long-term di ability.[1,2,8,9] More recent studies have found that, despite anatomical closed or open reduction, some residual ligamentous laxity is inevitable, though seldom severe enough to limit activity.[4,10–14] Smith[13] found evidence of mild to moderate laxity in 13 of 15 children in his series and suggested that the cause of instability must be elongation of the ACL before failure of the bone. It has been suggested that before the ACL fails, it often stretches significantly (as much as 50%) before the fracture occurs.

Gronkvist and colleagues,[11] in their retrospective review of 32 patients, found 11 with residual symptoms or clinical instability. Willis and colleagues[14] found objective evidence of ligamentous laxity in 74% of 50 children. Wiley and Baxter[4] reported that 51% of the 45 patients in their study had instability on clinical testing, though none had a subjective feeling of instability. Wiley and Baxter found an increase of 3 to 4 mm in anterior translation in the type II and type III tibial spine injuries, regardless of whether they were treated with open or closed reduction. Of interest, of the 8 knees with type I injuries in their study, all had less than 1 mm of increased laxity as compared with their uninjured counterparts. If the ACL truly elongates before fracture, one might expect a similar amount of instability between type I and type III fractures that are anatomically reduced and maintained until healed.

Our group of knees with type III fractures, all of which were treated with open reduction and internal suture fixation, showed a mean increase of 1.1 mm (range, 0–3 mm) in anterior laxity over that of their uninjured counterparts. The 2 patients with an associated MCL injury had the most residual laxity (3 mm). Seven of our 12 patients showed no laxity increase on comparison testing.

In our preferred fixation method, we pass a suture through the base of the ACL and fracture fragment, down into the bony crater, and out through drill holes. This method allows us to tension the ACL, pull the bony fragment snugly down into its fracture bed, and secure the fragment there by tying the suture over a bony bridge. All this is done through a small (~3 cm) incision made along the medial side of the patellar tendon after arthroscopic evaluation and treatment of associated meniscal injuries.

Although arthroscopic techniques addressing intercondylar eminence fractures have been the subject of many recent reports,[15–17] our experience is that adequate reduction of the fragment is often difficult to obtain arthroscopically. We believe that there is little if any increased morbidity associated with mini-arthrotomy as compared with a pure arthroscopic technique in which percutaneous pins, staples, or screws are placed into the fragment. In addition, when pins or screws are used, a second procedure must be performed to remove them, or, if pins are left outside the skin, there is a potential risk for pin-site infection with possible tracking into the joint.

Conclusion

We agree with the recommendation that type III fractures be treated operatively to obtain proper tensioning of the ACL and secure internal fixation. Given the results of our study, we no longer believe that residual ligamentous laxity is inevitable. Arthroscopic evaluation with mini-open arthrotomy and secure suture fixation and tensioning of ACL avulsion fractures can be successful in repairing these fractures, decreasing or eliminating residual ACL laxity, and helping young athletes return to full participation in sports.

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This paper will be judged for the Resident Writer's Award.