

# Tibial tubercle avulsion fracture clinical and epidemiological features in Chinese teenagers

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## Abstract

**Background** : Tibial tubercle avulsion fractures in toddlers are uncommon. Accumulated information on clinical and epidemiological features of this fracture is important for clinical colleagues to deal with such fractures successfully.

**Methods** : Clinical and epidemiological parameters from 29 patients with tibial tubercle avulsion fractures treated at our hospital in the previous 7 years were examined retrospectively.

The study included 29 adolescents with 30 tibial tubercle fractures. They were all males, with an average age of 13.8 (12-15) years and a Body Mass Index (BMI) of 26.4. (19.2-34.3). According to the statistics, 41.4% of injuries happened while jumping, and 1 (3.4%), 12 (41.4%), and 16 (55.2%) patients were injured bilaterally, on the right and left sides, respectively.

Type I (4), II (3), III (13) and IV (10) fractures were identified in the individuals. Two patients (three knees) with type IV fractures were treated with close reduction and plaster immobilisation for six weeks. One patient with a type IV fracture received close reduction and was stabilised with two cannulated screws. The remaining 26 cases were fixed with two

or three cannulated screws after open reduction. The typical follow-up period was 38 (14-98) months, with no complications. Twenty-seven patients had good results.

**Conclusion** : In Chinese adolescents, tibial tubercle avulsion fractures are more prevalent in boys with a higher body weight; jumping is the most common cause of injury; and treatments are effective regardless of fracture type.

## Introduction

The tibial tubercle develops in four stages: cartilaginous, apophyseal, epiphysal, and bone. 1 2 The proximal tibial epiphysis shuts posterior to anterior and then distally to the tubercle apophysis, exposing the tuberosity to fracture. 1 Nonetheless, tibial tubercle fractures are rare in children, accounting for only 0.4%-2.7% of paediatric fractures and less than 1% of all physeal injuries. 3-5 Tibial tubercle fractures are most common in teenagers between the ages of 13 and 17. It corresponds to the growth and fusion of the proximal tibial epiphysis with the tibial tubercle apophysis. 6 A rapid contraction of the patellar tendon frequently causes a tibial tubercle avulsion fracture.

Because tibial tubercle avulsion fractures are uncommon, accumulated information on clinical and epidemiological features of this fracture is important for clinical colleagues to deal with such fractures effectively. In this report, we examined all tibial tubercle avulsion fracture cases treated in our hospital in the previous 7.5 years.

## METHODS

### Patients

From January 2012 to June 2019, records of patients with tibial tubercle avulsion fracture who received treatment at our facility were examined. Multiple fractures, exposed fractures, pathological fractures, and systemic disorders were not allowed in the patient population. This study included 29 patients with a total of 30 fractures. Age, gender, weight, Body Mass Index (BMI), mechanism of injury, involved side, clinical and radiographic examinations (X-ray and CT), treatment and adverse effects, as well as results, were examined for each patient. According to the modified Watson-Jones classification-fractures were classified as follows<sup>7</sup>: type I, fracture

distal to the junction of ossification center of tuberosity and proximal tibial epiphysis; type II, fracture extends into the junction of proximal tibial physis; type III, fracture extends to the joint through proximal tibial epiphysis; and type IV, fracture extends transversely through proximal tibial physis. The results were assessed, and three categories of performance were determined: poor (range of motion is limited to more than 20°, and symptoms are present with daily or minimal exercise), fair (range of motion is limited to less than 10°, and symptoms are present with vigorous and full activity), and outstanding. (range of motion is normal, asymptomatic, or full activity).

## Statistical analysis

The clinical and epidemiological characteristics of the tibial tubercle avulsion fracture in Chinese adolescents are presented in this study primarily using descriptive statistics. Continuous variables are expressed as mean with range, while categorical variables are stated as frequencies with percentages.

## RESULTS

### Summary of clinical and epidemiological features

In the last 7 years and 5 months, we located a total of 29 individuals who had 30 tibial tubercle fractures. As shown in table 1, all of the patients were boys with mean age of 13.8 years, body weight of 71.8 kg and BMI of 26.4; 12, 16 and 1 fractures occurred in right, left and both side(s); 8 (27.6%) and 11 (37.9%) injuries happened while playing basketball and running, respectively, and the most common injury mechanism was jumping during activities (41.4%). Fractures that fall into types I, II, III, and IV of the modified Watson-Jones categorization are 4 (13.3%), 3 (10.0%), 13 (43.3%), and 10 (33.3%), respectively. Type III and IV fractures make up the majority of cases. The majority of the individuals are overweight. Thirty percent of fractures are caused by normal weight condition. Due to a lack of patients, we are unable to make any inferences regarding the association between various fracture kinds and BMI. A type I fracture in one patient was accompanied by patellar tendon avulsion, and a type III fracture in another patient was accompanied by medial meniscus damage. There were no documented preoperative complications. After surgery, one patient developed a tissue infection that was treated before release.

In cases where the fracture showed clinical and radiographic union, the plaster was taken off six weeks after the operation. Following the removal of the cast, weight bearing under

protection, active knee flexion and extension, and quadriceps-strengthening routines were all started. The follow-up period lasted an average of 38 (14 to 98) months. Up until the most recent follow-up, no problems were discovered. Two patients (6.9%) were rated as having a fair result, while 27 patients (93.1%) had an excellent outcome. At the most recent follow-up, one of these patients had a slight limp when running, and another patient experienced discomfort when flexing excessively.

## DISCUSSION

Rare as it is, tibial tubercle fracture always affects teenage males. The higher percentage of teenage males who engage in jumping activities could be a contributing factor.<sup>1</sup> According to Ogden and Southwick,<sup>9</sup> there was some uncertainty regarding the relationship between tibial tubercle injury and Osgood-Schlatter disease. Three of the 19 kids with Osgood-Schlatter disease were present, according to Frey et al.<sup>10</sup> However, there is no research indicating a connection between Osgood-Schlatter disease and tibial tubercle fracture.<sup>1</sup> Osgood-Schlatter disease was not present in any of our cases. All of our patients were male, with an average age of 13.8 years. Jumping-related behaviors accounted for 41.4% of all injury mechanisms. These characteristics line up with earlier accounts from countries other than China.

19 tibial tubercle fracture cases were examined by Riccio et al.<sup>16</sup> The usual BMI at the time of the follow-up is 28.8. (18.5–43.8). According to Shin et al.<sup>17</sup>, there was insufficient data to conclusively demonstrate that having a high BMI would raise the risk of fractures. In their study, the average BMI is 24.3. (16.0–31.1). Our series' average BMI is 26.4 (19.2–34.3), which indicates overweight. It is debatable whether there is a link between BMI and fracture. Obesity is believed to increase the risk of lower extremity fractures in children.<sup>18</sup> <sup>19</sup> The increased chance of fractures among children of normal weight compared to underweight children has been demonstrated to be proportional to BMI, according to Sabhaney et al.<sup>20</sup>

Left-sided injuries predominate in some of the texts.<sup>14</sup> <sup>21</sup> In a single-leg jump, a right-handed basketball player's left leg is the push-off leg<sup>14</sup>; however, not all studies back up this assertion. Eight left-sided and ten right-sided injuries were recorded by Frey et al.<sup>6</sup> In our 29 cases with 30 fractures, left-sided injuries accounted for 55.2% (16/29) of the fractures, while right-sided injuries accounted for 41.4% (12/29) of the fractures.

The fracture was first divided into three kinds by Sir Reginald Watson-Jones<sup>22</sup>, with type I involving a fracture through the tibial tubercle itself. Type II fractures break at the proximal tibial physis. The proximal tibial epiphysis is the entry point for type III fractures into the joint. This classification was modified in 1980 by Ogden et al<sup>7</sup>, who divided the prior fracture types into group A (non-comminutive fractures) and B. (comminutive fractures). The fourth form of fracture, a fracture of the tibial epiphysis with posterior extension, was introduced by Ryu and Debenham<sup>23</sup> in 1985. We discovered 4 type I fractures, 3 type II fractures, 13 type III fractures, and 10 type IV fractures in our subjects.

Meniscal injuries and patellar or quadriceps tendon avulsions have been associated with tibial tubercle fractures; the overall rates range from 10% to 20%.<sup>13 14 24</sup> These were infrequently noticed among our patients. In our research, one patient had a type I fracture with a patellar tendon avulsion, and a type III fracture with a medial meniscus injury. However, this could be a mistaken impression brought on by a lack of use of more sophisticated medical imaging techniques, like MRI, to detect comorbid injuries like meniscus injury. Another harm that was related was preoperative compartment syndrome, which occurred 4% of the time.<sup>14</sup> None of our patients had this situation. One explanation might be that we quickly conducted close or open reduction and fixation. (an average of 2.3 days)

Regardless of the type of fracture, treatments for tibial tubercle fractures produce satisfactory clinical results, but not all outcomes assessed by subjective validated surveys are.<sup>16</sup> In our study, two patients with fractures of type IV underwent close reduction and cast immobilization for 6 weeks; one patient with fracture of type IV underwent close reduction and was fixed with two cannulated screws; and the other 26 fractures underwent open reduction and were fixed with two or three cannulated screws. During the 14–98 months of follow-up with our patients, 27 had outstanding outcomes, and 2 had fair outcomes; no complications were found at the most recent follow-up.

## CONCLUSIONS

Boys in their adolescence who are overweight tend to have more tibial tubercle fractures. The most frequent action leading to injury is jumping. Regardless of the type of fracture, treatment guarantees a positive clinical result. A mild displaced fracture may be managed conservatively; more severe

displaced fractures typically necessitate internal fixation and open reduction.

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