Incidence of tibial tubercle fractures in patients with and without Osgood-Schlatter disease

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INTRODUCTION:

Tibial tubercle apophysitis, also known as Osgood-Schlatter disease (OSD), is a common cause of anterior knee pain in adolescents. During this period of skeletal immaturity, the tibial tubercle apophyseal ossification center is at risk for injury due to its weakness relative to the patellar tendon. Stresses from quadriceps contraction with sustained running and jumping can cause repetitive microtrauma at the tibial tubercle apophysis.

Tibial tubercle fractures occur when quadriceps contraction causes acute injury of the tibial tuberosity. These fractures are relatively rare, accounting for <1% of all physeal injuries. Patients with OSD have been proposed to be at increased risk of tibial tubercle fractures, with prior literature estimating that ~23% of patients with such fractures have a history of OSD. However, there remains a paucity of robust literature analyzing this relationship.

In the current study, we analyze the incidence of tibial tubercle fractures in patients with and without OSD on a population level, utilizing a large, nationally representative insurance claims database. We hypothesized that the incidence of tibial tubercle fractures would be higher in patients with OSD.

METHODS:

A retrospective cohort analysis of the PearlDiver (PearlDiver Technologies, Colorado Springs, CO) database was performed by querying all patients diagnosed with OSD between January 2010 and October 2022. An OSD cohort of 146,672 patients was captured using International Classification of Diseases, 9th Revision (ICD-9), 10th Revision (ICD-10) billing codes, and age as inclusion criteria. A control cohort of 1,184,841 patients without a diagnosis of OSD was randomly generated. Student's *t*--test and -*chi*-square analyses were used to compare demographics between the OSD and control cohorts. Multivariable logistic regressions controlling for residual differences in age, sex, and obesity, were used to compare rates of tibial tubercle fractures, calculated at 1-, 3-, 6-, and 12-months after diagnosis of OSD.

RESULTS:

Patients with a recent history of OSD were found to have higher rates of tibial tubercle fractures than the control group at all measured time points ($p<0.001$). The one-year rate of tibial tubercle fractures was 0.62% in the OSD group. The incidence of tibial tubercle fractures in the OSD group was 627.3 cases per 100,000 person-years compared to 42.7 cases per 100,000 person-years in the control group ($p<0.001$). At the 12-month time point, 920 patients (0.62%) in the OSD cohort sustained a tibial tubercle fracture compared to 506 patients (0.04%) in the control group ($p<0.001$).

Obesity was associated with an increased risk of tibial tubercle fracture. At the 3-month mark, an elevated BMI was associated with significantly increased risk of developing a tibial tubercle fracture (aOR = 1.32, 95% CI, 1.13 – 1.54). This trend was also present at the 6-month (aOR = 1.30, 95% CI, 1.12 – 1.49) and 12-month (aOR = 1.26, 95% CI, 1.11 – 1.43) marks (all $p < 0.001$).

To control for the difference in maturation between males and females, we separated our findings by sex (**Table 2**). At the 12-month timepoint, the rate of tibial tubercle fracture was higher in the OSD cohort than the control cohort for both males (0.78% vs. 0.06%) and females (0.39% vs. 0.03%) (all $p < 0.001$). When comparing by sex within the OSD and control cohorts, males demonstrated a higher fracture rate ($p<0.001$).

When comparing demographics of patients with tibial tubercle fractures in each cohort (**Table 3**), there were significantly more male patients and patients with obesity that sustained fractures in the OSD cohort. With regard to sex, males comprised 75.5% of patients with fractures in the OSD cohort compared to 63.0% of controls. Similarly, 23.8% of patients with fractures in the OSD cohort were obese compared to 15.8% of controls (all $p<0.001$).

DISCUSSION AND CONCLUSION:

Our study is the first to our knowledge to investigate the incidence of tibial tubercle fractures in patients with and without OSD at a population level. The incidence of tibial tubercle fractures in the OSD group was 627.3 cases per 100,000 person-years compared to 42.7 cases per 100,000 person-years in the control group ($p<0.001$). We report a higher rate of tibial tubercle fractures in patients with OSD compared to controls at all measured time points ($p<0.001$). These findings support previous assumptions about the association between OSD and tibial tubercle fractures. We also found that male sex and obesity were associated with an increased risk of developing tibial tubercle fracture within both OSD and control groups.

In conclusion, we report a significantly higher incidence of tibial tubercle fractures among patients with OSD compared to healthy controls. Additionally, we demonstrate that male sex and obesity are risk factors for tibial tubercle fracture regardless of OSD diagnosis. This information may be useful to counsel patients and their families on the risk of tibial tubercle fracture after being diagnosed with OSD and may influence clinician recommendations regarding follow-up for patients with OSD.

Table 1. Rate of Tibial Tubercle Fractures

Timeline	Number of Tibial Tubercle Fractures		Unadjusted Analysis		Adjusted Analysis	
	OSD (n = 146,672)	Control (n = 1,184,841)	OR (95% CI)	p-value	OR (95% CI)	p-value
1 Month	530 (0.36%)	164 (0.01%)	26.20 (21.99-31.21)	<0.001	23.11 (19.40-27.68)	<0.001
3 Months	699 (0.48%)	242 (0.02%)	23.44 (20.25-27.13)	<0.001	20.36 (17.58-23.65)	<0.001
6 Months	797 (0.54%)	345 (0.03%)	18.76 (16.53-21.29)	<0.001	16.15 (14.21-18.38)	<0.001
12 Months	920 (0.63%)	506 (0.04%)	14.77 (13.25-16.47)	<0.001	12.69 (11.37-14.18)	<0.001

Table 2. Rate of Tibial Tubercle Fractures in Male and Female Patients

Male				
Timeline	OSD (n = 89,324)	Control (n = 515,763)	OR (95% CI)	p-value
1 Month	383 (0.43%)	103 (0.02%)	21.56 (17.27-26.69)	<0.001
3 Months	518 (0.58%)	155 (0.03%)	19.40 (16.21-23.22)	<0.001
6 Months	597 (0.67%)	221 (0.04%)	15.70 (13.45-18.31)	<0.001
12 Months	695 (0.78%)	319 (0.06%)	12.67 (11.10-14.47)	<0.001
Female				
Timeline	OSD (n = 57,348)	Control (n = 669,070)	OR (95% CI)	p-value
1 Month	147 (0.26%)	61 (0.01%)	28.18 (20.91-37.99)	<0.001
3 Months	181 (0.32%)	87 (0.01%)	24.35 (18.85-31.44)	<0.001
6 Months	200 (0.35%)	124 (0.02%)	18.88 (15.09-23.62)	<0.001
12 Months	225 (0.39%)	187 (0.03%)	14.09 (11.60-17.11)	<0.001

Table 3. Demographics of patients with tibial tubercle fractures

Demographic	OSD (n = 920)	Control (n = 506)	p-value
Age, mean ± SD	13.1 ± 2.3	13.3 ± 3.0	0.148
Sex, n male (%)	695 (75.5)	319 (63.0)	<0.001
Obesity, n (%)	219 (23.8)	80 (15.8)	<0.001