Tibial Tubercle Avulsion with Concomitant Patellar Tendon Avulsion in the Pediatric Population: A Case Series

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Introduction: Tibial tubercle avulsion fractures are a rare pediatric injury, representing less than 1% of all physeal injuries [1]. The tibial tubercle fracture was first classified by Watson-Jones and then by Ogden et. al. in 1980. This type of fracture results from a sudden contraction of the quadriceps muscle (i.e., jumping) or when rapid knee flexion occurs with contracted quadriceps (i.e., landing) [1]. Physically active adolescents between 13 and 17 years of age are at particular risk for this injury pattern. Osgood-Schlatter disease and high body mass index (BMI) have been suggested as risk factors, however, a relationship has not been proven due to the limited number of cases in studies [1]. There have been several proposed mechanisms of concomitant patellar tendon rupture including: 1) tubercle avulsion followed by rotation, 2) violent flexion of the knee in opposition to a contracted quadriceps, and 3) tibial tubercle avulsion with incompletely detached or incarcerated tubercle fragment leading to avulsion of the patellar tendon [1]. Simultaneous tibial tubercle avulsion with patellar tendon avulsion is a strong indication for expedited surgical repair, making identification crucial [1]. Potential indicative preoperative findings have been recommended, including an increased distance between the distal pole of the patella and the avulsed tibial tubercle fragment with knee flexion, loss of active knee extension, and the finding of calcified fragments below the patella [1,2]. Preoperative magnetic resonance imaging (MRI) provides definitive evidence; however, this is an inefficient use of resources given the low incidence of this injury and limited MRI availability [2]. Although individual case reports and small case series have described these injuries, there is a paucity of comprehensive studies focused on the identification and treatment of this combined injury pattern. The lack of comprehensive research contributes to uncertainties in clinical decision-making, resulting in variability in treatment protocols and potential suboptimal outcomes. This case series aims to characterize demographics, fracture classification, and preoperative radiographic data as potential markers for concomitant patellar tendon rupture, with a secondary aim of describing a surgical technique and recovery protocol that has shown promise within our practice.

Methods: After obtaining institutional review board approval, thirteen cases of tibial tubercle avulsion with concomitant patellar tendon rupture treated by fellowship-trained pediatric orthopaedic surgeons between 3/15/2019 and 6/13/2023 were retrospectively reviewed. Demographics, including age at injury, race/ethnicity, BMI, preexisting conditions, and laterality were recorded by two medical students and a research assistant. Population data on obesity rates were collected from the New York Department of Health Student Weight Status Category Reporting System (SWSCR). Radiographic data including Ogden fracture classification, fragment rotation, comminution, patellar displacement ratio, and fracture displacement were evaluated by an orthopaedic surgeon. When available, postoperative data, such as complications and time to recovery, were recorded. Descriptive statistics and non-parametric Mann-Whitney U tests were utilized for analysis and calculated using R statistical software.

Results: The patient's average age at injury was 14.8±0.9 years (median 15.0 years, range 13-16 years). All thirteen patients were male, with 46% Caucasian, 38% African American and/or Black, and 15% were of unknown race. BMI averaged 26.8±5.7 kg/m^2 (median 26.2 kg/m^2, range 19.3-37.4 kg/m^2). Our sample had 54% meeting BMI criteria for obese or overweight with a BMI greater than 25 kg/m^2, which is higher than the population of Erie County Middle/High school males (2017-2019) that are 36.2% overweight/obese. One (7.7%) patient had Osgood-Schlatter's disease. Predominantly, injuries occurred to the right limb (62%). Only Ogden II (54%) and III (46%) injuries were observed. Twelve patients (92.3%) had preoperative radiographs for analysis. The fragments were rotated by an average of 97.8±63.1 degrees (median 86.0 degrees, range 22-180 degrees). Class II fracture rotation averaged 153.7±30.9 degrees (median 162.5 degrees, range 110-180 degrees) while class III fractures averaged 42±18.0 degrees (median 41.5 degrees, range 22-62 degrees) ($p=0.005$). Three (25%) of the injuries included comminution. The patellar displacement ratio averaged 2.0±0.2 (median 2.1, range 1.6-2.2). Lastly, the fractures were displaced on average by 35.5±14.6mm (median 37.0mm, range 15-70mm). All patients were initially diagnosed with a tibial tubercle avulsion fracture, with the patellar tendon involvement noted by the surgeon after the initial incision was made and there was a rent noted in the extensor mechanism. The surgical technique executed for all cases was as follows: the fragment was reduced and secured with one or two cannulated screws while the patellar tendon was repaired with Krakow stitches and secured to the tibia via two holes drilled into the tibia just distal to the fracture. After closure, the patient was placed in a range of motion knee brace in extension and kept as toe touch weight bearing for four to six weeks. The patients made a full return to sports in an average of 20.5±2.2 weeks (median 20.7 weeks, range 17.4-24.3 weeks) with no reported complications.

Discussion: To date, there is a scarcity of literature characterizing the preoperative radiographic findings indicating that a patient with a tibial tubercle avulsion fracture may have a concomitant patellar tendon rupture, along with an absence of a standardized treatment protocol. This case series aims to identify characteristics of the patellar tendon rupture, such as the fracture fragment rotation and the patellar displacement ratio. Key observations include that all fractures were Ogden II or III, and all Ogden II fractures were rotated at least 110 degrees. Furthermore, we sought to describe the surgical technique and recovery protocol developed by our practice to promote optimal outcomes. Our technique has led to excellent outcomes for our patients, allowing them to return to their normal activities. This case series study's limitations include retrospective and observational study design with no possibility to establish cause-effect relationships, limited sample size, and incomplete data records, with one patient missing preoperative imaging due to x-rays performed at an outside practice. Future research should focus on comparing the results to tibial tubercle avulsion fractures without patellar tendon involvement to identify unique radiographic characteristics differentiating the two injury patterns and increasing the number of patients to clarify preoperative indications and investigate short- and long-term clinical outcomes of our surgical technique and rehabilitation protocols.

Significance/Clinical Relevance: This case series holds clinical significance as it centers on the investigation of demographic and preoperative radiographic findings, offering essential guidance to clinicians for the early recognition of tibial tubercle avulsion fractures with concomitant patellar tendon avulsion in pediatric patients. Additionally, our study describes a surgical and postoperative recovery protocol to optimize patient outcomes, facilitating a comprehensive understanding of this rare injury pattern by enhancing diagnostic and treatment strategies within the medical community.

References:

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