Surgical treatment for acute ischial tuberosity avulsion fracture
A case report

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Abstract
Rationale: Ischial tuberosity avulsion fracture (ITAF) is a very rare sports injury, and there is currently no consensus on its diagnosis and treatment. Although conservative treatment is adequate for most patients, those with large displacement of the fracture need surgical management.

Patient concerns: A 13-year-old male athlete experienced tearing pain in the right hip during a sprint. Radiographic examination showed an avulsion fracture of the right ischial tuberosity.

Diagnosis: Right ITAF.

Interventions: On the 3rd day of injury, the patient was treated with open reduction and internal fixation of ITAF under general anesthesia.

Outcomes: The patient received a systematic postoperative exercise in 2 weeks, and the fracture healed 4 weeks later. After 8 months, the patient returned to the field to participate in the competition.

Lessons: Early surgical treatment can bring about good results in the treatment of ITAF with large displacement. The longitudinal incision and subgluteal approach is an ideal choice for the operative procedure.

Abbreviations: DFD = degree of fracture displacement, ITAF = ischial tuberosity avulsion fracture.

Keywords: avulsion fracture, epiphysis, ischial tuberosity, surgical approach

1. Introduction

Ischial tuberosity avulsion fracture (ITAF) is a relatively rare injury, most of which is caused by strenuous exercise in teenagers.\textsuperscript{[1–4]} The mechanism include the fact that the knee extends and the hip flexes during contraction of the hamstring.\textsuperscript{[5]} Although most authors support the conservative treatment approach,\textsuperscript{[1–6,7]} a degree of fracture displacement (DFD) >2 cm warrants surgical treatment.\textsuperscript{[8–10]} In January 2017, we treated a patient with ITAF and an uneventful recovery was observed postoperatively. We herein report this case.

2. Case presentation

2.1. Case report

A 13-year-old male patient, 173 cm tall and weighing 68 kg, suddenly felt the right hip “snap” during a 100-m sprint. He fell to the ground with a tearing sharp pain and a limitation in the movement of the right hip joint. At emergency visit to a local hospital, the doctor advised a pelvic radiograph, which revealed an avulsion fracture of the right ischial tuberosity. Thereafter, the patient was referred to our hospital. Physical examination revealed a swelling in the right hip, obvious tenderness of the sciatic tubercle, palpation of bone erosion and feeling of bone rubbing, no ecchymosis, inability of the patient to sit or walk, absence of flexion or extension of right hip joint, no abnormal nerve symptoms. Pelvic radiograph indicated right ischial tuberosity epiphysial avulsion fracture, where the fracture block was crescent shaped with downward and outward separation. The epiphysis of the contralateral ischial tuberosity was not closed and showed no displacement (Fig. 1). On 3D reconstruction of the pelvis suggested that the epiphysial mass of complete avulsion was a curved shell, concave upward, and 63.3 mm × 17.6 mm × 12.0 mm in size (Fig. 3). Based on these findings, we diagnosed the case as right ITAF. Owing to the presence of a
large avulsion fracture block and >2 cm displacement, we decided to perform surgical treatment.

Informed written consent was obtained from the patient for publication of this case report and accompanying images. Ethics approval and consent to participate: all information about the patient in this manuscript complied with the patient’s right of informed consent and is fully authorized by the patient. The ethical approval was provided by the Ethics Committee of the China-Japan Union Hospital of Jilin University.

2.2. Surgical procedure

On the 3rd day of admission, after obtaining the reports of investigations, the patient underwent surgery.

After general anesthesia, the patient was placed in a prone position (Fig. 4). A longitudinal incision was placed along the crease of the hip (Fig. 5), approximately 10 cm long. Following the reflection of the skin and subcutaneous tissues, the deep fascia was bluntly separated. The gluteus maximus was revealed and bluntly separated paying close attention to the sciatic nerve in the deep layer. With the posterior extension of the hip, and the flexion of the knee joint, the isolated fracture block can be reset (Fig. 6). Two steel wires were used to temporarily reset the isolated fracture block (Fig. 7), and the fractures were fixed with 3 Kirschner wires of 3.0 mm in diameter (Fig. 8). After the removal of the Kirschner wire, 3 full-threaded needles with a diameter of 3.6 mm and a non-skull screw were transferred into the C-arm.
fluoroscopy. Then we used the C-arm perspective, which showed that the screws were securely fastened and that the length of the screws was moderate. There was no abnormal movement and frictional sound in the active hip joint. The wound was sprayed with 10 mL dexamethasone injection to prevent tissue adhesion, ensure that the bursa is sutured, and that the incision is closed layer by layer.

2.3. Outcomes
Antibiotics were injected intravenously to prevent infection in the first 3 days of the operation. Postoperative radiograph and 3-D CT of the pelvis showed successful reduction of fracture (Figs. 9 and 10). An orthosis was used to prevent hip flexion during bed rest for the first 2 weeks. Subsequently, the patient began to walk gradually using crutches. The joint could bear 1/4th of the weight at the beginning, and increased by 1/4th weekly thereafter, until it was fully loaded at 6 weeks after the operation. The fixation time of the right hip and the right knee were gradually decreased from 4 weeks after the operation, and the orthosis was removed completely at 6 weeks. The patient underwent an increased amplitude and intensity of exercise for the right hip and right knee joint movement. After 8 weeks, the patient could walk normally; however, he reported sedentary pain. Three months after the operation, he seemed to be normal and began jogging. Four months after the operation, the right ITAF was observed to have completely healed based on radiographic examination (Fig. 11). The patient began active physical exercise at 6 months and took part in a running race 8 months after operation.

3. Discussion
The ischial tuberosity is the origin of the hamstring muscle.[9] In case of our 13-year-old young patient, the epiphysis was not yet closed, and the bond between the epiphysis and the ischial tuberosity was weak. Hence, when the hip was strongly stretched and bent, the strength generated by the contraction of the hamstring led to the ischial tuberosity epiphyseal avulsion fracture. In general, the ITAF is associated with strenuous exercises, such as running, soccer, and other competitive

Figure 4. Surgical position: prone position.

Figure 5. Longitudinal incision and subgluteal approach.

Figure 6. The black arrow indicates the avulsion fracture block of the ischial tuberosity.
Rossi and Dragoni reported that the average age of pelvic avulsion fractures is 13.8 years, mainly due to the characteristics of bone development at this time. However, although the bones of the elderly are matured, there are reports of ITAF in the elderly, in which case, pathologic fractures are considered.

The choice of treatment for ITAF is based on the displacement DFD. When the DFD is small, the doctors recommend conservative treatment. The early principles are mainly to control pain and limit activities; gradually, functional exercise is initiated when the fracture has healed to a certain extent. Successful cases of conservative treatment of ITAF have been reported. However, in recent years, attention has been drawn to the complications of conservative treatment, such as hamstring shortening and fibrosis, sciatic nerve compression, and pseudarthrosis of the ischium, which leads to continuous pain while walking. The affected limbs are weak and unable to sustain the sitting position for a long time. Therefore, Biedert proposed that surgery should be performed when the fracture demonstrates DFD > 2 cm, while Ferlic et al. argued that surgery is needed when the DFD > 1.5 cm. The DFD in our patient was approximately 2.4 cm, which is in accordance with the indication for operation. The patient received a surgical procedure during the acute period, which helped achieve anatomic reduction without delay.

Sikka et al. questioned the above criteria, arguing that it was incorrect to use only the DFD as the criterion for surgery. They reported 3 patients, 2 of whom had a DFD of only 5 mm. In conservative treatment, the muscle strength of the affected limb was significantly weakened, and the flexion and extension of the hip and knee joint were restricted. Hence, they emphasized that even slightly displaced nodular fractures can lead to significant disability and may benefit from surgery. Therefore, they...
suggested that patients should be considered for tolerance to injury and functional recovery; and the need for surgery should not be based on DFD alone. We are in agreement with them. Surgery is also indicated in patients with symptoms of neurologic injury and failure of conservative treatment. In addition, for those patients who are in accord with the indication of operation, the author suggests that the surgical procedure should be carried out early. Ferlic et al\(^9\) also support early surgery over advanced surgery.

In this present case, the patient was operated in the prone position, with the hip and knee joints slightly flexed in a special position. Hence, in this position, the ischial tuberosity was brought closer to the body surface, which facilitated the operation. We chose a longitudinal incision and subgluteal approach, which provided sufficient surgical field of vision for fracture reduction and internal fixation and allowed for extension of the surgical incision if necessary. The results of Miller and Webb\(^5\) showed that the sciatic nerve was located on the lateral side of the ischial tuberosity with an average of 1.2 ± 0.2 cm. Hence, our longitudinal incision centered on the ischial tuberosity is relatively safe and can reduce the risk of iatrogenic sciatic nerve injury. Our patient did not present with sciatic nerve injury and did not require additional exposure of the nerve, which in turn reduced the time of surgery; hence, we recommend the longitudinal incision and subgluteal approach for such surgery.

The patients received a systematic postoperative rehabilitation exercise. Following 2 weeks bed rest, the patient was loaded on the ground under the protection of braces and crutches; gradually the intensity of exercise was increased. Eight months after the operation, the patient completely recovered to the level of exercise before injury. Most authors\(^2,8\) support exercise starting 2 weeks after surgery and suggest fixation of orthosis for 4 to 6 weeks, while others\(^11\) recommend that patients sit on the 1st day of surgery and do not suggest orthosis protection. We believe this could be detrimental.

In summary, we recommend that when patients have a fracture displacement of >2 cm or sciatic nerve symptoms, surgery should be performed early. In cases with DFD <2 cm, early surgery may be considered if they want a better prognosis. The longitudinal incision and subgluteal approach is an ideal choice for surgical treatment of ITAF. In addition, systematic scientific rehabilitation exercise is also important for postoperative recovery of patients. Due to the rare occurrence of ITAF, there is currently no consensus on the diagnosis and treatment, and a large number of clinical studies are needed to provide a clear guidance.

**Author contributions**

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**References**

1. Tyberghein M, Kaux JF, Godon B, et al. Avulsion fracture of the ischial tuberosity in a young sprinter: functional versus radiological assessment. Isokinet Exerc Sci 2018;26:163–5.

2. Pilchou A, Sekouros N, Nikouli VS, et al. Missed avulsion fracture of the ischial tuberosity in an adolescent competitive athlete: case report and literature review. J Trauma Treat 2014;2:

3. Akova B, Okay E. Avulsion of the ischial tuberosity in a young soccer player: six years follow-up. J Sports Sci Med 2002;1:27–30.

4. Wani, Nie Zhugang. One case of avulsion fracture of ischium tubercle [in Chinese]. Chin J Bone Joint Injury 2012;3:2844.

5. Miller SL, Webb GR. The proximal origin of the hamstrings and surrounding anatomy encountered during repair. Surgical technique. J Bone Joint Surg Am 2008;90:105–16.

6. Kujala UM, Orava S, Karpakka J, et al. Ischial tuberosity apophysitis and avulsion among athletes. Int J Sports Med 1997;18:149–55.

7. Moon J, Kim Y, Park K, et al. Apophysyal avulsion fracture of ischial tuberosity during soccer: a case report and literature review. Korean J Sports Med 2017;35:202–5.

8. Spencer-Gardner L, Bedi A, Stuart MJ, et al. Iliotibial band impingement and hamstring dysfunction as a potential pain generator after ischial tuberosity apophysyal fracture non-union/malunion. Knee Surg Sports Traumatol Arthrosc 2012;20:535–61.

9. Ferlic PW, Sadoghi P, Singer G, et al. Treatment for ischial tuberosity avulsion fractures in adolescent athletes. Knee Surg Sports Traumatol Arthrosc 2014;22:893–7.

10. Sikka RS, Fetzer GR, Fischer DA. Iliotibial apophysyal avulsions: proximal hamstring repair with bony fragment excision. J Pediatr Orthop 2013;33:172–6.

11. Saka G, Kuicikdurzmaz F, Saglam N, et al. A tuber ischium avulsion fracture treated with fragment excision. Acta Orthop Traumatol Turc 2012;46:403–6.

12. Dailly SK, Brannam B, Archdeacon MT. Chronic (ten years) ischial tuberosity avulsion fracture non-union/malunion. Knee Surg Sports Traumatol Arthrosc 2017;25:55.

13. Ross F, Dragoni S. Acute avulsion fractures of the pelvis in adolescent competitive athletes: prevalence, location and sports distribution of 203 cases collected. Skeletal Radiol 2001;30:127–31.

14. Ed AHK. Sports injuries in children and adolescent. Springer Berlin Heidelberg 2011;6–9.

15. Ji S. Pathophysiology of epiphysis and epiphyseal plate injury [in Chinese]. Chin J Pediatr Surg 1996;3:184–5.

16. Bus-Mansfield LT, Chew FS, Lenchik L, et al. Nontraumatic avulsions of the pelvis. AJR Am J Roentgenol 2002;178:423–7.

17. Sanders TG, Zlatkin MB. Avulsion injuries of the pelvis. Semin Musculoskelet Radiol 2008;12:42–53.

18. Bolgla LA, Jones DL, Keskula DR, et al. Hip pain in a high school football player: a case report. J Athl Train 2001;36:81–4.

19. Bahk WJ, Brien EW, Luck JV Jr, et al. Avulsion of the ischial tuberosity simulating neoplasm—a report of 2 cases. Acta Orthop Scand 2000;71:211–4.

20. Biedert RM. Surgical management of traumatic avulsion of the ischial tuberosity in young athletes. Clin J Sport Med 2015;25:67–72.