Physeal-sparing Tibial Eminence Fracture Fixation With a Headless Compression Screw

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Abstract: Displaced tibial intercondylar eminence fractures frequently require operative fixation. Surgical techniques for fixation include the use of headed screws or sutures. However, these fractures commonly occur in skeletally immature patients, and current techniques violate the proximal tibial physis to maintain reduction and can result in growth disturbances. The authors present a physeal-sparing method for fixation of noncomminuted displaced tibial eminence fractures using a headless compression screw. They describe 2 skeletally immature adolescents in whom their technique provided maintenance of reduction until union and full return to activities.

The tibial intercondylar eminence is the nonarticular portion of the proximal tibia where the anterior cruciate ligament (ACL) and menisci attach. Avulsion fractures of the tibial intercondylar eminence represent approximately 14% of ACL injuries and more commonly occur in the pediatric population. Because of the possibility of bone healing, these injuries are amenable to direct repair. Treatment is dictated based on fracture displacement and the ability to obtain and maintain reduction.

Classification of these fractures, described by Meyers and McKeever,2,3 and modified by Zaricznyj,4 is based on displacement and guides treatment. Type I fractures are non-displaced, type II fractures are partially displaced with a posterior hinge, type III fractures are completely displaced, and type IV fractures are comminuted. Type I and II fractures may be treated nonoperatively using closed reduction and immobilization while in extension. Irreducible type II, III, and IV fractures are treated operatively.2,3,5

Open and arthroscopic techniques have been described in the operative management of tibial eminence fractures and typically involve the use of sutures or headed screws for fixation. When used in skeletally immature patients, these techniques involve either drilling or screw penetration of the proximal tibial physis.6-8 This creates the potential for growth disturbances, which have been reported after pediatric ACL reconstructions.9 The current article describes a physeal-sparing technique for fixation of displaced noncomminuted fractures using a headless compression screw.

SURGICAL TECHNIQUE

Patients are placed in the supine position and a tourniquet is applied high on the proximal thigh. The leg is placed into an arthroscopic leg holder at the level of the tourniquet such that the thigh is parallel to the ground. The nonoperative leg is placed into a padded well-leg holder in the lithotomy position. It is important to ensure that the leg is abducted sufficiently to allow for intraoperative imaging.

Once prepped and draped, an Esmarch bandage is used to exsanguinate the limb prior to tourniquet elevation. A high anterolateral portal is established, and a 30° arthroscope is inserted into the knee. A low anteromedial portal is made under direct visualization. A diagnostic arthroscopy is performed to evaluate all compartments of the knee to look for associated pathology. A diagnostic arthroscopy is performed to evaluate all compartments of the knee to look for associated pathology. An anteromedial portal is then made under direct visualization. A diagnostic arthroscopy is performed to evaluate all compartments of the knee to look for associated pathology.

Once diagnostic arthroscopy and associated pathology, if any, are addressed, attention is placed on the tibial eminence fracture. The fat pad is debrided to ensure that adequate visualization of the fracture is obtained. The fracture piece is then elevated and evaluated.
for comminution, which would preclude this technique (Figure 1A). The fracture bed is then debrided of any hematoma that would impede reduction with curettes and an arthroscopic shaver. The anterior horns of the medial and lateral menisci are evaluated to ensure they will not block reduction.

Reduction is then performed with the knee in a semi-extended position and with the aid of an Acufex posterior cruciate ligament tibial guide (Smith & Nephew, Andover, Massachusetts). Once anatomically reduced, the knee is slowly flexed while the Acufex guide holds the fracture in reduction. A Kirschner wire is then inserted percutaneously to assist in holding the reduction (Figure 1B).

Once the fracture is held in reduction, the guide wire for the headless compression screw is inserted. The starting point for the wire should be just medial or lateral to the patellar tendon near the insertion on the patella. This allows for a suitable angle to avoid the proximal tibial physis. The wire should enter the center of the fracture fragment and aim more horizontally to allow for a longer screw without penetration of the physis. The authors perform this portion of the procedure under fluoroscopy to ensure the proximal tibial physis is not violated.

Once the guide wire is inserted and its position is checked radiographically, a cannulated drill is used to drill the outer cortex and a cannulated headless compression screw is inserted over the wire (Figure 1C). Although any headless compression screw may be used with this technique, the authors prefer to use the standard Acutrak screw system (Acumed, Hillsboro, Oregon). The guide wires and Kirschner wire are then removed (Figure 1D).

Postoperatively, patients are immobilized in extension and restricted from weight bearing for 6 weeks. At that point, unrestricted range of motion (ROM) is initiated. Full activity is allowed at 12 weeks.

**Case Reports**

**Patient 1**

A 7-year-old girl fell from her bicycle onto her right knee. Significant clinical findings included no endpoint on Lachman testing and knee effusion. Radiographs showed a displaced type III tibial eminence fracture (Figure 2A). Surgical treatment was indicated, and the described surgical technique was performed. She was casted in extension for 4 weeks and instructed to remain nonweight bearing during this time. She was then allowed to begin ROM exercises and wear a knee immobilizer when ambulatory. At 3-month follow-up, she had full knee ROM and had achieved radiographic union of the fracture (Figure 2B).

**Patient 2**

A 15-year-old boy sustained an isolated injury to his left knee while playing football. Significant clinical findings were an inability to obtain full extension, no endpoint on Lachman testing, and knee effusion. Radiographs showed a type III tibial eminence fracture (Figure 3A). Surgical treatment was indicated, and the described surgical technique was performed. Postoperatively, he was placed in a hinged knee brace locked in extension and was instructed to remain nonweight bearing for 6 weeks. Weight bearing was then permitted, and he began ROM exercises. Ra-
radiographs at 6 months and 3 years postoperatively showed maintenance of reduction and progress to skeletal maturity (Figures 3B, C).

**DISCUSSION**

Tibial intercondylar eminence fractures often occur in skeletally immature patients. These fractures may require operative treatment if displaced and closed reduction methods fail to anatomically reduce the fragment. Arthroscopic-based procedures have been developed to provide a minimally invasive way to address these displaced fractures. Screw and suture techniques have been used to maintain reduction. However, these techniques violate the proximal tibial physis by transphyseal drilling or screw penetration. Growth disturbances can occur with transphyseal drilling and have been previously reported with pediatric ACL reconstruction.

In an effort to avoid potential growth disturbance, physeal-sparing methods have evolved and include suture and screw techniques. Vega et al. reported excellent results in a series of 7 patients with displaced tibial eminence fractures treated operatively. Fixation was obtained with a suture anchor anterior to the fracture at a 45° angle to avoid the physis and increase pull-out strength. Sutures were then shuttled through the substance of the ACL, and arthroscopic knots were tied with the knee of the ACL, and arthroscopic shuttle relays and suture retrieval. Screw techniques, although less technically demanding, may cause irritation and require a second procedure for removal. In addition, if the screw is left too proud, it may cause chondral damage. Retrograde screw fixation has been used to obviate the need for hardware removal. However, this technique requires the bone fragment to be 15 mm or larger in size.

Headless compression screw fixation allows a physeal-sparing method of managing these fractures without the need for hardware removal and the complexities of suture techniques. However, this technique requires the same prerequisites as headed screw fixation in that the fracture must be noncomminuted and of sufficient size to accept a screw.

To the authors’ knowledge, only 1 other study describes this technique in a skeletally immature population. Davies and McLaren described the technique and results of 4 children and 2 adults with displaced tibial eminence fractures fixed with an Acutrak screw. No clinical instability or complications were reported in any patient. Although this case series was limited by its low number of patients, its results correlate with the current study’s findings.

**CONCLUSION**

Headless compression screw fixation in skeletally immature patients offers a method of fixation without violation of the proximal tibial physis, the need for hardware removal, or the technical demands of suture passage. However, this technique has limitations. First, if a patient later requires ACL reconstruction, hardware removal may be challenging due to bone overgrowth. Second, the authors are unaware of any biomechanical studies that test a headless compression screw for this fracture. Therefore, they have remained cautious in the postoperative setting by limiting weight bearing and ROM in the first 6 weeks to allow bone healing. Further clinical and biomechanical studies are needed to evaluate this promising technique.
REFERENCES


