TECHNICAL NOTE

Transsupraspinatus arthrotomy through an enlarged transacromial approach for total shoulder replacement

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Summary
The authors describe a step-by-step technique for anatomic total shoulder arthroplasty using transsupraspinatus arthrotomy via the enlarged transacromial approach. This technique seems ideal to ensure adequate postoperative tensional balance of the infraspinatus and the subscapularis, which is critical for the rotator cuffs to function properly and to achieve optimal arthroplasty stability. Reviewing these different steps helps understanding each rotator cuff individual component's contribution to achieve optimal arthroplasty stability.

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Introduction
The proper functioning of a continuous cuff depends not only on the functional value of its different muscles, but also on their tension, particularly tensional balance of the infraspinatus and subscapularis muscles, the essential frontal and sagittal stabilizers of the glenohumeral joint [1]. To preserve this function during implantation of a total shoulder arthroplasty, neither of these muscles should be resected or disinserted in order to choose the prosthetic size that will restore tensional balance. This is provided by transsupraspinatus arthrotomy via the transacromial approach as described by Debeyre et al. [2] and enlarged by osteotomy of the clavicle's lateral part [3,4].

The objective of this article is to describe the operative technique and discuss the expected benefits.

Operative technique
The patient is placed in a seated or semi-seated position. The patient’s torso is stabilized on the operating table with adhesives. The forearm of the operated limb is supported so that it maintains the elbow flexed at a right angle and the shoulder in neutral rotation. The operative field leaves the entire shoulder and the entire upper

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extremity free and sterile to ensure freedom of movement.

The transacromial approach

The skin is incised approximately 12 cm, beginning at the tubercle of the spine of scapula, parallel to the spine of scapula, located 1 cm above it (Fig. 1). The incision curves slightly toward the back above the acromion, passing 1 cm forward from its posterior angle. Then the incision descends, moving slightly forward so that it is parallel with the middle fibers of the deltoid. It should stop two fingerwidths under the external edge of the acromion to prevent damage to the axillary nerve.

The upper trapezius muscle is incised using the electrocautery knife 1 cm above the spine of scapula. The middle fibers of the deltoid are spread apart vertically 1 cm forward from the acromial angle. The deep fascia of the deltoid is incised vertically and its deep side is detached forward and backward of the subdeltoid bursa. The acromioplasty is performed using the oscillating saw after having made the intra-acromial guides for the two parallel posterior anterior screws with a 2.5-mm drill bit for compression osteosynthesis at the end of the procedure. The osteotomy is located 1 cm in front of the acromial angle. The anterior acromion is released from its adhesions with the bursa roof. It is tilted around the acromioclavicular joint using a powerful Beckmann retractor. The retractor’s prongs are supported on the posterior acromion and the deep side of the anterior acromion. The roof of the bursa is resected after having been separated from the deep fascia of the deltoid, the acromion, and the coracoacromial ligament. This reveals the tendinous cuff of the rotators. The distal section of the supraspinatus is freed of the adipose panicle located at its superficial side once it has been detached from front to back from the coracoacromial ligament and the coracoclavicular ligaments. Bleeding can result if hemostasis is not secured using the electrocautery knife.

The transacromial approach is too narrow to implant the humeral component without rotating it in relation to the humerus. The anteroposterior space of the transacromial approach is widened by doing an osteotomy of the lateral part of the clavicle (Fig. 2) laterally to the coracoclavicular ligaments identified on the inferior side of the clavicle. The clavicular osteotomy zone is released minimally from the deltoid and trapezius muscle insertions. The osteotomy is performed using a narrow oscillating saw blade. The piece comprising the anterior acromion and lateral part of the clavicle is pushed toward the front with the Beckmann retractor, which is displaced so that its anterior branch takes

Figure 1  The transacromial approach. A. Supraspinatus muscle. B. Subacromial bursae.

Figure 2  The clavicle osteotomy and the rotation and translation of the anterior acromion-lateral part of the clavicle piece increases the size of the articular approach.
leverage on the inferior side of the acromioclavicular joint. The coracoacromial ligament is not resected.

**The transsupraspinatus arthrotomy**

The transsupraspinatus arthrotomy includes the distal sections of the coracohumeral ligament and the supraspinatus tendon. The anterior edge of the coracohumeral ligament is easily identified by stretching it with external rotation of the humerus. It should be marked with methylene blue. The posterior edge of the coracohumeral ligament is identified along the direction of the anterior edge of the proximal part of the supraspinatus tendon. It is marked with methylene blue. The coracohumeral ligament (Fig. 3) is cut 5 mm above the entrance of the intertubercular sulcus of the humerus. It is separated from the subscapularis and supraspinatus along the methylene blue lines. Its proximal insertion on the scapula is preserved. It is folded inward. The long head of the biceps brachii tendon, if it exists, is located immediately underneath. If it is preserved, the intertubercular sulcus must be opened vertically (Fig. 3) to perform tendon luxation, either forward or backward, depending on the surgical time available. The supraspinatus tendon is incised between 0.75 and 1 cm from its insertion on the greater tubercle (Fig. 4). The infraspinatus tendon is not incised and the infraspinatus muscle is not separated from the supraspinatus muscle. The supraspinatus tendon is then turned back.

**Resection of the humeral head**

The glenohumeral joint is not luxated. The humeral osteotomy is performed from the outside in, with the upper limb remaining in neutral rotation. In front, the osteotomy follows the deep insertion of the subscapular tendon and in back the deep insertion of the infraspinatus and the teres minor tendons. If the forward inclination of the osteotomy is good, the osteophytes come off with the humeral head. If part of the osteophytes remains on the distal humerus, the cut must be redone. Ablation of the osteophytes is checked manually.

**Exposing the glenoid**

Exposing the glenoid requires lowering the humerus by performing a perigenoid capsulotomy. This position is maintained with a two-pronged double-bent retractor hooked below the lower pole of the glenoid. The glenoid is viewed frontally (Fig. 5) and is prepared according to the needs of the surgeon and the implant used.
Exposing the humerus for preparation

Exposing the humerus for preparation is facilitated by lateral translation of the upper end guided by a fist in the armpit, with the elbow maintained close to the body. A slight anterior flexion and external rotation of the arm place the upper humeral resection in the enlarged acromial opening. The humerus is prepared according to the surgeon’s preferences and the implant material chosen.

The choice of the humeral head thickness

The choice of the humeral head thickness depends on the space created by the tensional balance of the infraspinatus and subscapularis muscles, with the trial glenoid implant in place. The upper end of the humerus is laterally externalized as described above. The humeral rotation should not be blocked. The adequate humeral head depth is the thickest one that allows inserting the humeral head implant without forcing. An implant with a humeral head that is too thick cannot be inserted into the space allotted. An implant with a humeral head that is too thin is implanted too easily and results in too much anteroposterior laxity, diagnosed immediately. Radiological verification confirms that the trial implants are properly positioned.

Permanent placement of the implants

The glenoid component is implanted first. If the humeral component is sealed in a plugged medullary canal, the 5 cm at the top of the humerus must be left free of cement to prevent reflux (which is then difficult to remove) under the medial part of the prosthetic humeral head when the implant is being inserted.

Closing

Closing the cuff is easy since the implant can never be too voluminous. The supraspinatus tendon is sutured with nonresorbable suture (2-0 nylon). If there has been a retracted rupture of the supraspinatus tendon, it can easily be sutured without tension using the same approach after translation of the muscle. The coracohumeral ligament is sutured to the intertubercular ligament, the subscapularis, and the supraspinatus using nonresorbable suture (0-0 nylon). If the long head of the biceps brachii tendon was preserved, the intertubercular sulcus must be closed and its reflection pulley reconstructed. Closing the transacromial approach (Fig. 6) begins with reducing the clavicle osteotomy. This reduction, verified with a finger placed on the cutaneous side of the clavicle, is obtained by reducing the acromiectomy, which is facilitated by laterally raising the upper limb toward 40°. The acromiectomy is supported by two 3.5-mm-diameter parallel screws [3,4]. The screws are placed back to front from the spine of the scapula inward from the acromial angle to the anterosuperior part of the anterior acromion. When the screws are mounted on rings and the posterior acromial trajectories have been enlarged, compression is excellent (Fig. 6). The trapezius muscle is sutured using nonresorbable cross stitches. The fibers of the deltoid muscle that had been spread apart are joined with nonresorbable (0-0 nylon) cross stitches. Thin aspiration drainage is placed in the supraspinatus fossa.

Postoperative rehabilitation

The upper limb is placed in a sling that maintains the arm in the plane of the scapula with slight lateral elevation and neutral rotation. Passive mobilization in lateral elevation and rotation is initiated immediately. Assisted active mobilization is initiated after the 28th postoperative day. The sling is discontinued toward the 45th day. Home rehabilitation replaces rehabilitation with a physical therapist after the third postoperative month.

Complications with the enlarged transacromial approach

The complications with the enlarged transacromial approach are exceptional. Out of 155 prostheses implanted between 1982 and 2004 to treat degenerative joint disease (n = 117) or rheumatic arthropathy (n = 38), no axillary nerve involvement was noted clinically. All the acromiotomies joined by two compression screws consolidated and in only three cases did the screw points cause pain, requiring their removal. The consolidation of the clavicle osteotomy was difficult to confirm with imaging. However, it was noted that palpating the osteotomy zone was not painful and that mobilization of the shoulder did not cause creaking.

Discussion

The expected benefits of the transsupraspinatus arthrotomy were:

- short term:
Enlarged transacromial approach and transsupraspinatus arthrotomy

• minimize the risks of intraoperative humeral diaphyseal fracture, even with arthropathies involving a high degree of stiffness, since resection of the humeral head and exposure of the glenoid do not require rotating the humerus,
• ensure sagittal centering of the implanted joint and minimize the risk of postoperative dislocation since the infraspinatus and the subscapularis were not sectioned or disinserted and the implant’s volume, providing a good prosthetic centering (stars are the points representing the thinnest joint space and the center of the glenoid). The glenoid remained satisfactory (Fig. 7).

- medium- and long-term:
  • preventing secondary subscapularis tears [5] and weakening the function of the subscapularis with the appearance or worsening of fatty degeneration of its muscle [6,7] found after anterior transsubscapularis arthrotomies. These different forms of involvement of the subscapularis can explain the progressive ascensions of the humeral implant that occur beyond five years and after anterior arthrotomy in 12 to 37% of the prostheses implanted for degenerative osteoarthritis [8,9] and in 25 to 43% of those placed for arthritis [9–12]. Humeral ascensions were only noted exceptionally at a longer follow-up after transsupraspinatus arthrotomy [13,14],
  • maintain good sagittal centering of the implanted joint. We found that this centering, assessed on horizontal CT slices at a mean follow-up of 6.5 years, remained satisfactory [15] (Fig. 7).

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References


Figure 7  CT scan horizontal section in neutral rotation with good prosthetic centering (stars are the points representing the thinnest joint space and the center of the glenoid). The glenoid and the humeral head osteotomy should be parallel in neutral rotation to obtain a good balanced tension between the infraspinatus and the subscapularis.