Suture Versus Screw Fixation of Displaced Tibial Eminence Fractures: A Biomechanical Comparison

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Purpose: Classification and treatment of tibial eminence fractures are determined by the degree of fragment displacement. A variety of surgical procedures have been proposed to stabilize displaced fractures using both open and arthroscopic techniques. Two common fixation techniques involve use of cannulated screws and sutures tied over an anterior tibial bone bridge. We are unaware of any biomechanical studies that have compared the strength of various techniques of fixation. **Type of Study:** Biomechanical study in a cadaveric model. **Methods:** Seven matched pairs of fresh-frozen human cadaveric knees were stripped of all soft tissue except the anterior cruciate ligament (ACL). Simulated type III tibial eminence fractures were created using an osteotome. Fragments of each matched pair were randomized to fixation with either a single 4-mm cannulated cancellous screw with a washer or an arthroscopic suture technique using 3 No. 2 Fiberwire sutures (Arthrex, Naples, FL) passed through the tibial base of the ACL and tied over bone tunnels on the anterior tibial cortex. Specimens were then loaded with a constant load rate of 20 mm/min, and load-deformation curves were generated. The ultimate strength and stiffness were computed for each curve. The failure mode for each test was observed. A paired 2-tailed *t* test was used to determine the statistically significant difference between the two methods. **Results:** Specimens fixed with Fiberwire had a mean ultimate strength of 319 N with a standard deviation of 125 N. Those fixed with cannulated screws had a mean ultimate strength of 125 N with a standard deviation of 74 N. This difference was statistically significant ($P = .0038$). There was no significant difference between the mean stiffness of Fiberwire constructs (63 N; SD, 50 N) and the mean stiffness of the cannulated screw constructs (20 N; SD, 32 N). The failure modes of the Fiberwire constructs included 1 ACL failure, 3 failures of suture cutting through the anterior tibial cortex, and 3 of suture cutting through the tibial eminence fragment. The single mode of failure for the cannulated screw constructs was screw pullout of cancellous bone. **Conclusions:** The initial ultimate strength of Fiberwire fixation of tibial eminence fractures in these specimens was significantly stronger than that of cannulated screw fixation. **Clinical Relevance:** It appears that Fiberwire fixation of eminence fractures provides biomechanical advantages over cannulated screw fixation and may influence the type of treatment one chooses for patients with tibial eminence fractures. **Key Words:** Tibial eminence fracture—Displaced—Screw fixation—Suture fixation—Biomechanics.

Fractures of the tibial eminence have been well described in the literature and are estimated to represent 14% of all anterior cruciate ligament (ACL) injuries.[1] These fractures have traditionally been considered more common in children and adolescents, but recent reports in the literature suggest tibial eminence fractures may occur just as frequently in adults.[1-5] Meyers and McKeever[6,7] originally classified tibial eminence fractures according to the degree of fragment displacement. In this classification, type III tibial eminence fractures are defined as those with complete separation of the bone fragment with no bone apposition. Their recommendations for treatment depended on the degree of fragment displacement. They recommended open reduction and internal fixation for all

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type III fractures. Although the reasons for the difficulty of closed reduction of displaced eminence fractures remain a debate, most researchers recommend surgical reduction and fixation of completely displaced fractures.[1,3,8-11] In addition, some advocate arthroscopy for proper diagnosis of all displaced fractures (type II and above), with subsequent fixation for completely displaced fragments.[1,12] Fixation of displaced tibial eminence fractures is most commonly achieved with screws placed directly through fragment, or with sutures passed through a tibial tunnel.[5,9,12-15]

There is little biomechanical information in the literature related to the fixation of tibial eminence fractures. No study has compared the initial fixation strength of tibial eminence fractures fixed with screws with that of fixation with sutures. Our hypothesis is that fixation of tibial eminence fractures with Fiberwire suture (Arthrex, Naples, FL) is biomechanically superior to fixation with partially threaded cancellous screws. The purpose of this study was to compare the initial fixation strength of displaced tibial eminence fractures fixed with a single 4-mm cannulated screw and washer complex with fixation with 3 No. 2 Fiberwire sutures. The study also serves to describe the stiffness and mode of failure of the 2 fixation methods.

METHODS

We used 7 matched pairs of fresh-frozen human cadaveric knees for this study. Specimens were stored at −20°C and allowed to thaw 24 hours before testing. Each knee was carefully dissected of all soft tissue with the exception of the ACL. Simulated type III tibial eminence fractures were created with a sharp osteotome. The fragments measured 1 cm × 2 cm and were 2-cm deep (Fig 1). The specimens of each matched pair were then randomized to 1 of the 2 treatment groups such that paired specimens received different fixation methods.

Specimens in the suture group were fixed with 3 No. 2 Fiberwire sutures. The sutures were passed through the ACL just above its insertion on the fragment using a 45° Arthrex SutureLasso. Two bone tunnels were created in a retrograde manner from the anterior tibial cortex into the fracture bed using a drill guide (ACL Set; Acufex, Mansfield, MA) and a 2.8-mm guidewire. The first tunnel was placed 2 cm distal to the articular surface and just medial to the tibial tubercle. The second tunnel was placed 1 cm medial to the first (Fig 2). The bone fragments were then reduced and the sutures tied over the bone bridge.

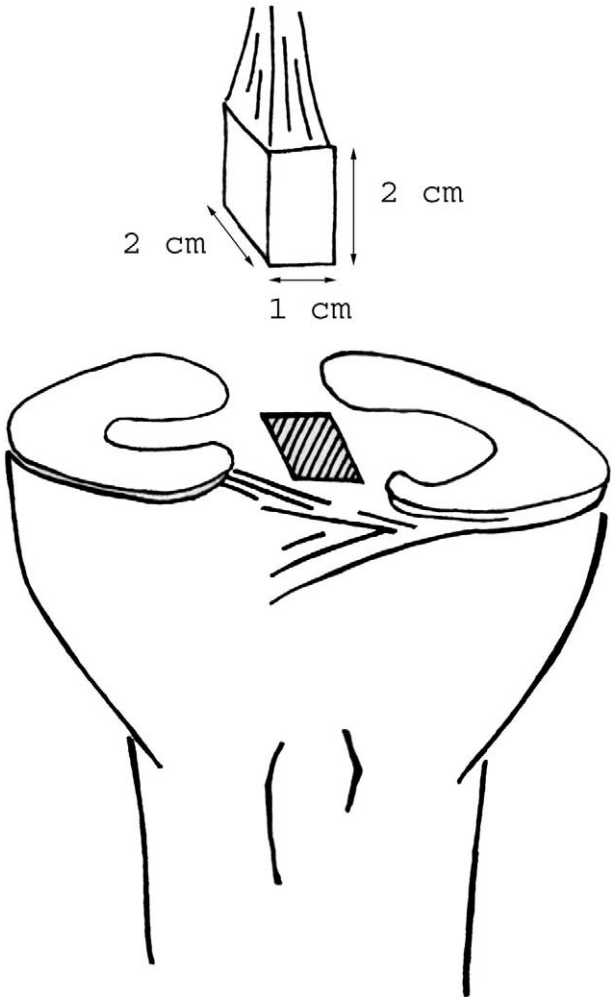

FIGURE 1. Simulated type III tibial eminence fractures were created with an osteotome.

Specimens in the screw group were fixed using a cannulated screw. Fragments were reduced and a guidewire was drilled through the center of the fragment at an angle 45° to the axial plane. The proximal cortex was then overdrilled with a 4-mm drill bit. A 4 × 40-mm partially threaded cannulated screw with smooth washer (DePuy Ace small fragment set; DePuy, Warsaw, IN) was placed over the guidewire. Care was taken to ensure anatomic reduction. The screw engaged only cancellous bone.

Specimens were mounted on a Materials Testing System-410 (Material Testing Systems, Dayton, OH) with the knee positioned in 30° of flexion. Tensile tests were performed according to the method of Tomita et al.[16] at a load rate of 20 mm/min. Load-deformation curves were generated for each specimen