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An unusual Ogden type V tibial tubercle avulsion fracture: a case report and literature review

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Abstract

Background Ogden type V tibial tubercle avulsion fracture is an unusual type of physial injury. Thus, little is known about its mechanism of injury and treatment. The type of osteosynthesis is variable and depends on the experience of the surgeon. We commonly used cancellous screws fixation combined with tension band wiring for displaced fracture of the anterior tibial tuberosity.

Case presentation The present manuscript describes a case of a Han nationality 13-year-old boy who presented with severe pain of the left knee, which began after landing following a high jump. He had no significant past medical history apart from a high body mass index of 30.3. Radiographs revealed that he had an unusual Ogden type V tibial tubercle avulsion fracture. He was treated by open reduction and combined fixation with cannulated screws and tension-band wiring. After 3 months, the fracture healed without any complications or knee symptoms with full range of motion. He underwent reoperation for symptomatic hardware, which was removed at 5 months after initial surgery, and returned to his prior level of sporting activity at 1 year follow-up.

Conclusion Our case suggests that excellent functional outcome could be achievable by open reduction with the combination of internal fixation and tension-band wiring for Ogden type V tibial tubercle avulsion fracture. This type of osteosynthesis could not only achieve anatomical reduction and stable fixation for such fractures, but also avoid further damage to the proximal tibial epiphysis, which prevents serious complications, such difference in leg length.

Keywords Ogden type V, Tibial tuberosity avulsion fracture, Cannulated screws, Tension-band wiring, Excellent functional outcome

Background

Fractures of the tibial tuberosity are uncommon, comprising less than 1% of all physial injuries and approximately 3% of all proximal tibial fractures [1]. In the reports reviewed, the commonest fracture type is type III. Almost half of all tibial fractures are Ogden type III (with intra-articular involvement) and only 2% are Ogden type V [2–4]. So Ogden type V tibial tubercle avulsion fracture is an unusual type of physial injury rarely reported previously in literature [2, 5]. None of them discussed the details of treatment. Herein, we report a case of Ogden type V tibial tubercle apophysis avulsion fracture, which

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was treated by open reduction and combined fixation with cannulated screws and tension-band wiring. The fracture healed uneventfully without further knee symptoms. He returned to his prior level of sporting activity with full range of motion and good strength at 1 year follow-up. Informed consent was obtained from this patient and his parents prior to publication of this case report.

Case presentation

A 13-year-old boy of Han nationality presented to our hospital's emergency department with severe pain in his left knee after landing from a high jump while playing basketball about 1 hour prior. He was unable to weight-bear immediately after sustaining the injury. His knee was swollen with a moderate joint effusion. Of note, he weighed 90 kg, and his body mass index was 30.3. There was no evidence of neurological or vascular deficits in the emergency department clinical examination. He was immediately sent to the radiology department for further examination. Radiographs of the patient's left knee showed an obviously migrated anterior intra-articular fracture fragment and a occult fracture line through the proximal tibial physis into the posterior tibial metaphyseal cortex (Fig. 1). Computed tomography images revealed a fracture through the physis of the proximal tibia—an Ogden IIIB fracture associated with a Salter–Harris type IV fracture of the proximal tibia (Fig. 2a, b). He was admitted to hospital for further treatment with a long leg cast of the left lower limb. Magnetic resonance imaging (MRI) examination of the injured knee was performed on the second day of admission. The fracture features were most clear in sagittal view MRI (Fig. 3). Coronal view MRI of the left knee showed that the proximal tibial growth plate was not closed (Fig. 4). The patient was taken to the operating room 3 days after sustaining the injury and placed in a supine position. A midline incision was made for a presumed open reduction and internal fixation. The fracture bed was carefully cleared of debris. A periosteal flap was found to be folded under the avulsed fragment, and it was extracted. An obviously migrated tibial tubercle fragment was found intraoperatively (Fig. 5). The fracture was then reduced and fixed surgically with three 4.0-mm cannulated screws, which were placed parallel to the growth plate in an anterior-to-posterior direction. Another two cannulated screws were fixed to enhance stability. Internal fixation was supplemented by tension-band wiring in a figure-eight fashion (Fig. 6a, b). Two K-wires were drilled into the tibial tubercle in an anterior-to-posterior direction distal to the growth plate of the proximal tibial epiphysis, and then titanium cables were driven proximally to the two initially placed K-wires and distally around the anterior cortex of the upper tibial diaphysis (Fig. 6a, b). The periosteum was sutured, and the skin was closed without a drainage tube. Cast immobilization was applied for the first 4 weeks, guarded physiotherapy (with a protective knee brace) was started after 4 weeks, including active flexion and extension of the knee and quadriceps-strengthening exercises.

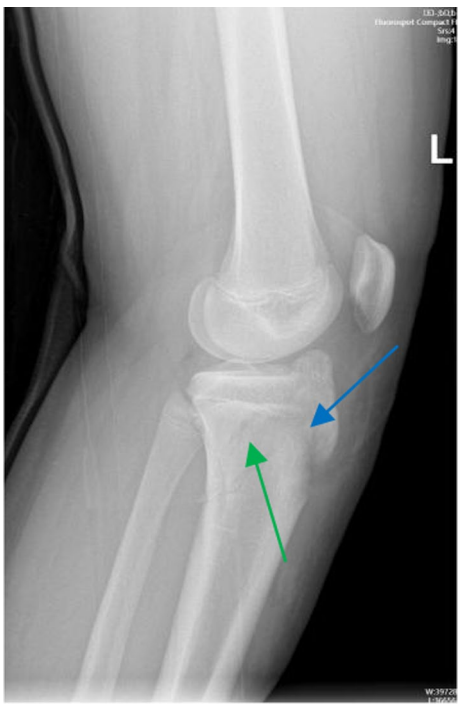

Fig. 1 Lateral view radiographs of left knee after injury showed an obviously migrated anterior intra-articular fracture fragment (blue arrow) and a occult fracture line through the proximal tibial physis into the posterior tibial metaphyseal cortex (green arrow)

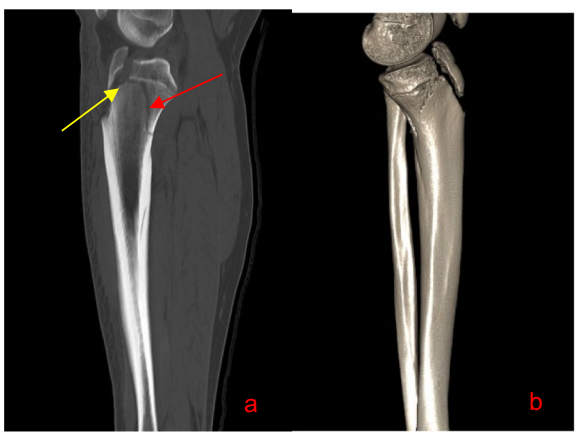

Fig. 2 **a**, **b** Sagittal view (**a**) and three-dimensional (**b**) computed tomography images show Ogden Type V tibial tubercle avulsion fracture, which combined Ogden type IIIB (yellow arrow) with Ogden type IV (red arrow) fracture of the proximal tibia of left side

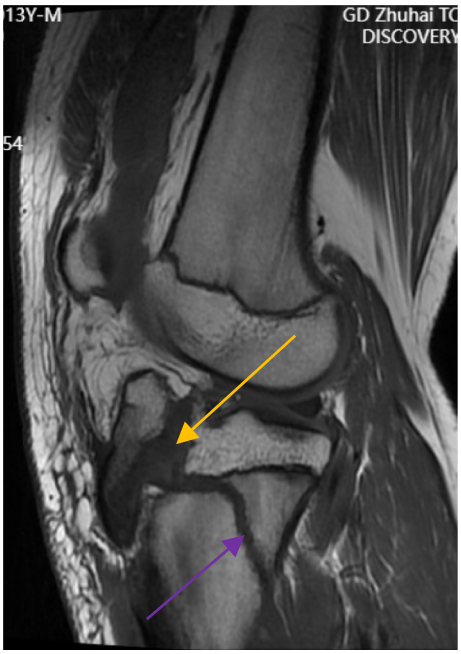

Fig. 3 Sagittal T1-weighted magnetic resonance image shows a migrated intra-articular fracture fragment extension through the physis and epiphysis into the knee (orange arrow) and a visible fracture line through the proximal tibial physis into the posterior tibial metaphyseal cortex (purple arrow)

Fig. 4 Coronal T1-weighted magnetic resonance image of the left knee show that the growth plate of the proximal tibia was not closed

Fig. 5 Intraoperative image showing clearly migrated tibial tubercle fragment

Fig. 6 **a**, **b** Postoperative anterior–posterior (**a**) and lateral (**b**) X-ray images of the left knee showing that Ogden type V tibial tubercle avulsion fracture achieved good reduction by cannulated screws combined with tension band wiring fixation

After cast removal, weight-bearing was initiated with support. The patient was able to walk with weight-bearing after 8 weeks and with good function of the left knee (Fig. 7a, b). The fracture went on to unite uneventfully at 12 weeks (Fig. 8a, b). At 5 months after initial surgery, he was asymptomatic with a full range of motion, good strength, and had returned to his prior level of sporting activity at 1 year follow-up.

Fig. 7 **a**, **b** Extension (**a**) and flexion (**b**) the left knee joint show good functional recovery 2-months postoperation

Fig. 8 **a**, **b** Anterior–posterior (**a**) and lateral (**b**) X-ray images of the left knee 3-months postoperation show good union of Ogden Type V tibial tubercle avulsion fracture

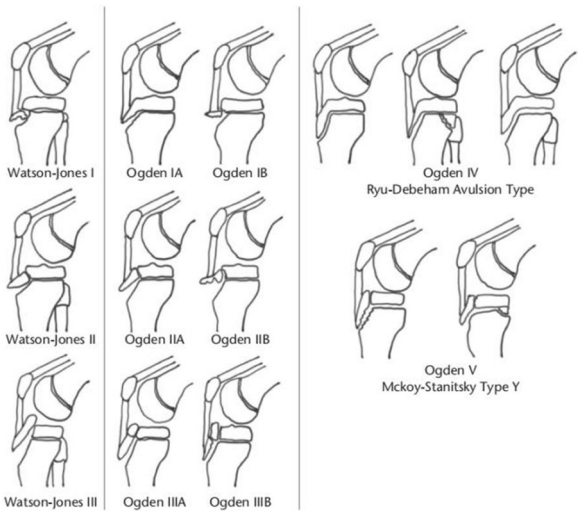

Fig. 9 Diagram showing Watson–Jones and Ogden classification systems for tibial tubercle fractures with the Ryu–Debeham and McKoyStanitsky modifications (diagram courtesy of Rodriguez *et al*. 2020 and the British Editorial Society of Bone and Joint Surgery—Rodriguez I, Sepu'lveda M, Birrer E, Tuca MJ: Fracture of the anterior tibial tuberosity in children. EFORT Open Rev 2020;5:260–267)

Discussion

The classification of fractures of the proximal tibial epiphysis was described by Watson and Jones in 1955 [6]. In the following years, several authors made modifications to the original classification. Ogden modified the most commonly used system in 1980 [7]. This has been further modified by Ryu and Debenham, adding type IV fractures in 1985 [8], as well as by McKoy, adding type V injuries in 2003 [5]. Ogden type V tibial tubercle avulsion fracture is a "Y" fracture combined with Ogden IIIB with a Salter–Harris IV fracture of the proximal tibia. The most commonly used classification of tibial tubercle fractures is derived from existing classification systems (Fig. 9) [9].

To our knowledge this is the first reported specific treatment for this unusual Ogden Type V tibial tubercle avulsion fracture in literature. Fractures of the tibial tuberosity is most common in male adolescents, and jumping sports account for most of these fractures. The underlying mechanism of type V tibial tuberosity avulsion has not been clearly described in previous literature. We suggest that the mechanism injury in our patient was acute passive flexion of the knee of more than 30°, with a contracted quadriceps muscle while landing, which led to an avulsion fracture of the tibial tuberosity with dislocation upward initially. This was followed by excessive flexion, which further led to complete separation of the proximal tibia through physial extension posteriorly when he landed. This differs from two proposed mechanisms of tibial tuberosity avulsion fracture—namely, strong quadriceps contraction during knee extension while jumping and rapid passive flexion of the knee against the contracting quadriceps while landing [10–12].

Although closed reduction and casting is a viable treatment option for some minimally displaced tibial tubercle fractures, operative treatment with open reduction and internal fixation remains the standard of care for displaced fractures, especially those with epiphysial or intra-articular extension. Open reduction and internal fixation in combination with tension-band wiring was used for this patient. First, good compression of the fracture lines was achieved using three 4.0-mm cannulated screws placed parallel to the growth plate in an anterior-to-posterior direction. At the same time, this prevented damage to the growth plate of the proximal tibial epiphysis. Ideally, 4.0-mm screws are recommended because they minimize soft tissue irritation, which can occur with larger screws over the long term.

Second, tension-band wiring facilitated the neutralization of tensile forces and reduced the probability of fracture redisplacement. We added two additional K-wires

to prevent damage to the patellar tendon; these were inserted distal to the tibial tubercle by titanium cable with the knee joint in flexion. This step differed from those used by other surgeons [13–15]. Although we used more hardware than we would have used with simple internal fixation (which might be associated with an increased risk of complications, such as infection), we did not notice any additional complications in this case, and the reduction and fracture union remained intact. The functional results were excellent, and this patient returned to his previous activities.

Conclusion

Ogden type V tibial tubercle avulsion fracture is a very rare injury. Excellent functional outcomes are achievable by open reduction with the combination of internal fixation and tension-band wiring. This type of osteosynthesis could not only achieve anatomical reduction and stable fixation for such fractures, but also avoid further damage to the proximal tibial epiphysis, which prevents serious complications, such difference in leg length.

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Not applicable.

Author contributions
M-RZ designed the study and wrote the manuscript; XZ, Q-JX, and H-YC were involved in the treatment; XZ performed literature review; Q-JX performed data collection and processing. All authors contributed to writing the manuscript. All authors read and approved the manuscript.

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Availability of data and materials
The data used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the ethics committee of Guangdong Provincial Hospital of Chinese Medicine (approval no: AF/04-07.1/10.0).

Consent for publication
Written informed consent was obtained from the patient's legal guardian for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests
All Authors declare that no benefits in any form have been, or will be received, from any commercial party related directly, or indirectly, to this study.

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