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Primary total shoulder arthroplasty performed entirely thru the rotator interval: Technique and minimum two-year outcomes

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Background: Total shoulder replacement (TSR) is an effective treatment of shoulder arthritis. However, subscapularis insufficiency after TSR remains a significant cause of poor outcomes after shoulder arthroplasty. We describe a novel technique for performing a TSR entirely through the rotator interval (RI) without tenotomy of the subscapularis or supraspinatus tendons and without dislocating the shoulder using the superior approach.
Material and methods: We prospectively followed up 22 patients who underwent this procedure. Subjective patient satisfaction, Constant, Simple Shoulder Test (SST) scores, and range of motion (ROM) were evaluated preoperatively and postoperatively at a mean follow-up of 29 months. Radiographic findings are also presented.
Results: Subjective patient satisfaction results were good in 5 of 17 patients and excellent in 12. Patients also had significant increases in Constant, visual analog scale, SST, and ROM scores. One patient was excluded due to a traumatic periprosthetic fracture (fall), 3 patients refused to return for follow-up, and 1 patient was lost to follow-up. Postoperative results included nonanatomic humeral head osteotomies in 6, residual inferior humeral neck osteophytes in 8, and the humeral head prosthesis was undersized in 5.
Conclusions: The patients had favorable clinical outcomes. This technique for TSR demonstrates that in the postoperative period, patients can immediately partake in unrestricted physical therapy. This study reports the clinical outcomes of this technique for TSR with a minimum of 2 years of follow-up.
Level of evidence: Level 4; Case series, treatment study.

Keywords: Total shoulder replacement; minimally invasive surgery; subscapularis; superior approach

Conventional total shoulder arthroplasty is an established treatment for glenohumeral osteoarthritis, with mostly good or excellent outcomes reported in the literature using the deltopectoral approach.[7] However, subscapularis dysfunction related to tenotomy of the subscapularis[15,16] or osteotomy of the lesser tuberosity remains a significant problem in some patients.[1,9,23] Patients are often progressed through a graduated therapy program after total shoulder replacement (TSR) with the deltopectoral approach to protect the subscapularis until adequate healing of the tenotomy or osteotomy has been achieved.

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We have developed a novel technique using the superior approach for total shoulder arthroplasty (TSA) that does not violate any of the tendons of the rotator cuff and is performed entirely through the rotator interval. This report describes the technique for this procedure and evaluates the clinical and radiographic outcomes at a minimum of 2 years of follow-up using the rotator interval approach for primary TSR. We hypothesize that a TSA could be performed entirely through the rotator interval, resulting in comparable early results for functional outcomes and levels of pain relief compared with the standard deltopectoral approach for this procedure.

Materials and methods

This study was conducted by a private institution with no Institutional Review Board; thus Institutional Review Board approval was not applicable. Between February and October 2004, 22 consecutive patients were treated with primary TSA using the superior approach by the senior author (L. L.), as originally described by Neviasor in 1982.[14,19] Five patients were excluded from the study: 3 refused to return for follow-up, 1 was lost to follow-up, and 1 patient fell 15 months after the index procedure and sustained a periprosthetic fracture. This patient was excluded because we did not have several of the documented clinical examination outcomes because the accident occurred within 24 months of the surgery. We concluded that we could not truly evaluate and compare this patient's outcomes with other patient outcomes in the study because it would potentially skew our results in a misleading fashion. We will continue to monitor these patients as well as future patients for periprosthetic fracture trends. However, because this was an isolated incident, this patient was excluded. Aside from the 5 patients excluded, all patients who underwent this procedure during the study period were included in our analysis.

The remaining 17 patients (10 women) were an average age of 63.5 years. Preoperatively, 15 patients had primary degenerative joint disease and 2 had secondary arthritis from late-stage osteonecrosis. The standard surgical indications for TSR were used to select patients for TSR through the rotator interval by the superior approach, including pain, functional limitations that did not improve with conservative treatment, and radiographic evidence of advanced glenohumeral joint destruction. Patients were excluded for TSR through the rotator interval if they did not have an intact rotator cuff or if the TSR was a revision procedure.

Each patient in the study was examined by an independent examiner at an average of 28.6 months (range, 24-33 months) after their procedure. The outcome measures used to evaluate each patient preoperatively and postoperatively were the visual analog scale (VAS), the Simple Shoulder Test (SST), the Constant score, the active range of motion (ROM) in forward flexion, external rotation, and internal rotation, and the belly-press test.

For each patient, radiographs were taken preoperatively and after the TSR at a minimum of 24 months (range, 24-33 months), which included true anteroposterior, axillary, and transscapular views taken at the time of the last follow-up visit. A preoperative computed tomography arthrogram was used to evaluate rotator cuff integrity and glenoid morphology in all patients. Strength testing was performed according to the criterion defined by the European Society for Shoulder and Elbow Surgery. Each patient's shoulder was tested in 90° of forward flexion in the scapular plane. The hand in pronation was tested with a spring balance on the distal forearm while the resistance was measured 3 times in kilograms, and strength was recorded as the average of the 3 measurements.

Measurements were expressed as the mean and standard deviation. The means were compared using the t test for continuous variables. A value of $P < .05$ was considered statistically significant. Single-variable regression analysis was used to determine if relationships between age, preoperative range of motion, humeral head height, and humeral head size had a significant effect on the clinical outcome parameters evaluated in this study.

Operative technique

The patient is positioned in the beach chair position with a hydraulic arm holder (Spyder Arm Holder, Tenet Medical Engineering, Inc, Alberta, Canada). General anesthesia with an interscalene blockis used for the procedure.

An 8-cm vertical superolateral skin incision is made 1 cm anterior to the posterior margin of the acromioclavicular joint (Figure 1, *A*). The incision is continued to the level of the deltoid fascia, and full-thickness skin flaps are elevated on both sides of the incision to gain exposure of the anterior border of the acromion and at least 2 cm of the posterior acromion. This approach does not require undermining of the subcutaneous tissue, and the skin flaps are retracted adequately as in any other standard surgical approach so that the deltoid can be clearly visualized (Figure 1, *B*).

The deltoid is split in line with its fibers between the anterior and middle raphe and medially over the acromioclavicular joint. The deltoid is then elevated completely (subperiosteally with sharp dissection) off the acromion for a distance of 4.5 cm.[14,19] Elevating the deltoid in this fashion and having the split in line with its fibers allows the deltoid to be mobilized and is an essential key for this approach.

The axillary nerve is under the reflection of the bursa and a bursectomy is performed. The axillary typically lies inferiorly to the deltoid split and, in our experience, has not been an issue. A specialized Hohman retractor designed for this procedure (Depuy, Warsaw, IN) is placed medially at the level of the coracoid process to expose the rotator

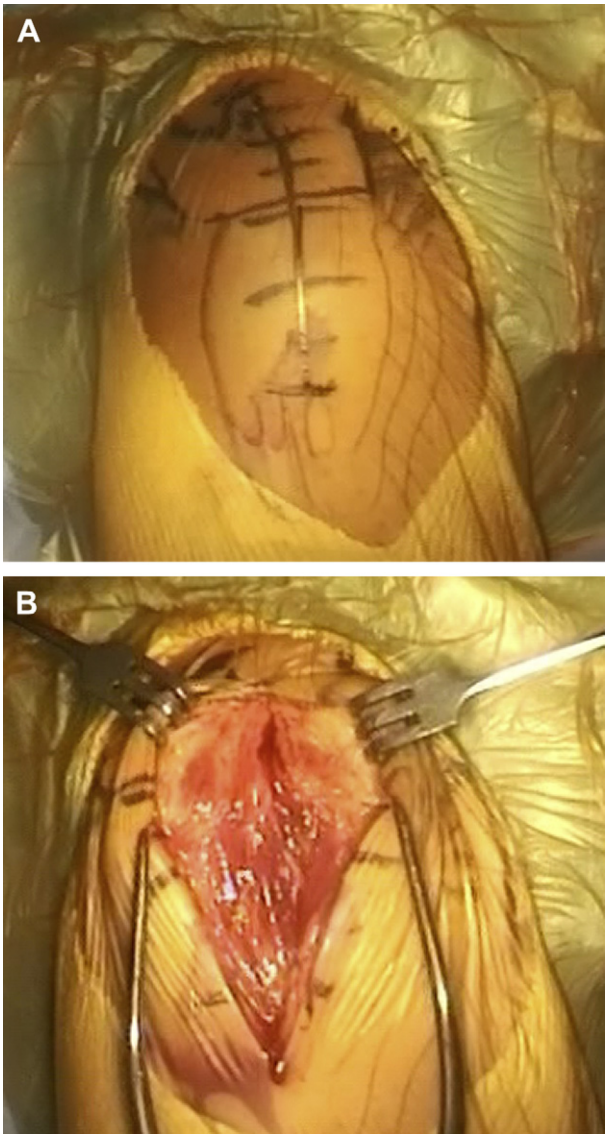

Figure 1 **(A)** The superolateral skin incision for this procedure, which is the *hashed line* in the middle of the field, is made approximately 1 cm anterior to the posterior margin of the acromioclavicular joint. **(B)** The incision is extended to the level of the deltoid.

interval. This retractor, which is essentially a Hohman retractor with a 75° backward bend, serves several functions: it allows for retraction of the soft tissue anteriorly without disrupting visualization of the surgical field, allows for blunt release of the glenohumeral joint capsule when placed anteriorly and posteriorly within the joint (as described), and also protects the axillary nerve when repositioned within the glenohumeral joint capsule.

The trapezoidal rotator interval is identified using the anatomic landmarks of the superior border of the subscapularis inferiorly, superior glenohumeral ligament (SGHL) superiorly and the anterior border of the supraspinatus tendon posteriorly, and the base of the coracoid

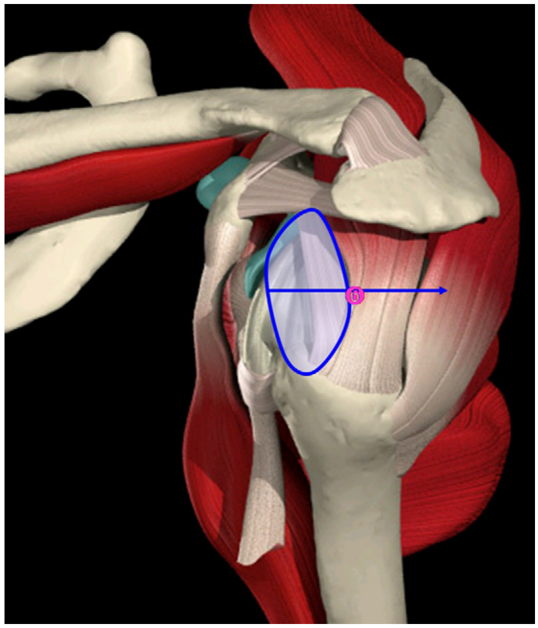

Figure 2 The trapezoidal rotator interval flap is retracted posteriorly and the glenohumeral joint is exposed through this window. The trapezoid outlines the reflection of the flap (which does not violate the supraspinatus).

medially (Figure 2). The rotator interval is opened anteriorly using a knife with a 4-cm incision at the junction of the subscapularis and the anterior border of the coracohumeral ligament (CHL). The long head of the biceps is identified within the bicipital groove, which assures that the surgeon is in the correct position within the rotator interval. Next, a 2-cm lateral incision detaches humeral insertions of CHL and SGHL and terminates at the anterior border of the supraspinatus footprint. This incision should not violate the subscapularis or supraspinatus.

The arm is then repositioned with slight abduction and slight flexion to allow for anterior exposure of the anterior pole of the bicipital insertion as well as the CHL and SGHL insertions. A third 3-cm incision is made medially in the rotator interval, releasing the CHL from the base of the coracoid and the SGL from the glenoid. The trapezoidal rotator interval flap is retracted posteriorly over the supraspinatus with the aid of 2 sutures placed in the CHL flap (Figure 1, *C*) and forms the window that enables the shoulder arthroplasty. The glenohumeral joint is easily visualized through this rotator interval window behind the long head of the biceps tendon.

A saw is used to perform an acromioplasty, which allows greater access to the shoulder and eliminates a source of impingement. The biceps tendon is sectioned along with approximately 2 cm of superior labrum, and the biceps is tenodesed to the superior border of the subscapularis tendon at its insertion into the lesser tuberosity with nonabsorbable sutures. The remaining stump of biceps proximal to the level of the tenodesis is resected.

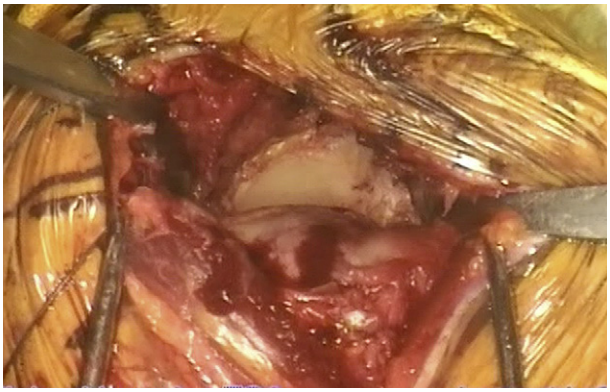

Figure 3 Two specialized glenoid retractors are placed on the anterior and posterior scapular neck to retract the subscapularis anteriorly and the superior and posterior cuff posteriorly and enable good glenoid exposure.

The arm is repositioned to neutral and the specialized Hohman retractor is repositioned under the subscapularis and rests on the scapular neck anteriorly. A second specialized Hohman is positioned posteriorly on the scapular neck and posterior glenoid (Figure 3). These 2 Hohman retractors widen the window for the rotator interval exposure and enable the capsular release of the glenohumeral joint circumferentially when traction is applied to the Hohmans. The soft-tissue release continues with resection of the anterior and anteroinferior capsule and labrum. The capsule is removed off the subscapularis. At this point, the anatomic neck of the humerus is easily visualized.

The starting awl for the intramedullary reamer is introduced into the humeral head approximately 1 cm medially to the supraspinatus insertion. The intramedullary reamers are used to ream to a 10-mm diameter, and a specialized humeral head-cutting guide (Depuy-Mitek) is applied to the reamer stem. The cutting guide has slots on both sides in which a key can be placed (Figure 4, *A*). The key sits on the medial aspect of the humeral head and allows for an accurate cut in height, inclination, and version (Figure 4, *B*). The cutting guide is fixed in place through 2 pins placed through the supraspinatus. Once the guide is in place, the reamer and the superior components of the guide system are removed, and a third pin is placed through the cutting guide (Figure 4, *C*). The neck cut is then made anteriorly, being careful to protect the supraspinatus.

Because the humeral osteotomy cannot be performed with the guide in place, the guide is removed and the cut is finished, again while paying close attention to protecting the cuff. Because we typically use a Depuy-Mitek Global fixed-neck prosthesis, the cutting guide enables an anatomic neck cut and permits the patient's retroversion to be incorporated in the osteotomy.

After the osteotomy of the anatomic neck has been performed, a specialized reverse osteotome is used to remove the inferior osteophytes from the inferior aspect of the humeral neck. The glenoid can now be exposed by placing a glenoid retractor (Figure 5, *A* and *B*) under the inferior rim of the glenoid neck. This retractor pushes the humerus inferiorly and the scapula superiorly and enables an en face exposure of the glenoid. Because this exposure allows an en face view of the glenoid, the size of the glenoid can be judged by placing special drill guides in the undreamed fossa and estimating the correct size based on the superior and inferior guide fit. This guide allows for a central drill hole to be placed. The glenoid is reamed and abnormal glenoid version is corrected during this step. A second drill guide with a central peg and 3 drill holes (1 hole is superior and 2 are inferior) is placed in the glenoid. The glenoid prosthesis is sized with a trial component.

Cement with a short set time is applied to the outer 3 drill holes with a syringe while the central drill hole/peg hole is left uncemented. A very small amount of cement is applied to the polyethylene prosthesis with morselized bone graft applied to the central peg, and the prosthesis is gently impacted into place with a glenoid impactor. The excess cement is cleaned away and fit is confirmed.

The glenoid retractors are removed, and 2 specialized humeral retractors are used to facilitate exposure of the humerus. The humeral head size is first estimated by using the size of the humeral head that has been resected. The humerus is broached and a trial stem is placed. We have a series of special flat discs (Depuy Mitek) with a variety of sizes, widths, and offsets that are compared with the resected head to initially estimate the humeral head size. Once the trial stem is in place, the disc can be inserted on top of the stem in similar fashion to a trial head. The arm is then ranged and offset can be determined and adjusted according to the need of a concentric or eccentric disc.

The trial stem is removed and a stemless humeral head (with a neck component and no stem) trial is used to determine the appropriate size of the humeral head. This complex can be seated snugly within the canal. This allows us to determine whether an eccentric or concentric humeral head prosthesis provides the best anatomic fit for the definitive prosthesis. The trial head cannot be placed on the trial stem because the peg on the trial head is too long and cannot be properly seated on the trial stem in vivo. The arm is ranged, and fit and offset are confirmed during flexion-extension, internal-external, and abduction-adduction movements. With the arm in approximately 90° of external rotation, the definitive prosthesis is assembled and placed into the intramedullary canal anteverted 90° to its final placement on the neck cut (Figure 6, *A* and *B*). This position is important because it avoids impingement of the humeral head on the lateral border of the acromion.

A Spanna instrument (Depuy Mitek, Warsaw, IN), which is a wrench with a notch that seats right below the prosthesis humeral head, is used to rotate the prosthesis into the correct and anatomic position within the humeral shaft, and an impactor is used to seat the prosthesis into its final

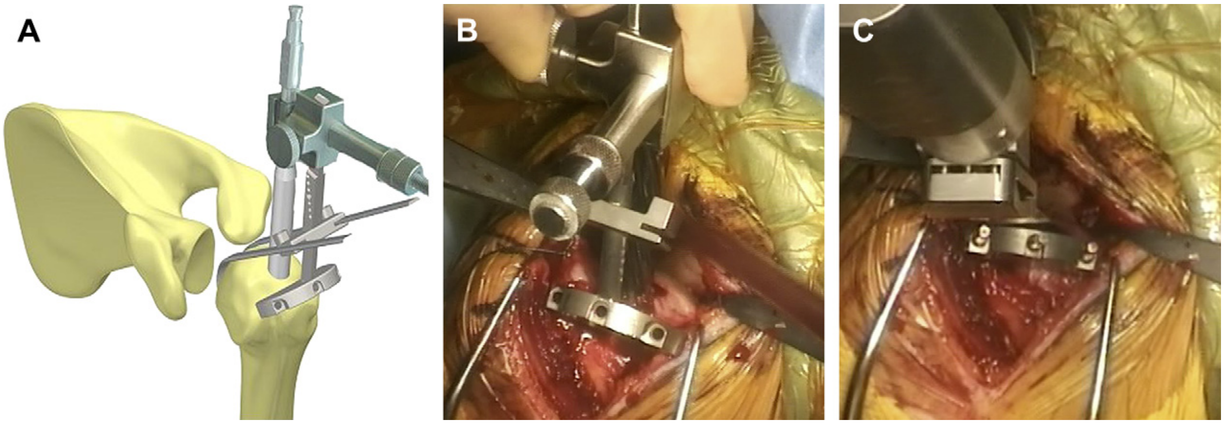

Figure 4 **(A)** A specialized intramedullary reamer and humeral cutting guide (DePuy Inc, Warsaw, IN) are used to make the humeral osteotomy for this approach. **(B)** Two keys are inserted through slot on the cutting guide and are used to determine the head cut. Once the appropriate position is determined, 2 pins are inserted into the cutting guide. The intramedullary reamer and the superior portion of the guide are removed, leaving just the portion of the guide with the pins anchoring inferior guide to the humerus. **(C)** A third pin is then inserted into the middle of the guide. The guide is now rigidly in place, and the humeral head cut can then be made.

position (Figure 7). This step is essential, because the remaining portion of the acromion would not allow full passage of the head. ''Wrenching'' the prosthesis into place allows us to guide the head past the acromion and into its anatomical position. Stability of the final prosthesis is assessed by passive ranging of the shoulder.

The rotator interval is closed by suturing the retracted CHL and SGL flap to the superior border of the subscapularis. Soft-tissue balancing obtained at the time of rotator interval closure is assessed by passive ranging of the shoulder. A drain is placed in the potential space between the rotator interval and the deltoid, and the vertical split in the deltoid is repaired with a side-to-side series of interrupted mattress sutures.

Postoperative rehabilitation

After the surgery, the patient is placed in an abduction sling for comfort only. The patient is permitted full active and passive range of motion with a therapist starting on postoperative day 1. The patient is observed in the hospital overnight. No restrictions are imposed on the postoperative rehabilitation program.

Radiographic evaluation

For each study patient, a series of radiographs were taken within the first 6 weeks after the procedure and at a minimum of 24 months after surgery (range, 24-33 months). The radiographic series comprised a true anteroposterior view in internal and external rotation, an axillary view, and a transscapular view. The parameters evaluated on the postoperative radiographs were humeral head height, glenoid version, presence of inferior humeral neck or glenoid osteophytes, and any evidence of glenoid or humeral component loosening.

Results

Clinical outcomes

The clinical outcomes for the study patients are presented in Table I. The mean preoperative and postoperative outcomes (Table II) were, respectively, Constant Scores, 25.1 (range, 6-48) vs 68.5 (range, 39-84; $P < .001$); VAS scores, 8.1 (range 4-10) vs 2.4 (range 1-5; $P < .01$); SST values, 16.1 (range, 0-42) vs 86.8 (range 33-100; $P < .05$); active forward flexion, 71.2° (range 30°-160°) vs 48.2° (range 90°-180°; $P < .001$); and strength, 3.24 vs 8.88 kg (range, 0.5-8 kg). No patients had enough internal rotation to reach T12 preoperatively, and 13 had enough internal rotation to reach T12 postoperatively. All had an intact subscapularis function with the belly-press test.

Radiographic outcomes

Postoperative radiographs in 6 of the 17 patients showed the anatomic neck cut was made too proximally or distally on the humerus, resulting in positioning of the humeral component superiorly or inferiorly in the glenohumeral joint. In 8 patients, the radiographs showed that the inferior osteophytes on either the humerus or glenoid had not been removed. In 5 patients, the size of the humeral head was smaller than the native anatomic head. None of the patients had a glenoid version that was not anatomic. There were no fractures or dislocations in any of the prosthesis. No loosening was evident on the radiographs at the 2-year follow-up.

Discussion

To our knowledge, this study provides the first published description and early results for a novel approach for

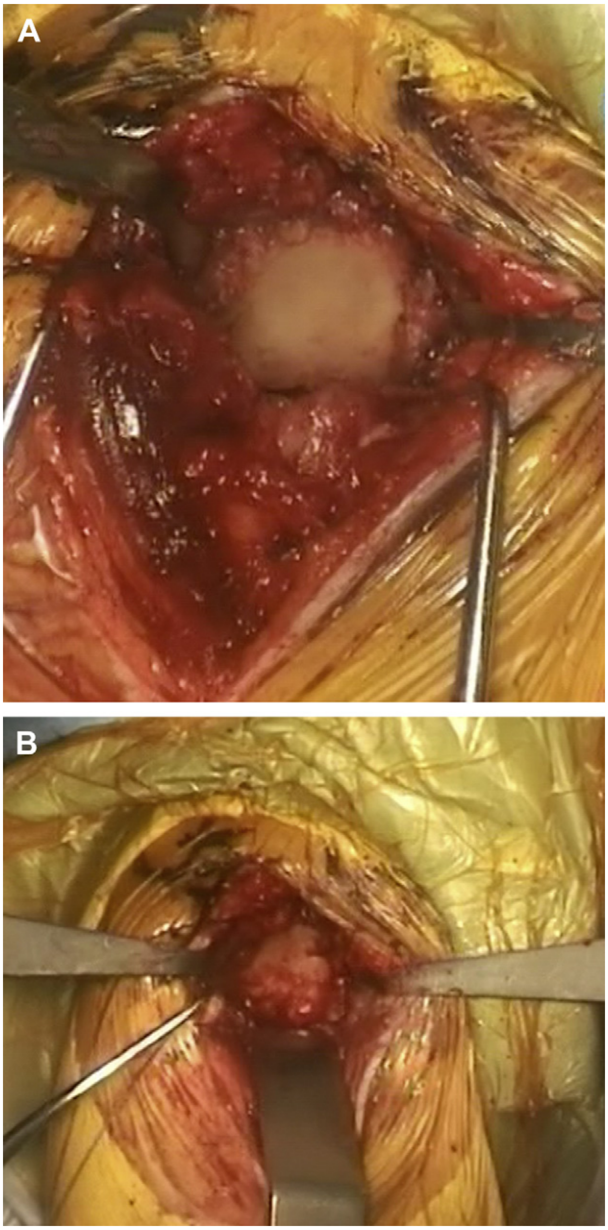

Figure 5 **(A)** After the humeral osteotomy has been made, **(B)** the anterior and posterior retractors are supplemented by the inferior glenoid retractor to expose the glenoid for preparation and implantation.

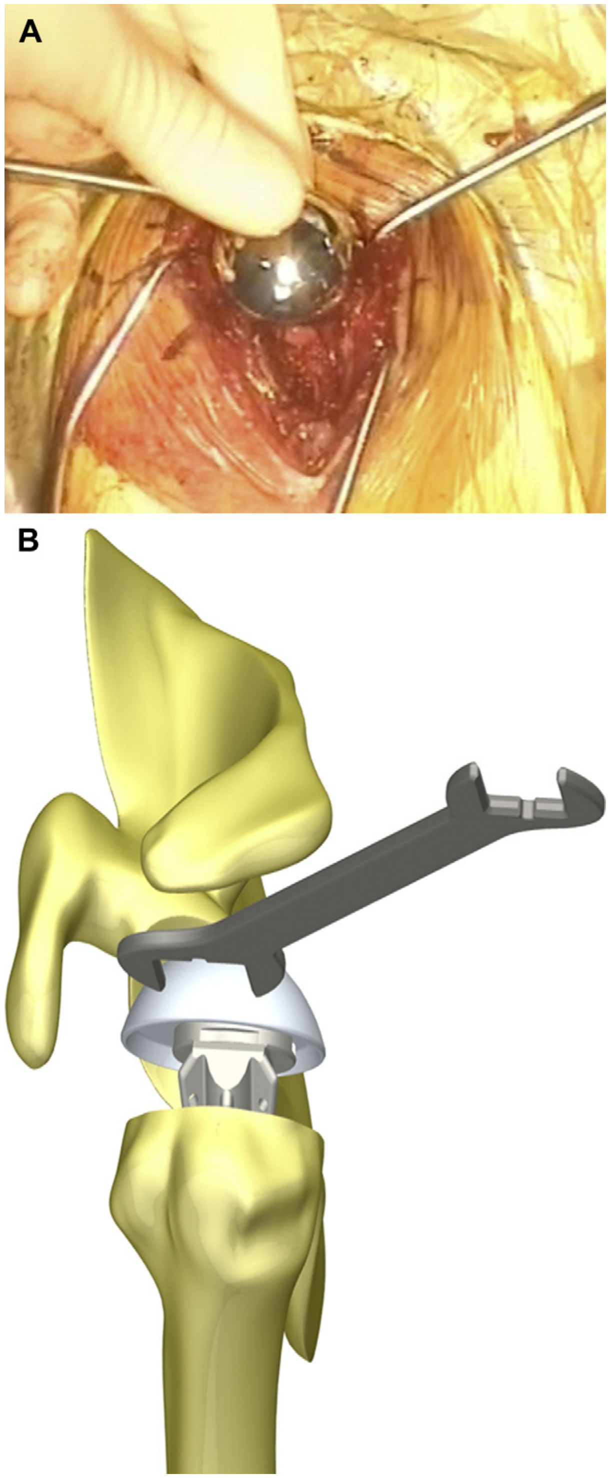

Figure 6 **(A)** The definitive prosthesis is constructed extracorporeally and placed into the intramedullary canal anteverted 90° until it has been impacted underneath the lateral acromion. **(B)** At this point, a Spanna wrench (DePuy Inc, Warsaw, IN) is used to rotate the prosthesis into its final and anatomic version.

performing a TSA entirely through the rotator interval. The short-term clinical outcomes from our study appear to compare favorably with the early outcomes reported for primary shoulder arthroplasty performed using the deltopectoral approach.

The rotator interval was originally described by Neer as the space separating the supraspinatus and subscapularis.[18] The rotator interval is trapezoidal in shape and occupies the space between the supraspinatus and subscapularis in the anterosuperior aspect of the shoulder.[2,6,13,20,21]

In our study, we hypothesized that a TSA could be performed entirely through the rotator interval, resulting in comparable early results for functional outcomes and levels of pain relief compared with the standard deltopectoral approach for this procedure. The results are summarized in Table II.

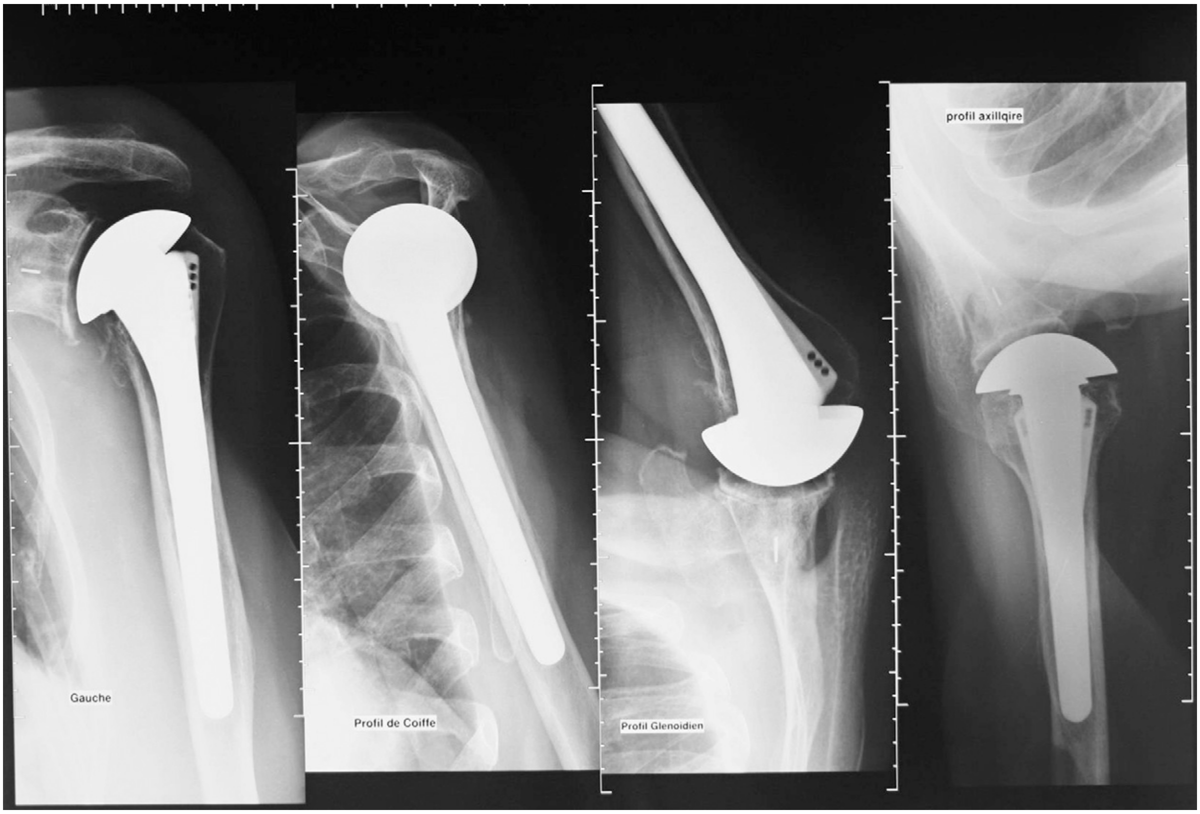

Figure 7 The prosthesis after it has been implanted using the rotator interval approach. Note remnant inferior osteophytes from the humeral neck remain on the different views. The head is well seated within the glenoid.

Table I Demographic data

Patient	Age, y	Follow-up, mon
1	77	33
2	45	33
3	57	33
4	62	32
5	55	32
6	75	31
7	67	31
8	76	29
9	81	29
10	67	27
11	71	26
12	71	26
13	74	26
14	49	26
15	80	25
16	57	24
17	66	24
Mean $\pm$ SD (range)	66.47 $\pm$ 10.794 (45-81)	28.65 $\pm$ 3.334 (24-33)

One of the key advantages of the rotator interval approach described in this study is that the subscapularis remains unviolated during TSR, so the risk of subscapularis insufficiency after shoulder arthroplasty as performed through the deltopectoral approach is avoided. The literature does not define a clear incidence of subscapularis failure after TSR surgery with release of the subscapularis.[5] However, several investigators have reported subscapularis insufficiency after TSR when a tenotomy of the tendon was used to exposure the glenohumeral joint:

- Walch and Boileau[24] have reported that the rate of subscapularis insufficiency after TSR to be as high as 40%.
- Armstrong et al[1] used ultrasound imaging to evaluate subscapularis dysfunction after TSR and found that 13.3% of 30 shoulders had a failed tendon repair at final follow-up.[1]
- Miller et al[15] reported a 5.8% revision rate after TSR for failure of the subscapularis repair in 119 patients.
- In a separate study of 41 patients after TSR using a complete tenotomy of the subscapularis for glenohumeral joint access, Miller et al[16] found an abnormal results for the lift-off test in 67.5% of patients and for belly-press test in 66.6%.

Several authors have shown that unrecognized failures of the subscapularis after anterior shoulder procedures progress along the natural history of traumatic subscapularis tendon ruptures and result in progressive fatty degeneration and atrophy, ultimately resulting in an

Table II Clinical outcomes according to preoperative and postoperative scores and subjective satisfaction

Patient	VAS		Adjusted CS		SST, %		FF,°		Subjective patient satisfaction score
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	
1	8	5	39	64	25	75	120	130	Good
2	8	5	24	57	25	83	60	140	Good
3	9	3	54	83	25	100	160	170	Good
4	9	2	38	96	33	100	90	170	Excellent
5	8	2	30	52	8	58	60	100	Excellent
6	7	4	26	46	17	33	70	120	Good
7	10	1	7	65	0	75	40	110	Excellent
8	5	1	50	95	25	100	80	170	Excellent
9	10	1	27	90	8	100	90	160	Excellent
10	10	6	23	82	0	100	70	155	Excellent
11	4	1	28	98	42	100	80	160	Excellent
12	10	1	22	98	0	100	45	170	Excellent
13	9	1	22	90	33	100	30	180	Excellent
14	5	2	32	68	0	67	45	90	Excellent
15	10	1	13	79	0	92	60	155	Excellent
16	6	1	28	91	25	100	40	180	Excellent
17	9	4	27	90	8	92	70	160	Excellent

CS, Constant score; *FF,* forward flexion; *SST,* Simple Shoulder Test; *VAS,* visual analog scale.

irreparable tear.[10,16,17] If a lesser tuberosity osteotomy is performed to release the subscapularis, however, the problem of subscapularis insufficiency appears to be significantly lessened. Gerber et al[9] reported 36 patients who had a lesser tuberosity osteotomy for the subscapularis reconstruction during TSR and found that 75% and 89% of patients had a negative lift-off and belly-press test, respectively. An increase in fatty infiltration of the subscapularis by at least 1 stage was noted in 40%, however, and 15% had an increase of at least 2 stages using the Gouttalier staging system.[9] Ponce et al[22] studied 76 patients after TSR using a lesser tuberosity osteotomy to release the subscapularis and had 1 failure of the subscapularis reconstruction. They also reported that the belly-press and lift-off test results were normal in 62 patients, abnormal in 5, and not documented in 9.[22]

A superior approach for primary TSR using the Neer II prosthesis was recently described by Zilber et al.[25] They retrospectively reviewed 20 shoulders in 16 patients. At a mean of 3.5 and 11.5 years follow-up they reported Constant scores of 57 and 51 points, respectively, compared with a preoperative mean Constant score of 25 points. The approach they described differs from the technique we are reporting because it included sectioning of part of the subscapularis tendon and a small portion of the supraspinatus. They were able to show that the incidence of superior migration of the humeral head was significantly decreased with the superior approach. Interestingly, they did not observe significant problems with rotator cuff tear or weakness longer-term, although the gains in forward flexion postoperatively was only 20° compared with our early results at 2 years demonstrating a mean increase in forward flexion of 77°.

Another advantage of the rotator interval approach for performing TSR, in our opinion, is that the glenohumeral joint is never dislocated. We hypothesize that TSR is a soft-tissue balancing procedure and that avoiding the dislocation of the glenohumeral joint results in less disruption of the soft-tissue structures about the shoulder joint, thereby enabling optimal tensioning of the shoulder arthroplasty.[8,12] It is our view that all arthroplasty is a soft-tissue procedure and adequate soft-tissue balancing is essential for a good outcome. This procedure alone does not confer soft-tissue balancing, because this must be done at the time of surgery. In this procedure, we do not take down the subscapularis because several problems have been associated with subscapularis take-down.[15,16]

The mean postoperative forward flexion in the scapular plane was 148.2° compared with a preoperative flexion of 71.2°, which is comparable to early results from other studies for flexion. The results for internal and external rotation after TSR are relatively underreported in the literature, although many would acknowledge that these are functionally important motions for the shoulder. The mean internal rotation of the patients in this study was to L1, and the mean postoperative external rotation was with the hand behind the head and elbow anterior to the coronal plane of the thorax. As such, a nearly full range of external and internal rotation was achieved after TSR. We propose that these results favorably reflect on the ability to regain good soft-tissue balancing after TSR with the rotator interval approach we have described.

The analysis of the postoperative radiographs from the patients in this study demonstrates 3 technical difficulties with the rotator interval approach for TSR we have described. First, an anatomic humeral neck cut is difficult to ensure given that the anterior shoulder is not well visualized with this technique. As a result, 6 of the 17 postoperative radiographs showed humeral osteotomies that were not anatomic.

Second, the inferior humeral neck osteophytes were not adequately resected in 8 patients. This problem is likely the result of poor visualization and access to the inferior neck of the humerus from the superior approach used to perform the TSR described in this study. The clinical significance of this finding is unclear, although no statistically significant difference in function was found in those patients with adequate inferior osteophyte resection and those with inadequate débridement of the inferior neck osteophytes.

Third, humeral head sizes were too small in 5 of the 17 patients. Again, this problem is likely the result of technical difficulties with assessment of the trial components in the coronal plane while visualizing the glenohumeral joint from the superior approach through the rotator interval. We noted a tendency to size the humeral head component smaller than it should have been as analyzed with postoperative coronal plane images postoperatively because none of the patients had humeral head components that were too large. Interestingly, no glenoid components were malpositioned. We hypothesize that this outcome is the result of the excellent glenoid exposure that is achieved en face using the superior approach through the rotator interval exposure. We also had no patients with deltoid insufficiency.

Because the rotator interval approach for TSR described in this study involved a split in the deltoid and no tenotomy of the subscapularis, our postoperative rehabilitation protocol did not include any restrictions. The subscapularis was never tenotomized, so subscapularis insufficiency was not anticipated or observed in any of the 17 patients. The patients were encouraged to move their shoulders actively in all planes as soon as tolerated immediately after surgery. We believe this confers a significant potential advantage and change from graduated rehabilitation programs where the subscapularis has been violated during TSR.[3,4,11]

The weaknesses of this study include the small sample size and the relatively early follow-up of 2 years. In addition, this study was not randomized to include a cohort of patients undergoing TSR using the standard deltopectoral approach. The study did not include any revision TSRs, and we would not advocate this approach for a revision procedure.

In conclusion, the results of our study compare favorably with other studies evaluating pain relief and functional outcome after TSR. Our hypothesis is that rotator interval approach for TSR described in this study possesses several theoretic advantages compared with the deltopectoral approach for primary TSR, including that the subscapularis is not tenotomized, the glenohumeral joint is not dislocated, and the postoperative rehabilitation does not include any limitations. Longer-term follow-up and further study are necessary to definitively determine whether the rotator interval approach is comparable with the deltopectoral approach for TSR.

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