Arthroscopic Treatment of Greater Tuberosity Avulsion Fracture

62

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Abstract

Due to the development of minimally invasive techniques, arthroscopic technique has become increasingly important to orthopaedic surgeons. The treatment of greater humeral tuberosity fracture has changed from open approach with plating or screw fixation to arthroscopic approach with cannulated screw fixation or double row anchor screw (internal row + external row) fixation. Arthroscopy has the advantages of small wound, rapid recovery, and accurate reduction under the arthroscope, so it is more acceptable by the surgeons and patients. However, arthroscopic approach is more technical demanding with higher risk of failure which may limit its popularity for clinical use. Due to the unique advantages of shoulder arthroscopy for the microscopic evaluation and treatment of fractures, more surgeons look forward to mastering this technology as soon as possible. Therefore, this article discussed and summarized the applied anatomy, surgical approaches, indications, contraindications, surgical techniques and postoperative care of shoulder arthroscopy, and the author's experience in this approach.

Keywords

Shoulder joint · Greater tuberosity · Fracture
Arthroscopy

62.1 Introduction

- Arthroscopic technique has been widely accepted as the gold standard for diagnosis and treatment of major joint disorders.
- In the upper extremity, proximal humerus fractures are common injuries. Fractures of the greater tuberosity of the humerus account for approximately 19% of proximal humeral fractures [1]. The greater tuberosity of humerus is one of the insertion sites of rotator cuff. Avulsion fracture of greater tuberosity of humerus will affect stability and function of the shoulder joint and the quality of daily life of patients [2].
- Classical approach of open reduction and internal fixation can achieve good curative effect, but it has the disadvantages of significant surgical trauma, destruction of blood supply, long recovery time, high chance of wound complications, and so on [3, 4]. Arthroscopic treatment of greater tuberosity avulsion fracture has been widely promoted because of its less surgical trauma, less postoperative pain, and low complication rate [5].

62.2 Indications

- Simple avulsion fracture of the greater humeral tuberosity with the bone fragment displaced more than 5 mm.
- Fracture displacement between 3 and 5 mm, accompanied by symptoms of limited abduction and lifting function.
- The main symptoms are shoulder pain and swelling, accompanied by aggravation of pain after shoulder movement.

62.3 Contra-indications

- Presence of concomitant shoulder injuries, such as rotator cuff injury, SLAP lesions, and Bankart lesion.
- Combined with fracture of the surgical neck of humerus or lesser tuberosity fracture.
- Combined with scapular fracture.
- Combined with nerve and vascular injury.

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62.4 Author Preferred Technique/ Procedures

62.4.1 Pre-operative Planning

- Master surgical indications: there should be a detailed operation plan and alternatives before operation, so as to have good communication with patients.
- Equipment: 4.0 mm, 30° arthroscope, video system, special surgical instruments, such as radiofrequency (RF) wand, arthroscopic shaver, working cannula, probe hook, pusher, thread cutter, graspers, suture hook, etc.
- Fluid inflow is driven by gravity.

62.4.2 Patient Positioning

- For shoulder arthroscopic surgery, the more commonly used patient positioning is lateral position and beach chair position. The author often adopts lateral position, because we believe that lateral position can obtain better arthroscopic visualization of the shoulder joint anatomy, which is the key of success of shoulder arthroscopic surgery.
- Place the patient in the lateral position, and the armpit pad should be placed under the armpit of the non-operative side. Place a cushion between the legs and fix the patient's trunk with a vacuum pad. Cuff balance suspension system is placed on the upper limb of the operative side. The upper limb is abducted 30°–45° and forward flexed 20° with 4–6 kg balanced suspension traction.
- The operation team consists of the surgeon, the first assistant and two scrub nurses. The surgeon is positioned behind the patient's shoulder, the first assistant is positioned at the patient's head, and the first scrub nurse is positioned behind the operator, taking charge of the Mayo instrument table and tool table. The second scrub nurse is positioned in front of the patient and is responsible for regulating the position of the upper limb on the operation side with the shaver, grinding drill, and plasma knife on another Mayo instrument table.

62.4.3 Portal Design

- The advantage of shoulder arthroscopic surgery over open surgery is that the instruments can insert into the shoulder joint from multiple angles, and the fracture and displacement of greater tuberosity of humerus can be clearly seen.
- The posterior portal is an observation portal, which is located 1–2 cm below and 1–2 cm medial to the posterior–lateral corner of the acromion. If the posterior portal is placed only 1–2 cm away from the distal acromion, problems will arise as the operation proceeds. The portal incision will shift upward as a result of the increasing soft-tissue swelling due to intra-operative fluid extravasation. This may lead to poor angle of entry to the subacromial space via this portal.
- It is also necessary to establish an anterior–lateral portal, which is located 5–10 mm lateral to the anterior–lateral angle of the acromion. Through this portal, shaver can be inserted into the subacromial space for synovectomy in order to fully expose the fracture ends, and instrument can also be inserted into the glenohumeral joint through the rotator interval.

62.4.4 Surgical Technique

- The bony landmarks and portal sites are marked on the skin. General endotracheal anaesthesia is combined with brachial plexus block. The patient is placed in lateral position. The affected limb is flexed 20° and abducted 45° for traction.
- The posterior portal is the observation portal. Use NO.11 blade to make a 10 mm long longitudinal incision. Arthrocope-cannula together with blunt tip trocar is inserted via the posterior portal into the glenohumeral joint pointing toward the coracoid process. The trocar is then replaced by the 4 mm 30° arthroscope. The scope is then advanced into the subacromial space under arthroscopic guidance. The size of the greater tuberosity fragment, degree of fracture displacement, and the size of articular defect are assessed arthroscopically. The hypertrophied synovium, scar tissue, haematoma, and small fracture fragments obscuring the arthroscopic view are cleaned up using radio frequency knife and shaver.
- If the greater tuberosity fragment is small, wire anchor fixation method is adopted. A thread threading device is placed and arthroscopic drilling is performed through the avulsed fragment to the humeral head. First, a 4.5 mm × 14 mm internal row suture anchor is placed in the hole, and four suture limbs are sutured through rotator cuff at the cartilage–bone interface just medial to the fracture and the fragment is fixed. Then, a 4.5 mm × 24 mm external row knot free anchor is placed to fix the greater tuberosity fragment. Secure fixation of the fragment in good position can be confirmed arthroscopically by moving the shoulder [6](Figs. 62.1, 62.2, 62.3, 62.4).
- If the fragment is single and large, percutaneous cannulated screw fixation is adopted. Most of the fragments are displaced backward by rotator cuff pull. The tiny bone fragments and blood clot at the fracture site is removed, and the arthroscopic probe hook is placed through the standard lateral portal to assist in the reduction of the fracture. If the displacement is more than 3 mm, the rotator

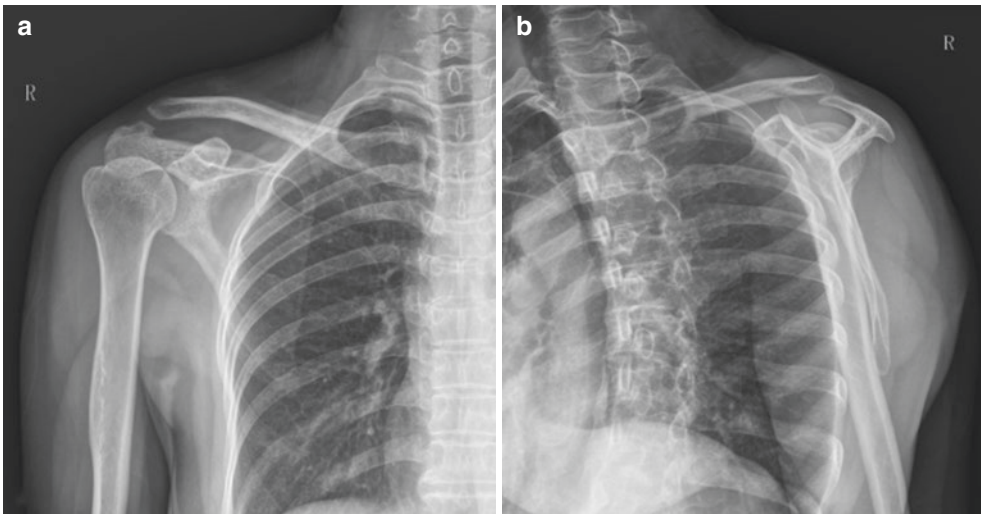

Fig. 62.1 Preoperative X-ray (taking the right shoulder as an example). (**a**) Preoperative anteroposterior radiograph of right shoulder. (**b**) Preoperative lateral radiograph of right shoulder

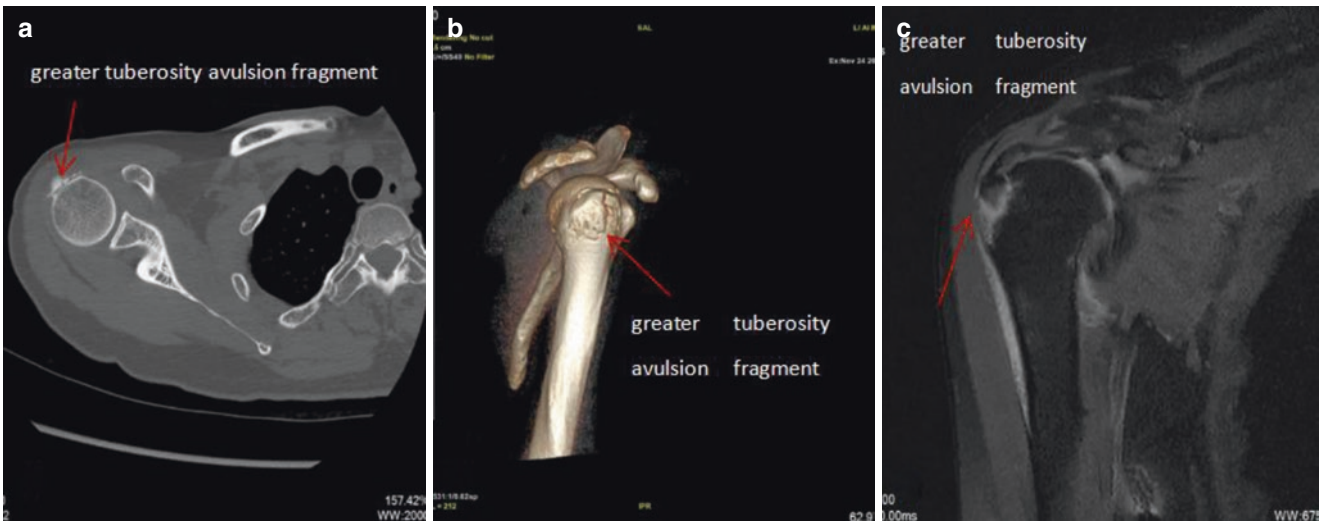

Fig. 62.2 (**a**) Preoperative CT transverse plain scan of shoulder. (**b**) Preoperative CT three-dimensional reconstruction image of shoulder. (**c**) Preoperative coronal plain MRI images of shoulder

cuff can be pulled laterally with grasping forceps to reduce the fragment. If reduction is difficult, arthroscope is inserted into subacromial space through the lateral portal. The shoulder joint is abducted moderately, and a 2.0 mm K wire is inserted into the fragment. This K wire is used as "joy-stick" to assist fracture reduction and the K wire can then be shot through the fracture to the humeral head as temporary fixation of the fracture. Usually, the Kirschner wire is inserted just lateral to the acromion and drilled vertically into the fragment and fixed the fracture. After the fracture is reduced and temporarily fixed with the K wire, 1–3 cannulated screws of diameter of 3.5 mm according to the size of the fragment together with screw washers are inserted to fix the fracture. Intraoperative fluoroscopy can confirm good fracture reduction and cannulated screw fixation position. The Kirschner wire is removed and the fixation stability is checked under arthroscopy by rotating and abducting the shoulder joint. The debris and fracture fragments in the subacromial space are cleaned up again, an indwelling catheter is inserted after complete hemostasis, and the incisions are sutured [7].

62.4.5 Complications

- Nerve injury.
- Shoulder dislocation.
- Rotator cuff injury.
- Soft-tissue edema.
- Wound dehiscence.
- Infection.
- Thermal injury.

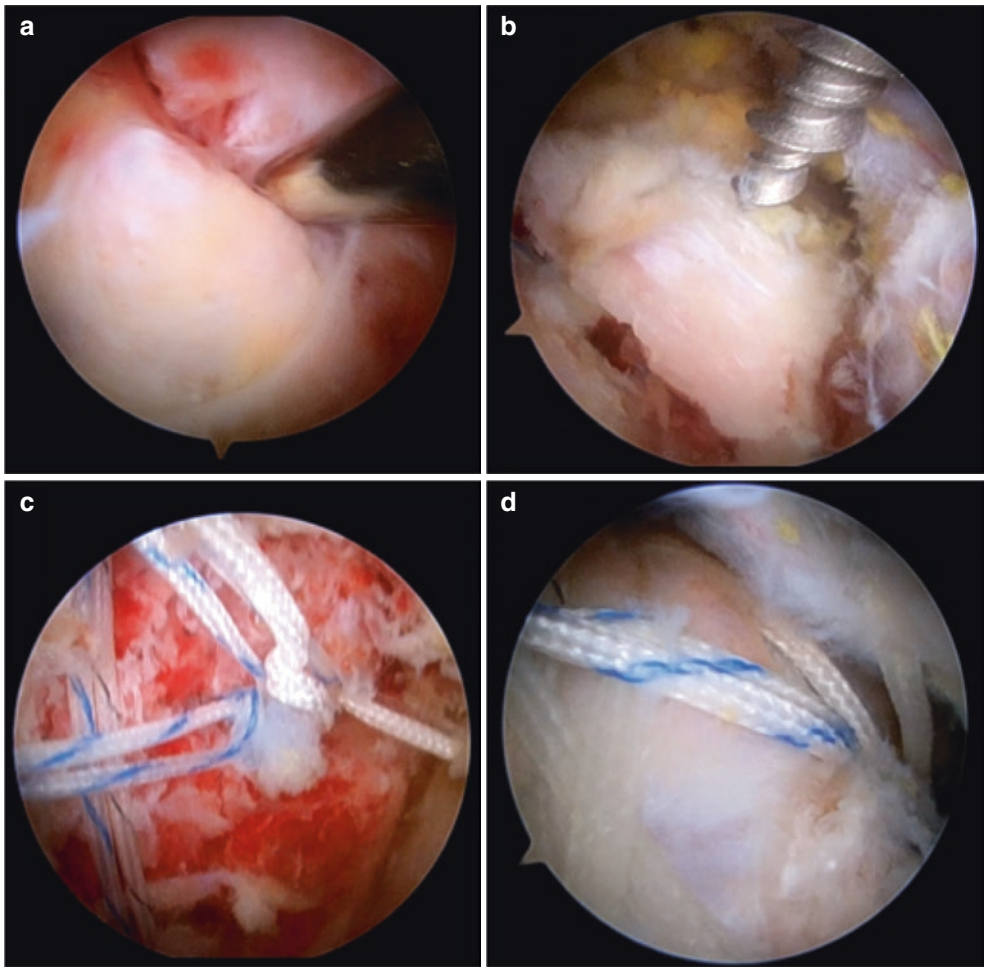

Fig. 62.3 (**a**) Fragment of the greater tubercle of humerus is found to be tilted upward during the operation. (**b**) Arthroscope is placed in the articular cavity, in front of the rotator cuff area of the humeral head and above the avulsed fragment of the great tubercle, and three linear internal row anchors are successively screwed into the hole through the rotator cuff. (**c**) Two tail lines of the same color of the anchor nails are knotted, respectively, and row the anchors in three inner parts to form a mattress suture without cutting the tail wires. (**d**) Tail lines are crossed and fixed to the lateral edge of the avulsed fragment of the greater tuberosity through two external anchors

62.4.6 Technical Tips to Avoid Complications

- During the operation, the traction of the affected upper limb should be within 4–6 pounds.
- The traction time during operation should not be too long, especially for the elderly patients with other comorbidities.
- It is necessary to combine intraoperative fluoroscopy with arthroscopy to determine the fracture reduction.
- Pay attention to suture management when fixing with suture anchor.
- Special care must be taken when using the RF probe. Sufficient liquid flushing is required to reduce the RF intensity and the risk of thermal injury.

62.4.7 Post-operative Care

- Nursing of complications: we found that intra-articular hematoma is a common complication, so ice packs are applied after operation. If there is active intra-articular bleeding, the nurse should inform the doctor to deal with it in time. Once the incision is erythematous and swollen, the stitches should be removed to drain the underlying collection, wound swab and bacterial culture shall be carried out, and appropriate antibiotics shall be used for treatment.
- Systemic observation: nursing staff should closely observe the vital signs of patients and deal with abnormalities in time [8].
- Rehabilitation training and nursing: shoulder arthroscopy postoperative nursing focus is to strengthen postoperative rehabilitation exercise. (a) Infection prevention: use antibiotics correctly according to the doctor's advice before and after operation to prevent and reduce infection risk. (b) Psychological nursing: nurses should actively contact patients, do a good job in the psychological comfort of patients, eliminate patients' bad psychology, and establish patients' self-confidence in treating diseases. (c) Pain care: oral painkillers are given routinely the day before the operation. Adopt appropriate methods to relieve patients' psychological pressure, distract patients' attention, and improve the degree of pain relief [9]. (d) Functional exercise: make rehabilitation exercise plan according to the actual situation of patients before or after operation. If the patient's condition permits, functional exercise should be carried out in time after operation.

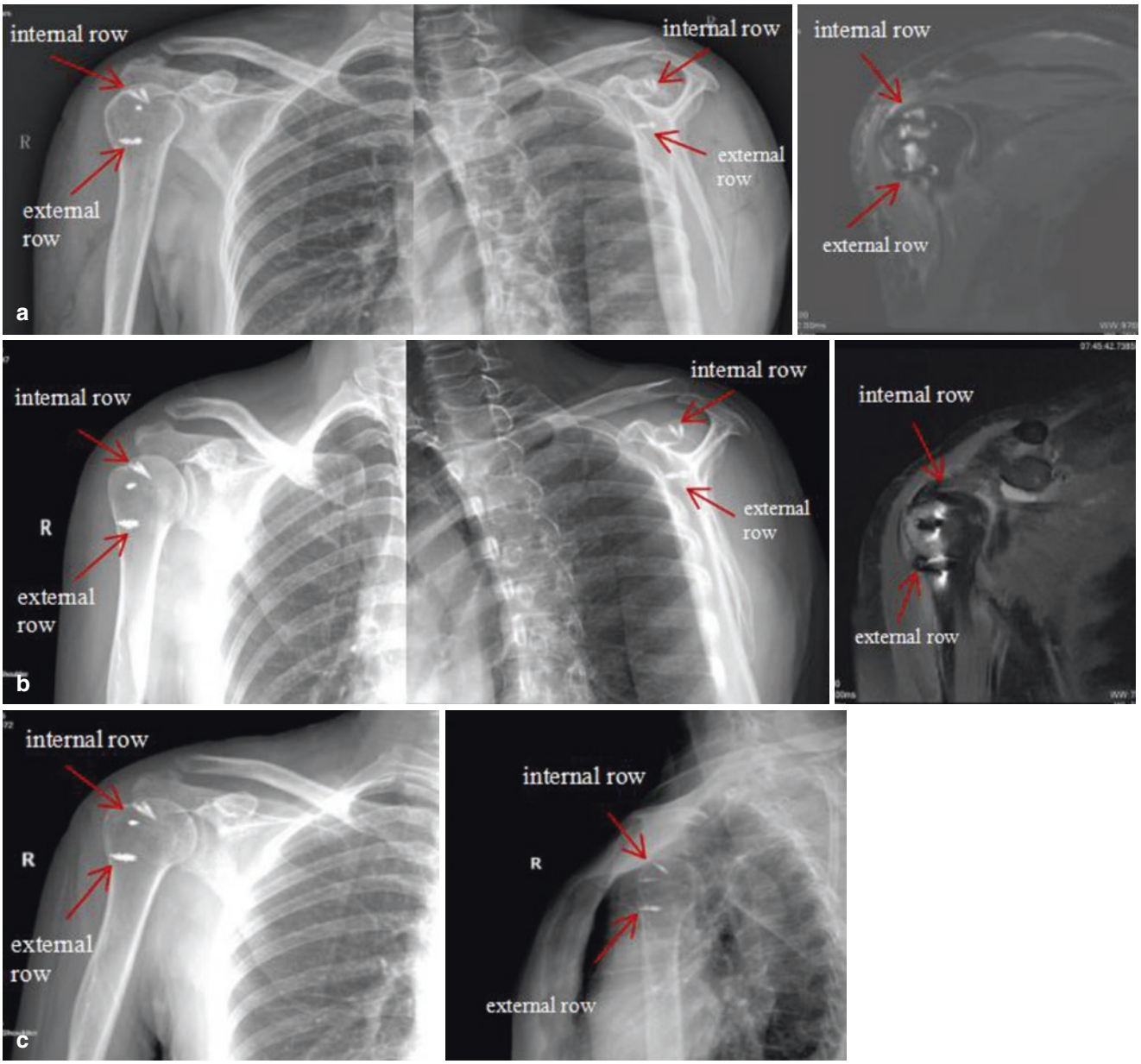

Fig. 62.4 (**a**) Postoperative right shoulder X-ray and MRI. (**b**) X-ray and MRI of right shoulder 2 weeks after operation. (**c**) X-ray of right shoulder 3 months after operation

Main contents of exercise: isometric contraction of shoulder muscles, active extension and flexion of elbow joint, passive forward flexion to active forward flexion within 90°, passive abduction to active abduction and active backward extension within 90°.

62.4.8 Outcome

- Although many scholars [6, 7] have found that non-surgical treatment of humeral greater tuberosity fracture has also achieved good results. However, in the long-term follow-up, it is found that the proportion of shoulder joint dysfunction after conservative treatment of humeral greater tuberosity fracture is increasing [8]. Currently, most scholars [9, 10] believe that surgical intervention is necessary for the fracture of the greater tuberosity of humerus with displacement more than 5 mm. For athletes, heavy manual workers and other people with high requirements for shoulder range of motion, surgical treatment is recommended if the displacement is more than 3 mm [11].
- Open reduction and plating fixation through the deltopectoral approach is the classic approach, which requires long incision and extensive dissection, causing great damage to soft tissue. This will lead to large surgical scars, which will

have an adverse impact on aesthetics; on the other hand, postoperative complications such as disuse atrophy of deltoid muscle and shoulder adhesion are common, which have adverse impact on the recovery of shoulder joint function.

- Arthroscopic suture bridge technique has certain advantages in the treatment of greater tuberosity avulsion fracture. It is firmly fixed. The use of double row suture anchor has good effect on the recovery of dynamic balance and biomechanics of the whole shoulder joint. Compared with the locking plate internal fixation, the damage to the surrounding soft tissue, nerves, and blood vessels can be minimized. Double row anchor fixation can better protect the local blood supply of shoulder joint. The fixation method can fully cover the fracture area of the greater tuberosity, disperse the fracture stress, and reduce the risk of loosening of the internal fixator. The use of suture bridge technology in surgery can effectively disperse the shear force and torsional force of suture, achieve a better effect of suture fixation, and have obvious biological advantages. It can be operated under direct arthroscopic vision to make sure good fracture reduction, and achieve accurate anatomical reduction. Other advantages include no need for later removal of the fixation devices, less damage to the patient, reduced risk of infection, and good biocompatibility of the fixation.
- Arthroscopic cannulated screw fixation can provide accurate fracture reduction and fixation. Therefore, the surgical trauma and bleeding are less. Meanwhile, shoulder arthroscopy can provide a broad and clear field of vision, which is conducive to the comprehensive and accurate judgment of the size, shape, and displacement of the fracture fragment, and shortens the operation time. The forward flexion and lifting, abduction, external rotation range of motion, and constant score of the shoulder joint on the affected side are improved, and the rehabilitation time is significantly shortened.
- However, the impacts of comminuted fracture, old fracture, and humeral greater tuberosity fracture combined with rotator cuff injury on clinical outcome depend on the specific situation of the patient, the surgeon's surgical techniques, and clinical experience.

62.5 Summary

- With the development of surgical instruments, the expansion of indications, and the improvement of shoulder arthroscopy technology, surgeons start to show increasing interest in this field.
- Compared with open surgery, shoulder arthroscopy has many advantages, including less surgical trauma, shorter recovery time, and higher patient satisfaction.
- However, arthroscopy also has its limitations, such as the fixation of double row anchor suture is not as rigid as steel plate. It is also technically difficult to reduce old or comminuted fractures under arthroscopy. The fixation strength of the percutaneous cannulated screw is more reliable, but it is not easy to control in practice and is restricted by many factors, such as the size of the fragment and the degree of crushing.
- Due to the fine anatomy of shoulder joint, the practical application of shoulder arthroscopy still require careful evaluation, to explore whether there are more indications for surgery.
- There is no doubt that shoulder arthroscopy as a minimally invasive method for the treatment of greater tuberosity avulsion fracture will be more and more popular and accepted by the public.

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