MENTORS IN ORTHOPEDICS

A SUBSCAPULARIS-SPARINGAPPROACH FOR REVERSE TOTAL SHOULDER ARTHROPLASTY

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SUMMARY

Background: Standard surgical approaches for reverse total shoulder arthroplasty (RTSA), including deltopectoral and superolateral techniques, typically necessitate subscapularis tenotomy or deltoid muscle dissection. These maneuvers are associated with specific morbidities, such as postoperative instability, subscapularis insufficiency, and potential axillary nerve injury. While subscapularis-sparing techniques are established for anatomic shoulder arthroplasty, their application in RTSA remains less frequent despite the theoretical benefits regarding joint stability and accelerated functional recovery.

Objective: This article details a surgical technique for RTSA that preserves the integrity of both the subscapularis and deltoid muscles and evaluates the preliminary clinical outcomes and complications associated with this approach.

Key Points: The procedure utilizes a deltopectoral portal and accesses the glenohumeral joint through the rotator interval. Exposure is achieved via humeral extension and adduction, followed by a freehand humeral head osteotomy and glenoid preparation using specialized retractors. In a cohort of 65 patients, the mean Constant score improved from 45.6 ± 14.5 preoperatively to 74.7 ± 14.8 at one-year follow-up. The complication rate was 12%, including three tuberosity avulsion fractures and one transient axillary nerve palsy. No postoperative dislocations or infections were recorded. This approach facilitates immediate active mobilization without postoperative immobilization. However, the technique presents challenges due to restricted surgical exposure, which may increase technical difficulty in patients with significant joint stiffness or small anatomical proportions.

Conclusion: A subscapularis- and deltoid-sparing approach for RTSA is a viable alternative to traditional techniques. It facilitates early rehabilitation, reduces hospitalization duration, and maintains joint stability. While technically demanding, the approach demonstrates favorable short-term functional outcomes and a low complication profile.

KEYWORDS

Arthroplasty, Replacement, Shoulder; Shoulder Prosthesis; Rotator Cuff; Treatment Outcome; Postoperative Complications

INTRODUCTION

There are several possible approaches for a reverse total shoulder arthroplasty (RTSA), with the deltopectoral and superolateral approaches being the most common, each of which has its advantages and disadvantages. The deltopectoral approach, involving either subscapularis tenotomy or lesser tuberosity osteotomy,

allows better visibility and access to the humerus, better positioning of the glenoid component and a lower risk of loosening and scapular notching. [1] However, it also carries a higher risk of anterior dislocation and so the required degree of deltoid tension [2] places patients at risk of a neurological injury. [3] In addition, although the subscapularis tendon is often reconstructed after a tenotomy, the healing, integrity and therefore the function of this structure may still be compromised. [4],[5],[6],[7],[8] Subsequent subscapularis insufficiency appears to be a cause of poor outcomes [5],[9],[10] and even of failure for a shoulder arthroplasty [11]. This has prompted surgeons to consider other surgical options to avoid having to detach the subscapularis tendon during the procedure, or to improve its postoperative recovery. One alternative technique is to use a superolateral approach, whose main advantage is better postoperative stability because the anterior structures, including the ligament complexes, are spared.[12] Although this technique has been producing good outcomes, it involves dissection of the deltoid muscle which carries a risk of anterior deltoid weakening (mechanical or neurological, or due to damage to the distal branches of the axillary nerve) [2] and of impaired postoperative function [13].

Approaches have been developed for a total anatomical shoulder replacement that spares the subscapularis. [14],[15] The potential advantages of inserting the implant through the rotator interval include better subscapularis function and faster recovery. Initial results show positive clinical outcomes in patients who do not undergo subscapularis tenotomy.[16] This article presents our technique of sparing the subscapularis and deltoid muscles during RTSA.

METHODS

Surgical technique

The indication for a subscapularis-sparing approach is all types of primary RTSA with an intact subscapularis. The patient is placed in a semi-seated position, with the torso inclined to 60°, on the lateral edge of the operating table. The shoulder must be unsupported to allow the surgical technician to extend the joint and apply proximal force, at the elbow, in order to dislocate the head of humerus proximally. The skin incision runs from the tip of the coracoid process and follows the line of the arm. A deltopectoral portal is created.[17] The surgeon removes the bursa and examines the cuff. If subscapularis integrity is confirmed (Figure 1), a deep dissection is made, either across the supraspinatus tear or by detaching it. With the arm held in extension and adduction, two long blunt Hohmann retractors are placed around the head of humerus in order to fully expose the proximal humerus (Figure 2). The humerus is prepared to receive a short curved anatomical stem with 20° of retroversion (Figure 3). [18],[19],[20]

Figure 1: Left shoulder lateral view. A long wide-tipped Hohmann retractor is placed on the upper coracoid process. Brown-Deltoid and Langenbeck retractors on the posterior and median segments respectively retract the deltoid muscle and attached tendon. This allows the surgeon to confirm that the subscapularis is intact. [7]

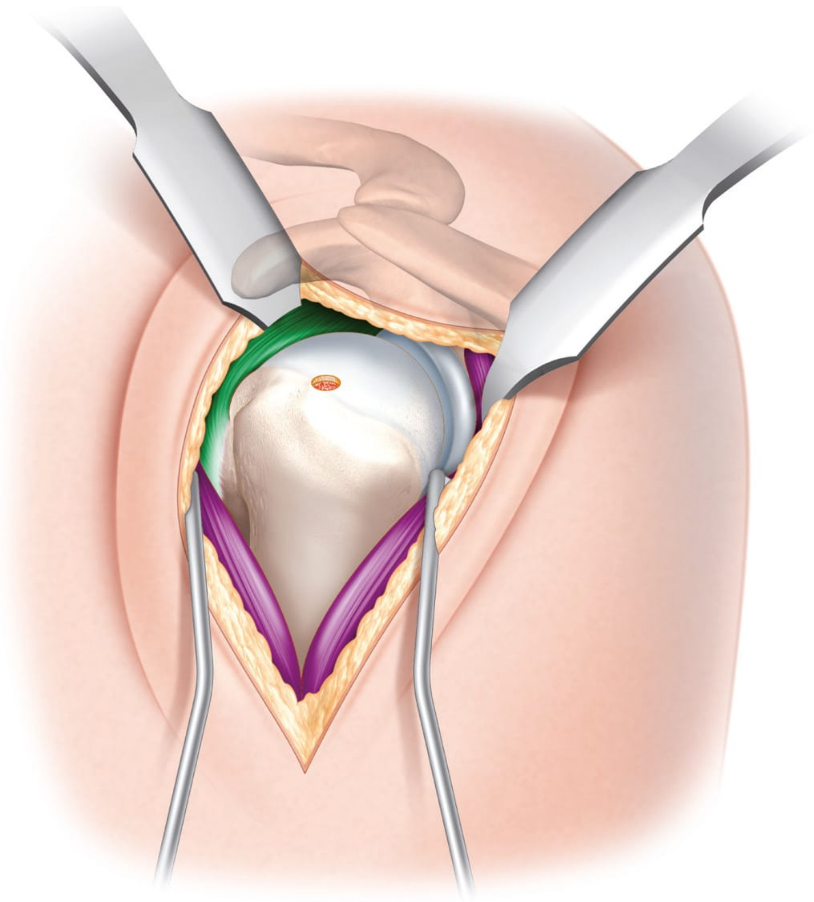

Figure 2: With the arm held in extension and adduction, two long wide-tipped Hohmann retractors are placed either side of the humeral head, retracting the subscapularis and posterior remains of the rotator cuff, allowing an unimpeded view of the head of humerus. [7]

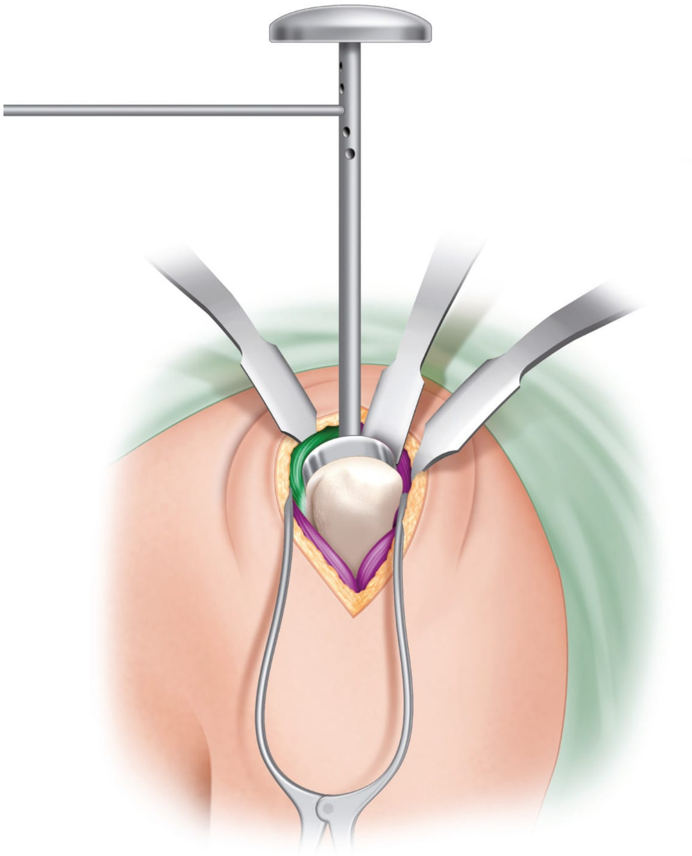

Figure 3: A 20° retroversion guide is put in place and the osteotomy cut is marked on the humeral head using an electric scalpel. [7]

A retroversion guide is put in place, the cut is marked on the humeral head with an electrocoagulation device and the osteotomy is performed freehand. The humeral head osteotomy must be generous to ensure optimal exposure of the glenoid cavity. The humeral stem is then prepared using only compactors (Figure 4). If the initial osteotomy is not deep enough, or if the tilt is suboptimal, it must be repeated to ensure a better anatomical fit between the implant and the bone.

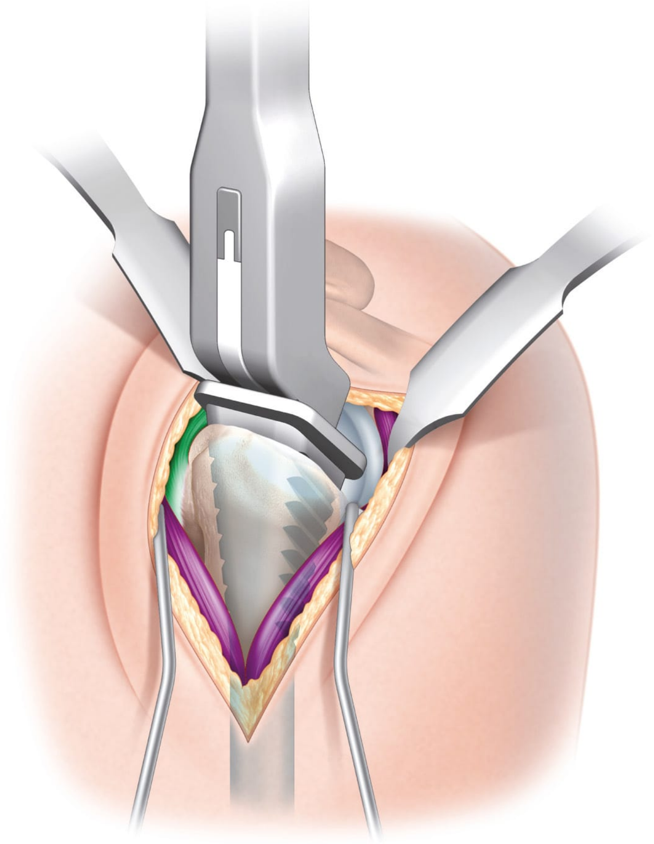

Figure 4: After resection of the head, the humerus is prepared for the stem using compactors only. [7]

Once the humerus is prepared, a trial humeral stem is inserted to protect the epiphysis during preparation of the glenoid. The cartilage is then debrided using a curette, the labrum resected and a capsulotomy is performed. Any tension in the inferior glenohumeral ligament, which could prevent sufficient exposure of the glenoid or reduce postoperative functional mobility of the shoulder, must be released using an electric scalpel, whilst maintaining contact with the bony glenoid rim. A forked Trouilloud retractor is inserted in the inferior section for better glenoid exposure and access (Figure 5). This exerts inferior pressure on the humeral epiphysis, which is protected by the trial implant.

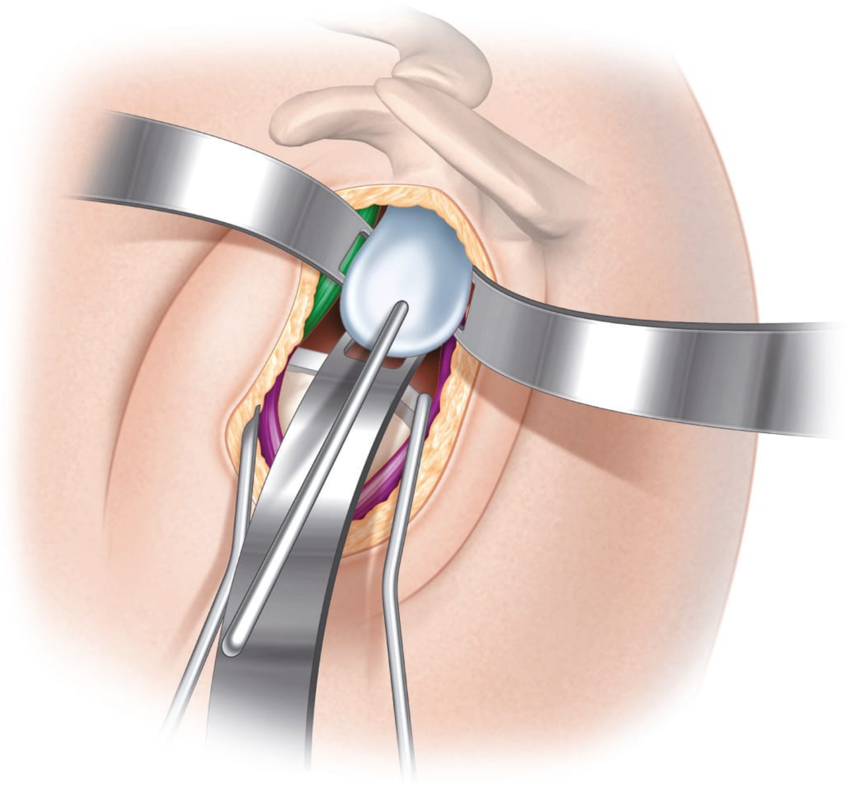

Figure 5: A forked retractor is placed below the glenoid to ensure good exposure and access. The glenoid is prepared using the recommended surgical technique, to obtain neutral version and tilt. [7]

The glenoid is prepared using the recommended surgical technique, to obtain neutral version and tilt. Preoperative planning software is used to determine the degree of interior tilt and whether glenoid asymmetry is required. The base is attached to the glenoid using locking and non-locking peripheral screws. A 36mm glenosphere with 2mm offset is used to prevent any impingement during lateral rotation, extension and adduction.[21] We do not recommend using a larger glenosphere because excessive lateralization could obstruct access to the humerus. The glenosphere is impacted onto the base using a Morse cone and secured with a locking screw. Once the glenoid component is in place, the surgeon dislocates the humerus anteriorly and superiorly. A stem is used together with a polyethylene insert to form a final assembly of 145°. This modular stem can be used with a centred or offset humeral tray (1.5mm or 3.5mm). A medial/inferior offset in the tray is still used to limit arm lengthening and optimise lateralization.[22] The shoulder is reduced by applying slight traction to the arm, and range of motion is tested in each direction to ensure good, unimpinged movement of the implant. A lateral tuberoplasty is performed, with removal of any osteophytes, to allow maximum flexibility and avoid any bone conflict.

Once the skin is closed, the surgical incision measures approximately 7-10cm (Figure 6).

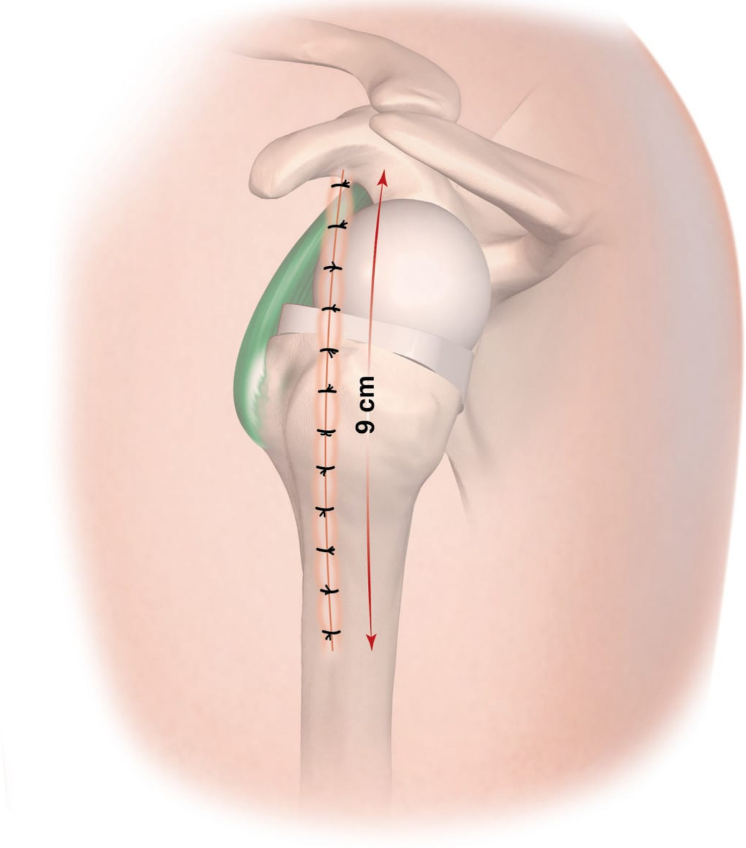

Figure 6: Length of the surgical incision (8cm in this case).

Postoperative rehabilitation

Using this subscapularis-sparing technique, patients do not need to be immobilized with a splint following the surgery. Immediate active mobilization in all axes is allowed.

RESULTS

One single surgeon (AL) performed 65 subscapularis-sparing RTSA between August 2013 and June 2017. The cohort contained 17 men and 48 women, with an average age of 76±8 years. The Constant score rose from 45.6±14.5 before the surgery to 74.7±14.8 at one year.

Complications

There were three tuberosity avulsion fractures requiring cerclage wiring. All three recovered with no pseudarthrosis and although one case developed stem subsidence, it did not need revision surgery. One patient presented with an impaired axillary nerve, possibly due to suboptimal removal of humeral osteophytes.[23] The nerve palsy had resolved entirely after one year. This complication could also be caused by lengthening of the arm, which in turn can be a result of the implant design and the need to restore deltoid tension in order to ensure better postoperative function [24] and stability.[25] Maintaining the integrity of the subscapularis improves stability, prevents excessive lengthening of the arm and protects the axillary nerve from traction injuries during the procedure, which would explain we experienced just one single case of nerve damage and no dislocation. Four scapular spine stress fractures were also recorded, although there was no confirmed causal link to the surgical approach. There were no infections. Preservation of the rotator cuff, which limits the subacromial dead space, could explain the absence of infection in this series of patients.

DISCUSSION

Traditionally, a RTSA involves dissection of the muscles or tendons to improve exposure of and access to the glenohumeral joint.[12],[17] However, there are benefits to using an approach that spares the subscapularis muscle, whether performing an anatomic or a reverse arthroplasty. This articles summarizes the experience of a surgeon who uses this less invasive RTSA technique for patients with an intact subscapularis tendon and where there is no need to touch the deltoid muscle. This technique has transformed our daily practice thanks to the clear short-term benefits. Lädermann et al. found that using a subscapularis-sparing approach for RTSA results in a shorter hospital stay, better functional and pain outcomes and is more cost effective than the traditional deltopectoral approach.[26]

The savings discovered by Lädermann et al.[26] are directly attributable to the length of hospitalization. However, this can vary by location and local healthcare policy. Because we allow patients to move freely and actively after lifting the nerve block, they are soon able to perform their daily activities independently and are allowed to leave hospital the day after the surgery. Follow-up care or referral to a rehabilitation centre is no longer needed and physiotherapy remains minimal or may not be required at all. Shortening the hospital say also reduces the rate of nosocomial infection [27], limits the risk factors of rehospitalization [28] and improves patient satisfaction.[29]

By using an approach that preserves the subscapularis, immobilization can be avoided because there is no longer any need to wait for the subscapularis reconstruction to heal. This early mobilization is probably why we have obtained such excellent short-term clinical outcomes.[26] One might argue that limiting the surgical exposure would prevent sufficient capsule release and restrict postoperative mobility. However, this has not been our experience. Other studies of the outcomes of an anatomical arthroplasty using a subscapularis-sparing technique confirm this finding. However, the improvement in functional recovery at three months is not also seen at one year.[26] As with recent studies into subscapularis-sparing techniques for anatomic replacements [16], longer clinical and radiological follow-up is required.

Another interesting point is the low rate of complications. The incidence is roughly 20% with traditional deltopectoral approaches.[30],[31],[32] In this series, the short-term complication rate was 12%.

Advantages of the subscapularis-sparing approach

There are many reasons to protect the integrity of the subscapularis during RTSA. First, the non-anatomic design of the implant can result in acute muscle lengthening. The lengthening occurs mainly in the supraspinatus muscle (19mm with an increased offset implant (BIO-RSA)), followed by the superior subscapularis muscle.[22] This muscle lengthening could, in theory, make reinsertion of subscapularis more complicated, especially when using BIO-RSA implants. Second, the inferior subscapularis muscle has no macroscopic tendons and it attaches directly to the bone, making reinsertion difficult. Third, subscapularis is described as being the largest of the rotator cuff muscles, and is stronger (53% of overall cuff strength) than supraspinatus, infraspinatus and teres minor combined.[33] If it is necessary to dissect a muscle, the logical choice would be to sacrifice the supraspinatus, which provides only 14% of the total power in the shoulder.[33] Fourth, the subscapularis muscle plays a crucial role in anterior elevation.

Collin et al. have already shown that subscapularis is the most important of the rotator cuff muscles for raising the native shoulder.[34] Although the configuration of the RTSA does partly change the role of the subscapularis muscle, an intact inferior subscapularis provides the necessary protection during joint movement [35] and the superior subscapularis muscle provides a positive vector force and serves as an abductor.[36] Fifth, although still the subject of debate in publications [37], subscapularis is important for providing postoperative stability [38],[39],[40], at least with medialized implant designs. Sixth, preservation of subscapularis could improve internal rotation. An internal rotation deficit is common after RTSA and, although not widely studied, insufficient recovery of subscapularis could explain this problem. Finally, preservation of subscapularis allows immediate mobilization.
Immobilization is associated with increased shoulder stiffness. [41]

Post RTSA immobilization is thought to ensure a better balance between optimal recovery and prevention of stiffness.

Six weeks of immobilization is typically prescribed to ensure recovery during the normal phases of inflammation, proliferation and remodelling.[42] If a patient requires subscapularis reconstruction during an anatomic arthroplasty, four weeks of immobilization give better recovery outcomes than early mobilization.[5] However, by using an approach that preserves the subscapularis, immobilization can be avoided because there is no longer any need to wait for the subscapularis muscle to heal. This early mobilization is probably why we have obtained such superior short-term clinical outcomes.

Disadvantages of the subscapularis-sparing approach

The main drawback of the subscapularis-sparing technique is the restricted surgical exposure. Although specialist instruments are not essential, there is a need for tools designed specifically for this type of surgery. In addition, the limited exposure prevents the use of patient-specific guides. Less invasive guides or guidance systems may become essential in the future. Even if the head of humerus can be properly exposed, the freehand osteotomy can cause difficulties. In one study, Lädermann et al. compared the deltopectoral and transdeltoid approaches.

The latter was associated with a more generous osteotomy (10mm, $p<0.001$) in order to expose the glenoid cavity. [2] The bone cut should produce a tilt of 145° or 135° and allow for sufficient removal of osteophytes from the inferior head of humerus. We recognize that the subscapularis-sparing approach can be technically difficult in certain cases (such as stiff shoulders and small patients) and in other cases may not be easy or even possible.

However, this is not a major problem because a subscapularis tenotomy or lesser tuberosity osteotomy can be performed at any time. In addition, the choice of implant design is crucial. We prefer to use a small curved stem with lateral humeral offset.[22] During the surgery, this prevents excessive lateralization of the glenoid because it would subsequently be impossible to expose enough of the humerus to implant the stem.

Nevertheless, this technique is possible, albeit more difficult, with a 42mm glenosphere or a bone or metal offset [43]. We use a baseplate that already incorporates a 2mm lateral offset; any greater could prevent sufficient exposure of the humerus and encourage iatrogenic tuberosity fractures due to excessive traction on the anterior and posterior rotator cuff muscles. However, the prevalence of these fractures is comparable to the rate of "controlled" fractures of the lesser tuberosity during deltopectoral approaches involving posterior humeral dislocation. Finally, damage to the anterior deltoid muscle could cause a problem. If there is any doubt, the arm is slightly abducted to release the tension, with the deltoid muscle protected using a sponge, and large Brown retractors are used.

Admittedly, this techniquhas several limitations.

Despite the greater technical complexity, I do however use this approach for all patients with an intraoperatively intact subscapularis. Few complications have been observed and this approach offers several theoretical advantages.

CONCLUSION

Using an anterior approach, sparing both the subscapularis and deltoid muscles, is an option for patients undergoing RTSA. Short-term outcomes appear better than when using the standard deltopectoral approach.

By protecting the integrity of the subscapularis tendon and the deltoid muscle, we can minimize the need for postoperative immobilization and rehabilitation, thus allowing the patient a better range of motion in the shoulder without any increased risk of dislocation. Total hospital stay and the length of the postoperative rehabilitation period are shortened, which creates significant financial savings. However, other studies with a longer follow-up are needed to document the potential long-term benefits of this surgical technique. Less invasive methods such as augmented reality and guidance systems could be useful in the future to ensure optimal implant positioning.

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