SUBSPECIALTY PROCEDURES

ARTHROSCOPIC RECONSTRUCTION OF MULTIFRAGMENTED ANTEROINFERIOR GLENOID RIM FRACTURES

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Abstract

Background: The optimal treatment of anteroinferior glenoid rim fractures remains a matter of debate. Surgical repair aims to prevent persistent instability and osteoarthritic changes of the glenohumeral joint¹⁻³ and is recommended in patients with a subluxated humeral head and substantial displacement of the fracture fragment(s)³⁻⁵. Arthroscopic reconstruction with suture anchors was described by Sugaya et al. for large solitary glenoid rim fractures using an indirect reduction and fixation via labral repair⁶. We present the arthroscopic reconstruction of a multifragmented anteroinferior glenoid rim fracture using a modified knotless anchor technique and bioabsorbable pins. The additional fixation and compression may improve reduction and consolidation of the fracture.

Description: The patient is placed in the lateral decubitus position with the affected arm fixed in a traction device. A standard posterior, an anterosuperior (suprabcipital), and a deep anteroinferior portal are required for this minimally invasive technique. A posterolateral portal may be required additionally. First, a diagnostic arthroscopy is performed to identify possible concomitant lesions. Labral repair enables an indirect reduction of the attached fracture fragments and is achieved by the aid of knotless suture anchors. Temporary reduction using Kirschner wires can be applied. Bioabsorbable pins can be used for additional ultimate fixation and compression of the fracture fragments.

Alternatives: A variety of surgical techniques for the reconstruction of glenoid rim fractures have been described in the literature, including open or arthroscopic screw osteosynthesis using either metallic or bioabsorbable screws^{3,6-10}. Screw osteosynthesis, however, is not a feasible option for fractures with multiple small fragments³. Isolated suture anchor reconstruction represents another alternative⁶. Good clinical results and a high subjective satisfaction rate, however, can also be achieved by nonoperative treatment, depending on the patient and fracture characteristics^{3,10-12}.

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Rationale: This minimally invasive technique enables an almost anatomical reconstruction of the glenoid rim with a minor risk of hardware impingement compared with screw osteosynthesis.

Introductory Statement

The arthroscopic reduction and fixation using a knotless suture anchor technique and bioabsorbable pins allows a secure and stable reconstruction of large multifragmented glenoid rim fractures.

Indications & Contraindications

Indications

- Displaced acute large solitary (type Ib) and multifragmented (type Ic) glenoid fractures according to Scheibel et al.^{3,10}

Contraindications

- Nondisplaced acute large solitary (type Ib) and multifragmented (type Ic) glenoid fractures
- Chronic glenoid bone loss (type III) according to Scheibel et al.^{3,10}

Step-by-Step Description of Procedure

Step 1: Surgical Setup (Videos 1 and 2)

Use general anesthesia and place the patient in the lateral decubitus position with the affected arm fixed in a traction device.

- Perform the operation with the patient under general anesthesia.
- Place the patient in the lateral decubitus position.
- Prepare and drape the affected arm in a sterile fashion and fix it in a traction device. Apply 5 kg of horizontal and 3 kg of vertical arm traction to achieve good visualization of the glenoid.
- Mark the following landmarks: the scapular spine, acromion, acromioclavicular joint, clavicle, and coracoid process.

Video 1 A 3-dimensional reconstruction of a preoperatively obtained computed tomography scan of a young patient after traumatic anterior shoulder dislocation, displaying a multifragmented anteroinferior glenoid rim fracture (type Ic).

Video 2 Surgical setup. Under general anesthesia, the patient is placed in the lateral decubitus position with the affected arm fixed in a traction device. The following landmarks are marked: the scapular spine, acromion, acromioclavicular joint, clavicle, and coracoid process.

Step 2: Portal Establishment and Diagnostic Arthroscopy (Video 3)

Establish 3 portals that are required at the beginning of the procedure: a standard posterior, an antero-superior (suprabcipital), and an anteroinferior portal.

- Perform a diagnostic arthroscopy once a standard posterior portal is established. Address identified concomitant lesions before or after glenoid reconstruction.
- Establish an anteroinferior working portal just above the subscapularis tendon using an outside-in technique and insert a cannula (e.g., an 8.25 mm × 7-cm transparent Twist-In cannula [Arthrex]) into this portal.
- Establish an anterosuperior portal and switch the scope to this portal. It allows direct visualization of the anterior glenoid rim.
- Then insert a working cannula into the posterior portal.

Video 3 Diagnostic arthroscopy. A diagnostic arthroscopy for the detection of possible concomitant lesions is performed via a standard posterior portal.

Step 3: Reattachment of the Superior Aspect of the Labrum and Reduction of the Fracture Fragments (Video 4)

If necessary, reattach the superior aspect of the labrum to reduce the fracture fragments indirectly before their fixation.

- Introduce a shaver via the anteroinferior portal to evacuate the fracture hematoma and verify the fracture. If they are present, remove small loose fragments located in the comminution zone.
- Mobilize the fragments using a liberator and the aid of a shaver. Make sure that all fracture fragments are attached to the labrum.
- Introduce a Wisinger rod through the posterior portal and, if necessary, an arthroscopic probe via the anteroinferior portal to reduce the fracture fragments. The inferior fragment is usually tilted upside down in the axillary pouch.
- Insert a suture shuttling device (e.g., a SutureLasso [Arthrex]) via the anteroinferior portal and penetrate the labrum at the superior aspect of the fracture. Advance a nitinol wire with its eyelet first and retrieve it via the posterior portal using a suture-grasper.
- Load a looped suture (e.g., FiberWire No. 2 [Arthrex]) through the eyelet of this nitinol wire. Retrieve the nitinol wire to shuttle the suture through the capsulolabral tissue and pass the free ends of the suture through its looped end to create a cinch stitch.
- Insert a drill from anteroinferior to establish a bone socket on the glenoid, thread the free ends of the inserted suture through a knotless anchor (e.g., a 3.5-mm PushLock anchor [Arthrex]), and insert it into the bone.
- If necessary, use Kirschner wires and additional sutures for reduction and temporary fixation of the fracture fragments.

Video 4 Reattachment of the superior aspect of the labrum and fracture reduction. First, the fracture hematoma needs to be removed using a shaver introduced via the anteroinferior portal. The fracture fragments are then mobilized with a Bankart knife. A Wisinger rod and an arthroscopic probe are used to reduce the fragments. Then the superior aspect of the labrum is reattached. A SutureLasso is inserted via the anteroinferior portal, and the labrum is penetrated at the superior aspect of the fracture. A nitinol wire with its eyelet first is advanced through the SutureLasso and retrieved via the posterior portal using a suture-grasper. A looped FiberWire is loaded through the eyelet of this nitinol wire, which is retrieved by shuttling the FiberWire through the capsulolabral tissue. The free ends of the FiberWire are looped through its looped end to create a cinch stitch. A bone socket is established on the glenoid at the 2:30 o'clock position. The FiberWire is threaded through a 3.5-mm knotless anchor, and the anchor is inserted to the bone. Kirschner wires are used for temporary reduction and fixation of the fracture fragments.

Step 4: Fixation and Compression of the Fracture Fragments (Video 5)

A set consisting of bioabsorbable, poly-L-lactide acid Chondral Darts (Arthrex); a single shot dart sheath; and a dart inserter is used, and a deep anteroinferior portal is required for their correct placement.

- Establish a deep anteroinferior portal through the inferior portion of the subscapularis muscle by inserting a spinal needle approximately 7 to 8 cm distal and 1 to 2 cm lateral to the tip of the coracoid process and then incising the skin. This portal is particularly important since it will allow a chondral dart insertion angle that is almost perpendicular to the fracture line.
- Insert the dart sheath via the deep anteroinferior portal and utilize it as a drill guide to predrill the dart insertion site for fixation of the inferior fracture fragment. Load the sheath with a chondral dart and introduce it with the aid of a dart inserter.
- Insert the dart sheath via the deep anteroinferior portal again and predrill the dart insertion site for fixation of the superior fracture fragment. Load the sheath and introduce a chondral dart with the aid of a dart inserter. Use ≥ 2 chondral darts for fixation and compression of each fracture fragment, depending on its size.

Video 5 Fixation and compression of the fracture fragments. A deep anteroinferior portal is established. This portal enables a chondral dart angle that is almost perpendicular to the fracture line. Chondral darts are inserted with the aid of a dart sheath and a dart inserter. Two chondral darts are used for fixation and compression of each fragment.

Step 5: Refixation of the Inferior Aspect of the Labrum (Video 6)

Reattachment of the inferior aspect of the labrum may require the establishment of a posterolateral portal.

- Insert a suture shuttling device (e.g., SutureLasso) via the anteroinferior portal and penetrate the labrum at the inferior aspect of the fracture. Advance a nitinol wire with its eyelet first and retrieve it via the posterior portal by using a suture-grasper. Load a looped wire through the eyelet of this nitinol wire. Retrieve the nitinol wire to shuttle the suture through the capsulolabral tissue and pass the free ends of the suture through its looped end to create a cinch stitch.
- If necessary, establish a posterolateral portal. Insert a drill and establish a bone socket on the glenoid, thread the free ends of the inserted suture through a 3.5-mm knotless anchor, and insert it into the bone.
- If required, place another suture and knotless anchor just above the superior fracture fragment via the anteroinferior portal.

Video 6 Refixation of the inferior aspect of the labrum. A SutureLasso is inserted via the anteroinferior portal to penetrate the labrum at the inferior aspect of the fracture. A nitinol wire is advanced via the SutureLasso and retrieved via the posterior portal using a suture-grasper. A looped FiberWire is loaded through the eyelet of this nitinol wire, which is retrieved to shuttle the FiberWire through the capsulolabral tissue. The free ends of the FiberWire are passed through its looped end to create a cinch stitch. A posterolateral portal is established, and a drill is inserted to establish a bone socket on the glenoid at the 7 o'clock position. The free end of the FiberWire is threaded through a 3.5-mm knotless anchor, and the anchor is inserted into the bone. Another FiberWire and knotless anchor are placed just at the 1:30 o'clock position via the anteroinferior portal.

Step 6: Wound Closure (Videos 7 and 8)

Close the arthroscopic portals in a standard fashion.

- Remove the Kirschner wires and additional sutures if used temporarily for reduction and make sure that the fixation is stable.
- Close all arthroscopic portals in a standard fashion.

Video 7 Arthroscopic result. All Kirschner wires used for temporary reduction are removed. Testing with a probe shows a stable situation.

Video 8 Three-dimensional reconstruction of the postoperative computed tomography scan displays a satisfactory anatomical reduction of the fracture.

Results

We evaluated a series of 23 consecutive patients who underwent arthroscopic reduction and fixation of a large solitary or multifragmented anterior glenoid rim fracture³. Twenty-one patients were available for clinical and radiographic examination after a minimum follow-up of 24 months. Eight of these patients underwent arthroscopic reduction and fixation of a multifragmented type-Ic glenoid fracture using the modified Sugaya knotless anchor technique. After a mean follow-up of 33.6 months, the 8 patients achieved a mean Constant score of 84.3 points, a mean Rowe score of 86.4, and a mean Melbourne Instability Shoulder Score of 94.0. The Western Ontario Shoulder Instability Index averaged 87.3%. The Subjective Shoulder Value was 89.4%. No recurrent instability or clinical signs of shoulder instability were noted. On evaluation, the subscapularis function demonstrated a negative internal rotation lag sign and belly-off sign in all patients. Radiographic evaluation revealed consolidation of the fragments in all cases. No signs of nonunion were noted. An anatomical reduction of the fracture was achieved in the majority of cases. A postoperative step-off of the glenoid was detected in 2 patients. One of them developed grade-III osteoarthritis; the other one showed no arthritic changes at the follow-up examination. Only 2 patients showed signs of osteoarthritis. No complications related to the surgery were observed³.

Pitfalls & Challenges

- Reduction and fixation of the fragments is challenging. Additional polydioxanone sutures may be helpful for reduction of the labrum and thereby of the fracture fragments, which need to be attached to the labrum.
- Loss of reduction may occur when the sutures are loose during anchor insertion, leading to an insufficient repair of the labrum.
- For temporary fracture fixation, Kirschner wires are inserted via the articular surface (see temporary inferior fragment fixation) or from outside the labral ring (for example, temporary superior fragment fixation). Placement of the anteroinferiorly located Kirschner wires via the articular surface allows placement from a more lateral direction, decreasing the risk of neurovascular damage.
- Placement of all Kirschner wires should always be performed under direct visualization and/or via cannulas.
- Placement of all anchors should be done at 30° to 45° in relation to the glenoid level to create a stable construct and avoid anchor breakout.
- The deep anteroinferior portal is in close relationship to the neurovascular structures and requires a thorough establishment and knowledge of the anatomy.
- Since most glenoid fractures are more anterior than inferior, the deep anteroinferior portal is not required to be located at the 5 o'clock position. Since the portal can be established at a higher position, the risk to damage neurovascular structures is substantially decreased.

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