Research Article **IJSMR (2021) 4:19**

International Journal of Sports Medicine and Rehabilitation
(ISSN:2637-5044)

Repair of avulsion fracture of the anterior superior iliac spine by knotless suture bridge: Surgical technique and a review of 5 cases

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ABSTRACT

Background: Avulsion fracture of the anterior superior iliac spine (ASIS) is a rare form of apophyseal avulsion fracture of the pelvis, and there is a lack of evidence-based guidelines for the selection of treatment options. There are various surgical procedures, but there is the risk of secondary removal of internal fixator and growth disturbance caused by epiphyseal fixation.

Methods: We treated 5 patients with avulsion fracture of the anterior superior iliac spine by knotless suture bridge technique who visited our hospital from 2015 to 2020.The surgical treatment results were retrospectively analyzed.

Results: 5 patients with fractures were healed after the surgery, no associated complications, the mean postoperative follow-up was 29.2 months (6-60months), all patients were not reported pain symptoms (visual analogue score of 0), they don't have the limitation of daily activities, and the hip joint function recovered well, and very pleased with the results (Harris score 100 points) at the final follow-up.

Conclusion: Knotless suture bridge technique is simple and effective in the repair of the avulsion fracture of anterior superior iliac spine. For such patients, this surgical technique can provide stable and reliable fixation, allow early recovery, and provide a feasible scheme for clinical practice.

Keywords: Anterior superior iliac spine; Avulsion fracture; Suture bridge; Surgical technique; Retrospective analysis

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How to cite this article:
Tengyun Yang, Yanlin Li, Fuke Wang, Renjie He, Chuan He. Repair of avulsion fracture of the anterior superior iliac spine by knotless suture bridge: Surgical technique and a review of 5 cases. International Journal of Sports Medicine and Re-habilitation, 2021; 4:19

eSciPub LLC, Houston, TX USA.
Website: https://escipub.com/

Background

Avulsion fracture of the anterior superior iliac spine (ASIS) is a rare form of apophyseal avulsion fracture of the pelvis, usually occurring in adolescent males [1-5]. The typical injury mechanism is caused by the sudden contraction of the attached tendinous muscle units (sartorius and tensor fascia lata) during accelerated motion, running, and jumping. Due to its rarity, there are few relevant literatures, most of which are presented in the form of case reports [6-9], and there is a lack of evidence-based guidelines for the selection of treatment options [1]. The current treatment options described in the literature are broadly divided into two categories: conservative treatment and surgical treatment. Patients with no or low displacement are usually treated conservatively. Open reduction and internal fixation is recommended for patients with high exercise requirements, displacement greater than 1.5cm, or lack of bone binding [1,3-5]. There are various surgical procedures, mainly including metal screw fixation, tension band fixation, absorbent screw fixation, etc., but there is the risk of secondary removal of internal fixator and growth disturbance caused by epiphyseal fixation [1,9]. In order to reduce and avoid the above risks, we used the technique of knotless suture bridge, and the short-term results in these cases were satisfactory. In this paper, we introduce our surgical technique and experience, review and analyze the clinical outcomes of surgery.

patients and Methods

patients

This study reviewed and analyzed 5 patients with avulsion fracture of ASIS who visited our hospital from 2015 to 2020. The data were obtained from the departmental database and analyzed. All the cases in this group were male adolescents, among which 3 occurred during running and 2 occurred during jumping. The mean age was 15.2 years (13-17 years), the mean course of disease was 6.4 days (2-15 days), and the diagnosis was made by clinical manifestations, physical examination, anteroposterior/axial X-ray and three-dimensional CT of pelvis (Fig.1). The avulsion fracture of the ASIS was repaired with knotless suture bridge with the informed consent of the family members.

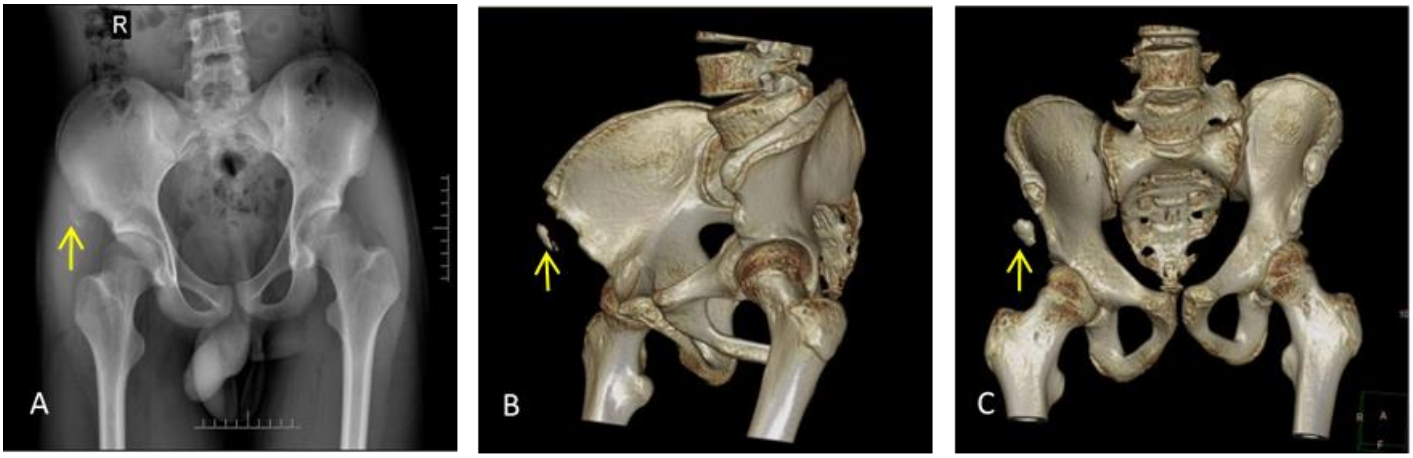

Fig. 1. A, B and C show typical anteroposterior/axial X-ray and 3-dimensional computed tomography obtained after the patient is injured.

Surgical technique

The operation was performed under general anesthesia. The patient is placed in a supine position with hip and knee flexion and the point of appointment is marked (Fig.2).

Fig. 2. The patient is placed in a supine position with hip and knee flexion and the point of appointment is marked. (star: ASIS; arrow: fragment)

This position helps to reduce the muscle tension in ASIS and thus better reduce the fracture reduction. The pelvis was prepped and draped in a typical sterile fashion. A vertical skin incision of about 5 cm is made under the iliac crest toward ASIS. After longitudinal fascia incision parallel to the skin incision, bone fragments can be reached. After the separation of the deep fascia, the location of the iliac crest and the avulsed fracture fragment was determined. The lateral femoral cutaneous nerve was exposed and protected by rubber ring pulling (Fig.3.A). The incarcerated soft tissue on the fracture surface is cleaned to enhance the alignment of the two ends of the fracture to facilitate healing, the fracture fragments are attempted to be reduced to their ASIS starting point, and the inner-row anchor position is preset. Two double-threaded 4.5mm Corkscrew anchors (Arthrex) are placed below and behind the fracture fragment (Fig.3.B). Four fiber sutures were threaded from the edge of the fracture fragment from inside to outside, tensied and compressed the fracture fragment at ASIS anatomical position, and gathered into a SwiveLock anchor (Arthrex) on the medial side of the ASIS of the fracture fragment (Fig.3.C). Using this triangular gather style fixation, the fracture fragment can be securely fastened to its as-is anatomical position in a knotless form. Finally, the wound was closed layer by layer.

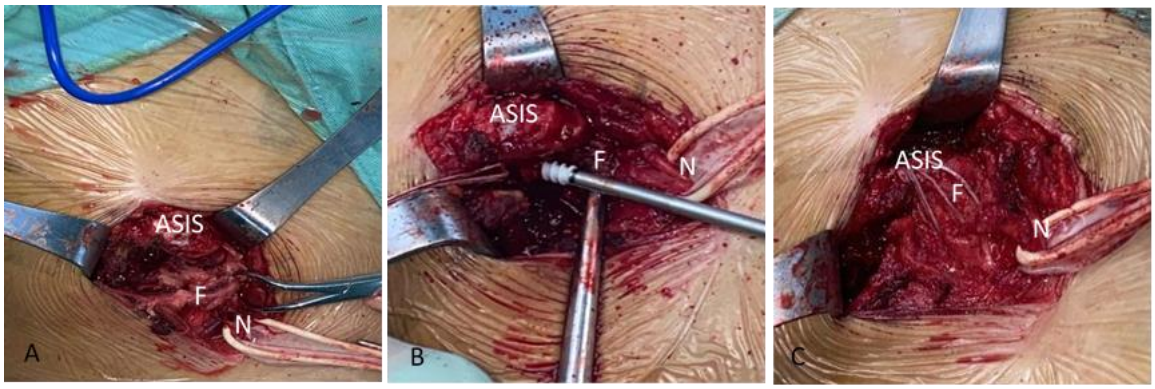

Fig. 3. Anchors preparation and insertion.

A: The location of the iliac crest and the avulsed fracture fragment was determined. The lateral femoral cutaneous nerve was exposed and protected by rubber ring pulling.

B: The inner-row anchor position. C: Triangular gather style fixation.

(ASIS: anterior superior iliac spine; F: avulsed fracture fragment; N: the lateral femoral

Postoperative management

Active and passive hip extension and knee flexion are recommended to be avoided for 8 weeks. The second day after surgery, immediate weight-bearing activity is tolerated. After 4 weeks, based on the presence of callus on the anteroposterior/axial X-ray, the patient was able to resume daily activities and gradually undergo tolerable physical exercise. After 12 weeks, there will be no restriction on physical activity. Healing progression and complications were assessed clinically and radiologically 3 days, 1 month, and 3 months postoperatively, and knee movement was assessed by physical examination. Imaging assessment mainly included anteroposterior/axial X-ray review 3 days after surgery and 3D CT assessment of fracture reduction before and after surgery. The growth and healing of fracture end were observed by anteroposterior/axial X-ray reexamination 1 month and 3 months after operation. At the last follow-up, the visual analogue scale (VAS) and Harris hip score were used to assess hip function at the follow-up.

Results

The average operation time of the 5 patients in this group was 53.2min (45-65min), and the average hospital stay after surgery was 3.8 days (3-5 days). All incisions were healed without complications such as deep infection, vascular injury, and sensory abnormalities of the lateral femoral cutaneous nerve. All fractures healed with no support, painless weight bearing and postoperative imaging assessment (Fig.4), and no signs of epiphyseal injury. The mean postoperative follow-up was 29.2 months(6-60months), all patients reported no pain symptoms (visual simulation score was 0), they had no daily activity restrictions, their hip function was well restored, and they were very satisfied with the results (Harris score was 100).

Fig. 4. A, B and C show typical anteroposterior/axial X-ray and 3-dimensional computed tomography obtained post-operation. The fracture has good alignment and healing.

Discussion

ASIS avulsed fractures are rare and tend to occur in adolescents and are associated with anatomic factors. As the ASIS osteophyte closes late and occurs at 20-25 years of age, muscles, tendons and ligaments are stronger than epiphyseal growth areas prior to this time. Sudden contraction of the sartorius and tensor fascia lata during running, jumping and other physical activities is likely to cause avulsion fracture ASIS [6,7,9]. Our cases were all injured in the course of adolescent sports, also consistent with these characteristics. Due to the low incidence of the disease and few clinical cases, there is no corres-

ponding clinical guidelines for diagnosis and treatment. At present, the mainstream treatment methods are mainly divided into conservative treatment and surgical treatment [1-5]. Studies by Kautzner et al. [10] suggest that both conservative and surgical treatment provide similar clinical outcomes at one-year follow-up after injury. The main advantages of conservative treatment are that there is no need for repeated anesthesia and only a minimal risk of infection. Patients treated with surgery achieved full recovery more quickly and were able to start full weight bearing and exercise earlier than those treated with conservative treatment. It is suggested that surgical treatment should be the first choice for competitive athletes and patients with large fracture and dislocation, while conservative treatment should be the choice for most non-competitive sports teenagers. Eberbach et al. [3] conducted a meta-analysis to compare the clinical efficacy of the two treatment methods and concluded that the overall success rate and exercise recovery rate of patients undergoing surgery were relatively high. In particular, patients with debris displacement greater than 15 mm and high functional requirements may benefit from surgical treatment. The same conclusion is described in the systematic review of Anduaga et al. [11]. Cai et al. [1] have also shown that absorbent screws can be safely used in the surgical treatment of ASIS avulsion fractures with a displacement of 1.5 cm by > in children and adolescents. Their results showed that absorbable screws had a shorter recovery time and fewer early complications compared to non-surgical treatments. Currently, surgical treatment is preferred for patients with displacement greater than 1.5cm or with high early exercise requirements. The surgical methods include lag screw, tension band fixation, absorbable screw, etc., but there is a risk of secondary removal of the internal fixator, and growth disturbance caused by epiphyseal fixation [9]. Willinger et al. [9] avoided the above problems by adopting the pentagram-like suture bridge technology. We believe that too many anchors placed may cause the risk of local fracture damage, and the economic applicability is also low. Suture bridge knot is also easy to cause local soft tissue friction inflammation, pain and other manifestations. To avoid the above risks, ASIS avulsion fracture is repaired with double row and three anchors and triangular gather knotless suture bridge technique. Knotless suture bridge technique is often used to repair rotator cuff injury [10,12-14], and has been gradually used to repair tendinous structures such as Achilles tendon [15], quadriceps tendon [16] and hamstring muscles [17] in recent years, showing good repair outcomes. In this study, short-term follow-up after surgery also showed the excellent performance of this technique. Moreover, it is reasonable to think that the surgical technique used has the following advantages. (1) Different from the surgical method of metal fixation, our operation does not require the removal of the internal fixation by a second operation. (2) The anchors implanted during surgery do not penetrate epiphyses and are only fixed with knotless, which avoids the local inflammation caused by postoperative fiber ligaments and the growth obstacle in the process of fracture healing. (3) When ASIS fracture is associated with sartorius avulsion, the avulsion fragments are small and move forward. Triangular convergence fixation is adopted to obtain solid fixation results, which shorens the operation time and reduces the patient's financial burden. However, for ASIS fractures with avulsion injury of tensor fascia lata, larger avulsed fragments and lateral displacement may require additional anchors [6]. Our study also has some limitations. Firstly, our sample size is small, so the results cannot be statistically processed. In the future,

more patients should be recruited. Second, although the mean follow-up time in our study was 29.2 months, the shortest follow-up time was only 6 months, we may need to cover a longer follow-up period in the future. Our study is a retrospective study, and future prospective studies will be designed to further explore its safety and efficacy.

Conclusion

Although there are still some deficiencies in our study, the technique of knotless suture bridge introduced by us is simple and effective for the repair of the avulsion fracture of ASIS. For such patients, this surgical technique can provide stable and reliable fixation, allow early recovery, and provide a feasible clinical scheme with satisfactory recent clinical outcomes.

Abbreviations

ASIS: anterior superior iliac spine; 3D CT: three-dimensional computed tomography.

Ethics approval and consent to participate

Ethics Committee of Kunming Medical University: All procedures were part of the standard medical care, and the need for ethics approval and consent to participate was waived.

Consent for publication

Written informed consent was obtained from the patient and parent for the publication of this report and any accompanying images.

Availability of data and materials

All data concerning these cases are presented in the manuscript.

Competing interests

The authors declare that they have no competing interests.

Fundings

The study was supported by National Natural Science Foundation of China (81560372; 81760403; 81960409); The combined and special Fund of Department of Scinece and Technology in Yunan Province and Kunming Medical University, China (202001AY070001-042); The fund of Yunnan Province Clinical Center for Bone and joint Diseases, China (ZX2019-03-04).

Authors' contributions

All the authors (TYY, YLL, FKW, RJH, CH) took part in the conception and design of the study. YLL, FKW and CH participated in the surgical and medical treatment. TYY, RJH and CH contributed to manuscript drafting and interpretation of data. TYY, RJH and CH revised the manuscript critically for important intellectual content. All authors (TYY, YLL, FKW, RJH, CH) read and approved the final version of the manuscript.

Acknowledgements

We would like to thank American Journal Experts for English language editing.

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