What's New in Tibial Spine Fractures? A Review of the Literature from 2017 to 2019

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Introduction

Tibial spine, or tibial eminence, fractures most often occur in children and adolescents, though cases have been reported in adults as well.[1-5] Traditionally, the highest risk activity for tibial spine fracture was considered to be a fall from a bicycle, though following the popularization of recreational sports, non-contact injuries in soccer, rugby, and skiing have become more common.[2,6] Regardless of sport type, the underlying mechanism remains similar to an ACL tear, namely excessive knee flexion with external rotation of the tibia and resultant excessive axial loading of the joint.[7,8]

The Meyers and McKeever classification,[7] later modified by Zaricznyj,[9] clusters tibial spine fractures by severity and displacement and helps guide management. Non-displaced (Type I) fractures are typically managed non-operatively with cast immobilization, while the management of partially displaced (Type II) fractures is more controversial. Operative management is indicated for completely displaced (Type III) or comminuted (Type IV) fractures. Surgical correction can be done arthroscopically or openly with a variety of fixation methods, ranging from cannulated screws[10,11] to suture anchors[12,13] to Kirschner wires.[14]

With an incidence of 3 per 100,000,[15] much of the evidence regarding the management and long-term outcomes of tibial spine fractures comes from case reports or retrospective case series, leading authors to call for retrospective, multicenter or prospective studies.[16-18] These studies would allow orthopaedic surgeons to better evaluate treatment options, however, conducting these studies takes time. The goal of this review was to determine what progress has been made in the research on tibial spine fractures over the past two years.

Methods

We performed a literature review of PubMed for articles published between January 1, 2017 and March 6, 2019 using the search terms "tibial spine fracture," tibial eminence fracture," "tibial spine avulsion," or "tibial eminence avulsion." Articles were reviewed to determine their categorization and level of evidence according to the Journal of Bone and Joint Surgery's (JBJS) Levels of Evidence chart. Articles were also characterized by study type of Research, Technique, or Review.

Results

The search yielded 39 publications: 26 original research studies, 8 technique articles, and 5 reviews. Research studies were predominantly of lower level evidence with zero Level I and only two Level II studies published since 2017 (Figure 1). Technique articles were primarily from Egypt (n=3) and the United States (n=3), with France, Japan, and China each producing one Technique article during the review period as well. Review articles came from the U.S. (n=3), France (n=1), and India (n=1).

Discussion

Techniques

Over the past two years, much of the newly published literature on tibial spine fractures has focused on arthroscopic surgical techniques. The benefits of arthroscopic approaches include inspection of the cartilage, ligaments, and menisci for concomitant injuries, less post-operative pain and need for hospitalization compared to the more invasive open approaches.[18,19] Many of the articles were case reports of novel techniques, though the largest case series included 27 operative patients.[20]

Figure 1. JBJS Levels of Evidence of Literature Published on Tibial Spine Fractures since 2017. One Level II study was diagnostic. One Level III study was prognostic. The remainder were therapeutic studies.

Regardless of technique, the principles of surgical management remain the same: ensure optimal tensioning of the ACL to prevent future injury and ideal fixation of the fracture without disrupting the physis.[18,21] Traditional arthroscopic fixation of tibial spine fractures has involved either suture-based or screw-based methods of fixation.[22] Recently, some authors have proposed novel techniques, including looped cerclage wires for compression of comminuted fractures[19] and a self-tensioning knotless, absorbable suture technique that obfuscates the need for distal fixation.[23] Others have proposed using bioabsorbable nails[24] and resorbable magnesium screws[25] for fixation, and demonstrated minimal deficits in range of motion or complications at long-term follow-up. Alternatively, some authors have adopted devices originally intended for arthroscopic fixation of acromioclavicular (AC) joint.[26,27] These suspension sling devices typically require drilling through the avulsed fragment and leaving hardware in the joint, however, Aboalata et al. published their new four-point fixation technique that avoids these risks.[27]

Recent variations of suture-based methods have included utilizing a single tibial tunnel,[28] a combination of suture anchors and EndoButtons,[29] and suture fixation over a bony bridge.[30] Gamboa et al. have demonstrated success with a suture lever reduction technique, in which they drill a tunnel underneath, rather than into, the avulsed fragment, thus eliminating the need for provisional fixation.[31] Similar to the method proposed by DeFroda, Pandey et al developed a novel technique of tying two non-absorbable sutures over a bony bridge by using an intravenous cannula needle as a suture passer. At final follow-up, all twelve patients with Type III and fourteen with Type IV tibial spine avulsion fractures exhibited complete range-of-motion and no knee instability.[32]

Original Research

Beyond new techniques, recently published literature has also included multicenter studies on the incidence of concurrent meniscal injuries,[33,34] the largest retrospective study on the epidemiology of tibial spine fractures,[35] and a cadaveric biomechanical study comparing suture-based, screw-based, and suture anchor methods of fixation.[22] In 54 patients studied, Feucht et al found that nearly 40% of those undergoing surgical treatment for tibial spine fractures have meniscal injuries, with those who are older or more advanced in their Tanner staging being more likely to have concomitant meniscal injury. As the only prospective study published in the past two years, they found that 90% of injuries were to the lateral meniscus, and that just two tear types (longitudinal posterior horn and root detachment of the anterior horn) accounted for 50% of all tears.[33] Among the retrospective studies, the largest, with a sample size of 163, describes rates of meniscal entrapment and associated injuries, however, as a case series it is not able to provide comparative analyses of treatment or outcomes.[34]

Two additional retrospective case series analyzed the epidemiology of tibial spine fractures and rates of concurrent ACL injury.[35,36] Axibal et al found that organized sports-related injuries were a more common cause of tibial spine fractures than bicycle injuries in 122 patients studied (36% vs. 25%). Younger patients were more likely to have displaced (Type III) fractures, but there were no other significant predictors of Meyers and McKeever classification.[35] In an earlier study, the same authors identified concomitant ACL injuries in 25 of their 129 patients (19%), with higher rates in older male patients. Interestingly, they noted that pre-operative MRI had low sensitivity (0.09) in identifying ACL injury compared to intra-operative evaluation.[36] Another group compared outcomes between tibial eminence fractures and ACL tears in controls matched based on age, sex, skeletal maturity, and preinjury activity level and found that those with tibial eminence fractures had higher rates or arthrofibrosis and residual laxity, but did return to sport sooner and had similar rates of subsequent ACL injury.[37]

Finally, comparisons of fixation methods were investigated in 24 cadaveric knees.[22] Li et al showed that a modified suture fixation technique using neckwear knots and the suture bridge technique were superior to traditional suture or screw-based fixation in terms of ultimate failure load and fragment displacement, respectively. In the future, similar biomechanical studies should be conducted in humans to better evaluate the clinical implications of these findings.

Over the past two years, progress has been made in research on tibial spine fractures with many new published techniques, the largest epidemiology study to date, and two multicenter studies evaluating concurrent injury rates. Continued collaborative efforts through prospective, multicenter studies will be necessary to determine which surgical approaches and methods of fixation are best.

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