Research Square

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Arthroscopic fixation of humeral greater tuberosity fracture with W-shaped suture

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Abstract

Background

Patients with a greater tuberosity fracture of the humerus often require surgery. Finding a less invasive and more effective way of doing surgery could help patients better.

Aim

To evaluate the clinical value of w-shaped suture technique under shoulder arthroscopy in the treatment of humerus greater tuberosity fractures.

Methods

A total of 17 patients were included in the study. These fractures are closed, and there is no neurovascular injury. These patients underwent arthroscopically assisted reduction and internal fixation. Fixation was done by means of sighting nails combined with W - shaped suture. The imaging data of the patients were collected. ASES score, Constant-Murley score and VAS score were used to evaluate the efficacy of patients. At the last follow-up (at least one year), the range of motion of the affected and contralateral shoulder joints was compared.

Results

All patients completed the operation successfully. The average follow-up time was 13 months. No complications such as fracture displacement, nonunion and internal fixation failure occurred during the follow-up period. According to the X-ray examination of the patients, we found that all the fractures healed smoothly, the healing time was 10–12 weeks, with an average of 11.5 weeks. After the operation, the patients complained that the shoulder joint pain was obviously relieved, and there was no influence on the activity due to shoulder joint pain and discomfort in daily life. The VAS score of these patients ranged from 0 to 3, with an average of 0.52 ± 0.73. At the last follow-up, the constant murlev score of these patients ranged from 83 to 97, with an average of 92.33 ± 7.55. The ases score of these patients ranged from 81 to 98, with an average of 93.15 ± 6.93. At the last follow-up, there was no significant difference in the range of motion of the unaffected limb

Conclusion

This study demonstrates that technique of W-shaped suture can effectively fix the fracture of greater tuberosity of humerus. This technique can disperse the shear force and torsion force of suture, and increase the fixed area to promote healing, which is an effective treatment method.

Background

Greater tuberosity fracture of humerus is one of the common fracture types in proximal humerus fracture[1].The arm of rotator cuff tendon was destroyed after the fracture of greater tuberosity of humerus. The displacement of the fracture block reduced the subacromial space. This can cause the shoulder to hit as it abducts. The function of the shoulder joint is affected[2]. Therefore, when the fracture appears displacement, strong fixation and perfect reduction are necessary.

With the development of arthroscopy, arthroscopic treatment of humeral greater tuberosity fracture has been widely used[3]. Many materials have been used to fix the fracture, including cannulated screws, Kirschner wires, plates and so on[4–6]. However, if the fracture block is small or the fracture is seriously crushed, these materials can not achieve accurate reduction and strong fracture effect. The appearance of wire anchor provides a new idea for the treatment of these fractures[7]. In this study, we retrospective evaluated the clinical outcome for the fixation of humeral greater tuberosity fracture by W-shaped suture technology.

Methods

We conducted a retrospective study between May 2015 and February 2019. A total of 17 patients with humeral greater tuberosity fracture who received arthroscopic assisted reduction and W-shaped suture fixation at our hospital were enrolled for the study. The inclusion and exclusion criteria are shown in Table 1. Among the patients, 11 were men and 6 were women. Their average age was 53.36 years old. The time from injury to operation was 2-9 days (average 5 days). These patients showed limited movement of the affected shoulder joint with pain before operation, but the blood supply and sensation of the affected limb were normal.

With the patient in the Lateral decubitus position, a routine examination of the intra-articular joint was undertaken through the posterior and anterior portals, and the displaced greater tuberosity fragment attached to the supraspinatus was detected. By using a shaver, the edge of the fragment and the crater of the fracture were debrided. Following that, the arthroscope was moved into the subacromial space and a bursectomy was performed, particularly around the lateral margin of the fracture and the adjacent intact metaphyseal cortex, in order to improve visualisation and ease the insertion of the anchor. The scope was then moved to the posterolateral portal to obtain a better view of the fragment. A suture-relaying device (Shuttle Relay Suture Passer; ConMed Linvatec,Largo, FL, USA) was passed through the full thickness of the supraspinatus tendon–tuberosity junction at 1–2 mm posterior to the most anterior extent of the fragment to pass a No. 2 polydioxanone suture, which was used as the suture shuttle for Orthocord braided sutures. Subsequently, an Orthocord suture was passed and retrieved through the anterior cannula. A second Orthocord suture was inserted at 1–2 mm posterior to the first one through the posterior portal using a similar technique. Each suture from the medial inverted mattress was retrieved through the lateral cannula(See Figure 1). On reducing the fragment with an arthroscopic hook, the sutures were anchored into place from anterior to posterior using Versalok anchors (DePuy Mitek,

Raynham, MA, USA) for the suture-bridge technique. The insertion point of the lateral anchor should be more than 5 mm from the fracture margin to prevent cracking the cortex and loosening the anchors. The degree of compression was adjusted under direct visualisation. A second Versalok anchor was inserted at 1.0 cm posterior to the first one using a similar technique. Reduction of the fragment could be seen from the articular and bursal surfaces and was confirmed using post-operative radiographs(See Figure 2)

Figure 1 Surgical procedure (The pictures are attached)

1. Obvious displacement of fracture was found in exploration
2. Clean the humeral surface
3. Two stitches through the sleeves
4. Grab the same color of stitches

E. After reduction, 4 sutures were fixed with external row of nails

F .The second outer row nail fixed the other four sutures

1. Complete fixation
2. Diagram

Figure 2

A .Preoperative X-ray

B.Postoperative X-ray examination showed that the fracture reduction was good

C .Fracture healing

The patients received wound cleaning and X-ray examination on the first day after operation. They received continual follow-ups at 4th and 12th weeks, and 6th and 12th months. After the operation, the affected limb was limited to 30 ° abduction by the shoulder brace to avoid the displacement of fracture end caused by the traction of supraspinatus muscle. After 3 weeks, patients were allowed to do passive exercise. According to the results of X-ray examination of shoulder joint, the general patients are allowed to take active exercise about 6 weeks after operation. After an X-ray identification of fracture healing, the patients would get the permission of full activities and weight-bearing.

Visual Analogue Scale was used to evaluate the pain of patients[8]. The lower the score, the lighter the pain .American Shoulder&Elbow Surgeons score and Constant-Murley score was used to evaluate the shoulder function of patients. The higher the score, the function. At the last follow-up(at least one year), the range of motion of the affected side was compared with that of the healthy side.

Statistical analysis

Data obtained from preoperative and postoperative visual analog scale (VAS) were compared with a 2-sample t-test. A significance level of p<0 .05 was used, and all results were presented as mean ± standard deviation (SD).

Results

All the operations were successfully completed. The operation time ranged from 45 to 95 minutes, with an average of 70.5 minutes. There were 2 patients with subscapular muscle injury, which was repaired during the operation. No patients developed complications, such as wound infection or vascular damage or nerve damage.The end of the follow-ups was fracture healing or revision surgery. But no patient needed revision surgery. The average follow-up time was 13 months. Postoperative X-ray film showed that the fracture was well reduced, and there was no internal fixation failure and anchor pulling out. According to the X-ray examination of the patients, we found that all the fractures healed smoothly, the healing time was 10–12 weeks, with an average of 11.5 weeks. After the operation, the patients complained that the shoulder joint pain was obviously relieved, and there was no influence on the activity due to shoulder joint pain and discomfort in daily life. The VAS score of these patients ranged from 0 to 3, with an average of 0.52 ± 0.73. At the last follow-up, the constant murlev score of these patients ranged from 83 to 97, with an average of 92.33 ± 7.55. The ases score of these patients ranged from 81 to 98, with an average of 93.15 ± 6.93. At the last follow-up, there was no significant difference in the range of motion of the unaffected limb (See in Table 2).

Table 2
Comparison of shoulder range of motion between the affected side and the healthy side

Variable	Affected side (n = 20)	Healthy side (n = 20)	Statistic(T-value /χ^2-value)	*p*-value
abduction	81.36 ± 6.77	83.26 ± 7.35	0.85	0.40
External rotation	53.26 ± 5.79	55.12 ± 6.33	0.97	0.34
Internal rotation	59.13 ± 4.37	60.35 ± 5.55	0.77	0.44
Adduction	31.23 ± 6.59	33.15 ± 7.13	0.88	0.38
Anteflexion	80.12 ± 6.55	82.36 ± 7.63	0.99	0.33
Extension	35.06 ± 3.92	36.15 ± 5.92	0.69	0.49

Discussion

There are still some controversies about the indication of fracture of greater tuberosity of humerus. The greater tuberosity of humerus is the insertion point of supraspinatus muscle. If the reduction is poor after fracture, the abduction strength of shoulder joint provided by deltoid muscle will be significantly

increased[10]. Some scholars believe that surgical treatment should be considered when the displacement of fracture is greater than 5 mm, and conservative treatment should be considered when the displacement of fracture is less than 5mm[11]. For young patients with fracture displacement less than 5 mm and greater than 3 mm, athletes and other patients with high requirements for shoulder joint function, surgical treatment is also recommended[12]. Anatomical reduction of greater tuberosity fracture is very important. If the fracture block is fixed to a lower position, the traction force of the rotator cuff to the large tubercle will increase, which may lead to the failure of fixation and the limitation of shoulder joint function, which may lead to secondary rotator cuff injury; if the fracture block is fixed to a lower position, acromion impingement syndrome may occur postoperatively[11].

Arthroscopy allows the surgeon to directly observe the location of the fracture mass, and can also cause potential rotator cuff injury[13]. Compared with open surgery, arthroscopy can reduce the formation of scar, reduce the incidence of shoulder joint adhesion, and minimize the impact on shoulder joint function[14]. Many scholars use arthroscopic suture bridge technique to treat humeral greater tuberosity fracture[15]. Compared with cannulated screw fracture, suture bridge technique can effectively utilize the traction force of supraspinatus muscle to the greater tuberosity bone mass, so as to stabilize the fracture. We have developed W-shaped suture on the basis of suture bridge technology. Our technology only needs two outer row anchors, while suture bridge technology generally requires four anchors. This can save part of the cost. W-shaped suture technology can make the fracture block cover the footprints 100%, which not only reduces the tension of supraspinatus muscle, but also provides the maximum contact area, which increases the fixation strength of the fracture block and reduces the formation of space. At the same time, we use W-shaped suture technology to disperse the high-strength thread at the end of anchor bolt on the fracture block, effectively disperse the shear force and torsion force of the suture, and achieve satisfactory suture and fixation effect. The reticular structure of high-strength line cross shaped knife can firmly fix avulsion bone block and rotator cuff tissue, and avoid fracture displacement. All of our patients achieved satisfactory fracture reduction. In the long-term follow-up, we found that the patient's function and shoulder range of motion were restored to the maximum extent.

For doctors who have experienced shoulder arthroscopy, it will be very easy to use our technique. But there are still some points to pay attention to during the operation. This method is not suitable for patients with large diameter (> 3 cm) of large nodule fracture. This is because the operation space becomes smaller and more difficult when the large tubercle fracture block is large, and it may increase the risk of axillary nerve injury[17–18]. The average distance from subacromial to axillary nerve is about 6 cm[19]. Therefore, the transverse mark should be made 5 cm below the acromion before operation, and the lateral mark should not be exceeded during the operation to avoid the injury of axillary nerve.

Limitations

The present study had a few limitations. First, the sample size of our study was small. Second, This study does not compare our technology with other technologies. Therefore, future studies should address the

present limitations to validate the findings of the present study and to obtain more comprehensive results.

Conclusion

This study demonstrates that technique of W-shaped suture can effectively fix the fracture of greater tuberosity of humerus. This technique can disperse the shear force and torsion force of suture, and increase the fixed area to promote healing, which is an effective treatment method.

Declarations

Disclaimer

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

Ethics approval and consent to participate

This study was approved by the institutional review board at The Second Affiliated Hospital of Fujian Medical University. This study has been performed in accordance with the Declaration of Helsinki. Written informed consent was obtained from all the participants in this study.

Consent to publish

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no conflict of interest

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Funding

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Ethical approval

Institutional review board approval was received from the Second Affiliated Hospital of Fujian Medical University

Informed consent

After our application, the informed consent was waived by the Ethics Committee of our hospital.

Author’s contributions

Study design: FKB. Study conduct:LXC.Data interpretation: SSJ. Drafting manuscript: WWH,KQF.DZS takes responsibility for the integrity of the data analysis. All authors have read and approved the manuscript, and ensure that this is the case.

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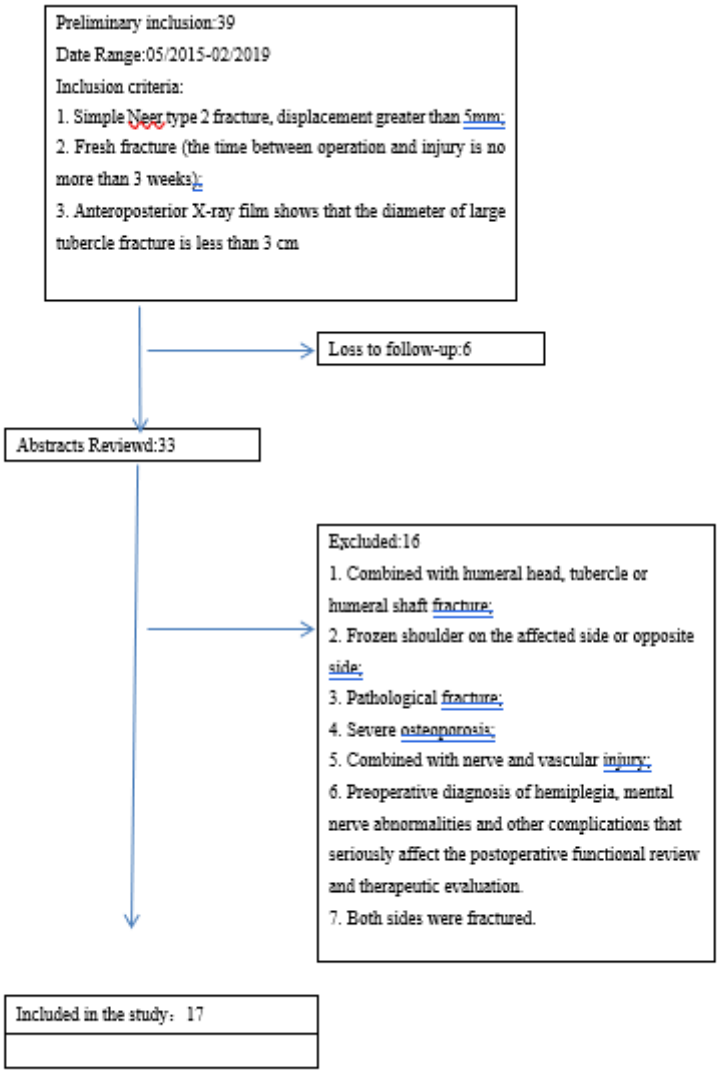
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Tables

Table 1. Inclusion and exclusion criteria



Figures

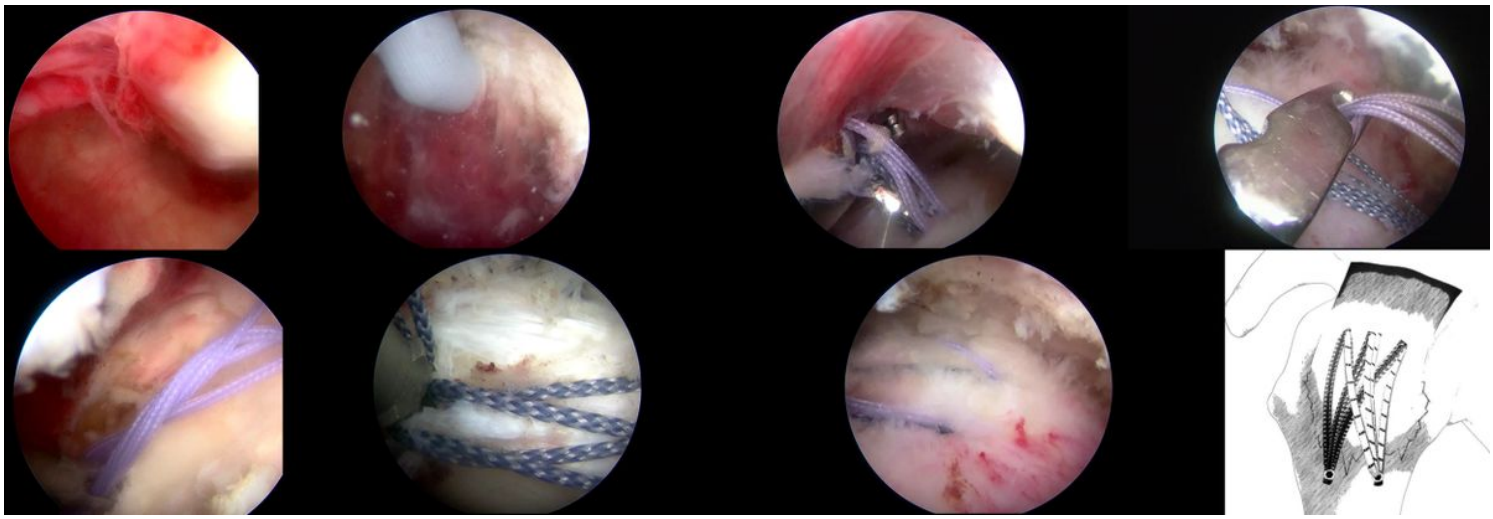


Figure 1

Surgical procedure (Top left) A. Obvious displacement of fracture was found in exploration (Top middle left) B. Clean the humeral surface (Top middle right) C. Two stitches through the sleeves (Top right) D. Grab the same color of stitches (Bottom left) E.After reduction, 4 sutures were fixed with external row of nails (Bottom middle left) F .The second outer row nail fixed the other four sutures (Bottom middle right) G. Complete fixation (Bottom right) H. Diagram



Figure 2

(Left) A .Preoperative X-ray (Middle) B.Postoperative X-ray examination showed that the fracture reduction was good Right) C .Fracture healing