Tibial Spine Fractures in Children: Is there Historical and Geographic Variability in Epidemiology?

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Introduction

Tibial spine fractures are intra-articular avulsion fractures of the intercondylar eminence which tend to afflict younger, skeletally immature patients in the vast majority of cases.[1] In the pediatric patient, incomplete ossification of the tibial spine increases the vulnerability of this structure to injury compared to the anterior cruciate ligament (ACL) to which it attaches.[2,3] Thus, when patients between 8–14 years of age are exposed to the "classic" mechanism of deceleration, hyperextension, and/or rotation of the knee for ACL rupture, they may instead experience avulsion of the tibial spine rather than ligamentous tear.

Given the relatively rare nature of these injuries, the epidemiology is not well-understood. There have been several estimates reported from single centers, though the potential for historical and regional variability in activities and risk factors limits the generalizability of their findings. Thus, the aim of the present investigation was to characterize the epidemiology of tibial spine fractures at our single high-volume pediatric hospital.

Methods

After obtaining IRB approval, a respective chart review was conducted to identify patients who presented to our level 1 pediatric trauma center for a tibial spine fracture from 2009 to 2016. Information regarding patient demographics, injury mechanism/activity, and imaging reports were extracted from the electronic medical record. Fractures were classified according to the modified Meyers and McKeever method which groups the injuries as nondisplaced (Type I), minimally displaced with an intact hinge (Type II), completely displaced (Type III), or completely displaced and comminuted (Type IV).[2,4] Descriptive analyses were performed to evaluate the epidemiology of these fractures at a single center.

Table 1. Demographics of 64 patients with tibial spine fractures.

	Value
Age	12 ± 3 years (range 7–17)
Sex	63% Male
BMI	20.6 ± 4
Laterality (R/L)	50% Right
Meyers and McKeever Classification	Type I – 0% Type II – 33% Type III – 41% Type IV – 26%

All values are expressed as means ± standard deviations or percentages.

Results

Sixty-four patients with tibial spine fractures over an eight-year period were identified (Table I). The mean age at the time of injury was 12 ± 3 years (range 7–17) and 75% of patients were 14 years or younger. The majority of patients were male (63%). With respect to fracture severity, 33% of patients were Meyers and McKeever Type II, 41% Type III, and 26% Type IV. None of the patients with a recorded classification were Meyers and McKeever Type 1. Overall, 67% of the fractures were completely displaced (Types III and IV).

The majority (51%) of patients with recorded mechanisms of injury reported a contact injury, while 39% reported a non-contact twisting mechanism (Figure 1). Only 10% reported knee hyperextension. Of note, mechanism of injury was uncertain in 6 patients and not recorded in 19. With regard to activity at the time of injury, over half (53%) of patients were involved in sports and 21% of patients were riding a bike (Figure 2A). Less common causes included a fall from height (8%), riding a scooter (8%), motor vehicle accident (3%) and horseplay (2%). Of

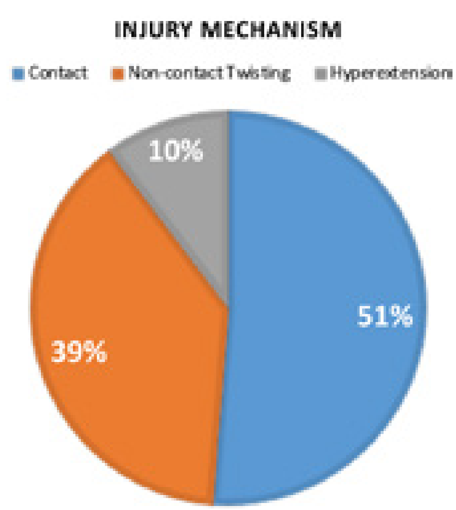

Figure 1. Reported mechanism-of-injury.

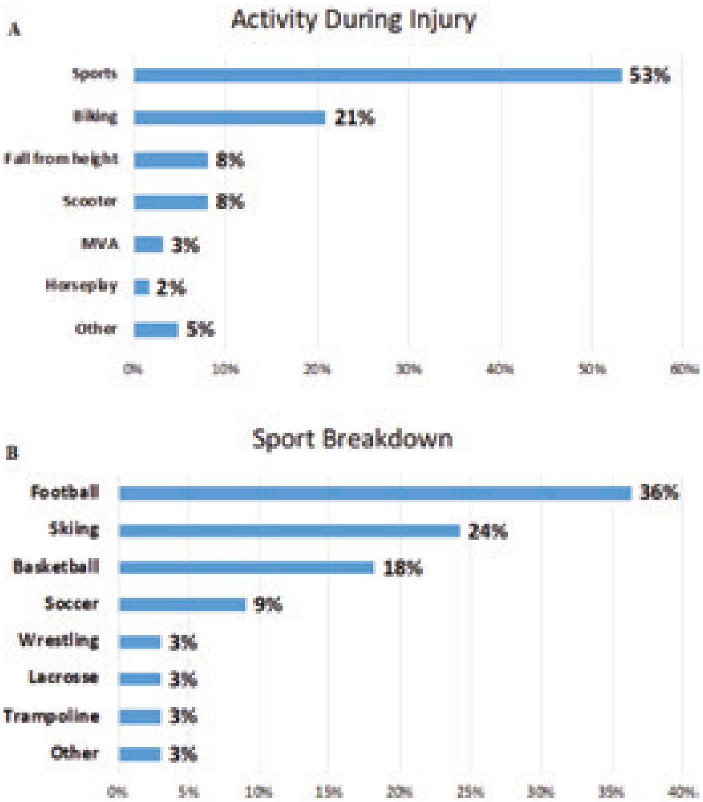

Figure 2. Activities **(A)**; and sports **(B)** at the time of injury.

those injured playing sports, football (36%), skiing (24%), basketball (18%) and soccer (9%) accounted for almost 90% of the injuries in this cohort. Wrestling (3%), lacrosse (3%), and a trampoline injury (3%) were each reported in one patient.

Of the 64 patients who presented to our center with a tibial spine fracture, 73% initially presented to a provider outside of our institution, including 23% to an orthopaedic surgeon, 6% to a pediatrician, and 44% to "other providers", which were most commonly outside emergency rooms or urgent care clinics.

Discussion

The epidemiology of tibial spine avulsion fractures has been reported in several small studies over the course of a few decades.[5] In one of the earliest descriptions of tibial spine fractures from 1970, Meyers and McKeever reported on 47 patients with these injuries and showed that 24 (51%) were injured in a bicycle accident.[2] In addition, only 21% of these fractures were completely displaced. Subsequent studies throughout the 1980s and 1990s reported similar findings[5–8] and bicycling was acknowledged as the top risk factor for this injury.

In the present study from our high-volume pediatric center, our findings suggest that sports-related injuries appear to have surpassed bike accidents as the top cause of tibial spine fractures, accounting for 53% in the present study. This finding is consistent with the growing popularity of competitive youth sports and year-round play, which has resulted in increased rates of several knee injuries in this patient population.[9–11] Our findings also strengthen the historical notion that these are injuries of young patients and that males are affected more frequently.

A large study in Colorado recently presented the epidemiology of this injury in 122 consecutive patients and ultimately showed similar findings, including a preponderance of sports-related injuries relative to biking accidents.[12] There were, however, a couple unique features of our cohort. First, while ACL ruptures and tibial spine fractures have most commonly been considered injuries resulting from a non-contact, twisting mechanism, contact injuries (51%) were actually the most common mechanism reported in our cohort. Second, the majority (67%) of patients at our center were diagnosed with completely displaced (Meyers and McKeever Type III or IV) fractures, in contrast to previous investigations which report mostly less severe (Type I or Type II) fractures.

There are a few possible explanations for these two findings. First, the higher proportion of contact injuries may be further evidence of the growing role of sports participation, since these are the patients at greatest risk for contact-induced knee injuries. Second, the increased fracture severity in our cohort may be explained by (1) the higher rate of contact-induced injuries, which may generate a greater degree of force through the ACL and its bony attachment to the tibia, yielding a greater degree of fracture displacement, or (2) possible selection bias in our cohort given the high rate of referral from outside institutions, including orthopaedic surgeons. Nonetheless, the link between injury mechanism and fracture severity should be investigated in future studies, as severity plays a significant role in determining treatment strategy.[1,13–15]

Conclusions

Ultimately, our study expands the existing literature which aims to understand the epidemiology of this rare injury. The patient demographics and mechanism of injury for tibial spine fractures appears relatively consistent across geographic distributions. However, the recent rise in youth sports participation, single sport specialization, and year-round play in pediatric athletes appears to have generated a new principal risk factor for this injury in sports participation.

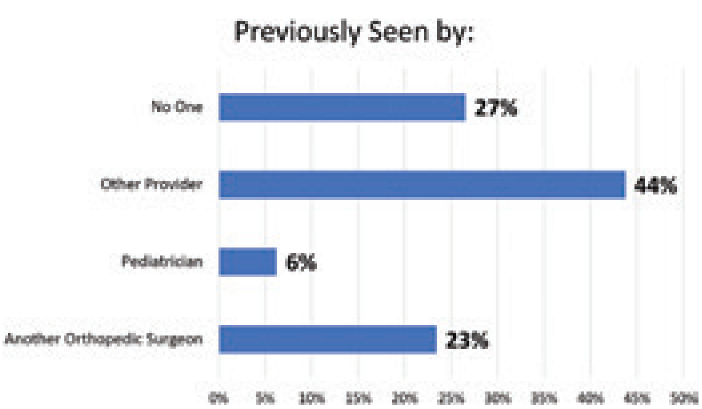

Figure 3. Initial evaluation of injury.

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