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ORIGINAL PAPER

Significant improvement in patient self-assessed comfort and function at six weeks after the smooth and move procedure for shoulders with irreparable rotator cuff tears and retained active elevation

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Abstract

Background It has been documented that the smooth and move procedure—smoothing the proximal humeral surface while maintaining the coracoacromial arch—can provide clinically significant long-term improvement in function for patients having irreparable rotator cuff tears with retained active elevation. This study sought to demonstrate that clinically significant gains in comfort, function, and active motion can be realized as early as 6 weeks after this procedure.

Methods We conducted a prospective cohort study of the 6-week clinical outcomes for 48 patients enrolled prior to a smooth and move procedure for irreparable rotator cuff tears. Prior rotator cuff repair had been attempted in 28 (70%).

Results In 40 patients with preoperative and 6-week postoperative measurements, the Simple Shoulder Test scores improved from an average of 3.4 ± 2.8 preoperatively to 5.7 ± 3.5 at 6 weeks ($p < 0.001$), an improvement that exceeded the published values for the minimal clinically important difference (MCID). The clinical outcomes were not worse for the 18 shoulders with irreparable tears of both the supraspinatus and infraspinatus. In 30 patients with preoperative and 6-week postoperative objective measurements of active motion, the average abduction improved from 93(± 43) to 123(± 47)° ($p = 0.005$) and the average flexion improved from 102(± 46) to 126(± 44)° ($p = 0.023$).

Conclusions In addition to its previously documented long-term effectiveness for shoulders with irreparable rotator cuff tears and retained active elevation, this study demonstrates that the smooth and move procedure provides clinically significant improvement as early as 6 weeks after surgery.

Keywords Irreparable rotator cuff tear · Smooth and move procedure · Clinical outcomes · Active abduction · Active flexion

Level of Evidence: Level II prospective cohort study

Investigation Performed at the University of Washington, Department of Orthopedics and Sports Medicine, Seattle, WA

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Introduction

Rotator cuff tears are among the commonest of shoulder conditions, affecting a high percentage of individuals over the age of 60 [1–6]. Many of these tears are asymptomatic [7–12]. Non-operative management is effective in a high percentage of symptomatic degenerative cuff tears [1, 13–15]. Over one quarter of rotator cuff repair attempts fail to re-establish the integrity of the rotator cuff, yet patients are often clinically improved in spite of this failure, suggesting that there may be a beneficial effect of rotator cuff surgery even if the repair is not successful [16]. Because of these observations, the indications for rotator cuff repair cannot be clearly defined [17–25]. The guidelines for the management of irreparable cuff tears are even less clear [26]: proposed treatment options include non-operative management [27–29], graft augmentation [30–35], superior capsular reconstruction [36–43], subacromial spacers [44–48], tendon transfers [49–59], debridement [60], tuberoplasty [61], and reverse total shoulder [62–66].

The smooth and move procedure offers a conservative surgical option for the management of symptomatic irreparable rotator cuff defects in shoulders with retained active elevation; the goal of this simple procedure is to smooth the surface of the proximal humeral convexity [67] while retaining the integrity of the coracoacromial arch and allowing immediate postoperative active motion [68]. A recent report of 151 patients with a mean age of 63.4 years at an average of 7.3 years after surgery found that in 77 shoulders with previously unoperated irreparable tears, the Simple Shoulder Test (SST) scores improved from an average of 4.6 to 8.5 ($p < 0.001$). For 74 shoulders with irreparable cuff defects after failed prior repair attempts, SST scores improved from 4 to 7.5 ($p < 0.001$). These improvements exceeded the published values for the minimal clinically important difference (MCID) in the Simple Shoulder Test [69, 70]. In addition to its efficacy, simplicity, and low cost, one of the principal advantages of the smooth and move procedure is that the patient can begin actively using the shoulder immediately after surgery, avoiding the functional limitations that are necessary to protect a reconstruction while it heals [71, 72]. Another important advantage is that this conservative procedure does not preclude the subsequent consideration of more complex surgeries should it fail to yield the desired outcome.

In that one of the proposed advantages of the smooth and move procedure is that it allows early resumption of active function, we sought to document the early recovery after the smooth and move procedure in a prospective cohort study. Specifically, we tested the hypothesis that this procedure would lead to clinically significant improvement in patient comfort, function, and active motion as early as 6 weeks after the surgery.

Materials and methods

In our practice, the range of management options is presented to patients with primary rotator cuff tears or failed prior repairs that we suspect are irreparable: non-operative management, attempted repair, superior capsular reconstruction, tendon transfers, and reverse total shoulder arthroplasty. The option of a smooth and move procedure is presented to patients with retained active elevation above horizontal, but with refractory symptoms of pain, stiffness, and crepitance in association with a rotator cuff defect that we suspect cannot be durably repaired. Evidence that the cuff may be irreparable may include some combination of atraumatic onset of symptoms, older patient age, longstanding weakness of elevation or external rotation, cuff muscle atrophy, superior displacement of the humerus relative to the scapula on X-rays (Fig. 1), or rotator cuff imaging revealing poor tendon quality and quantity. The smooth and move is not offered to patients with glenohumeral arthritis, glenohumeral instability, pseudoparalysis, anterosuperior escape, or active infection. Patients are informed that the final

Fig. 1 The preoperative X-ray of a shoulder with a failed prior attempt at rotator cuff repair. The patient had active elevation above 100° before surgery, but the shoulder was painful and limited his ability to pursue his interest in high-level wilderness photography. The radiograph shows contact between the upper aspect of the humeral head and the acromion, suggesting that the rotator cuff is irreparable

determination of an irreparable tear is made at the time of surgery, i.e., that the size of the defect and the quality of the remaining tissue preclude secure anatomic tendon reattachment to bone [73]. Patients are informed (1) that the goal of the smooth and move surgery is not to repair the cuff defect, but rather to improve comfort and motion by resolving scar tissue, adhesions, capsular contracture, surface irregularities of bone and soft tissue, and any debris from prior repair attempts and (2) that they will be encouraged to resume active use of their arm immediately after surgery without concern for disrupting a repair or reconstruction.

Patients consenting to this procedure are invited to enroll in a prospective cohort study, the goal of which is to compare the Simple Shoulder Test scores and active shoulder range of motion before surgery and at 6 weeks after a smooth and move procedure. This analysis included all 48 consenting patients having a smooth and move procedure for irreparable cuff defects with retained active elevation performed by an individual surgeon (FAM) between February 1, 2015 and September 28, 2018.

At the preoperative clinic visit, demographic data and Simple Shoulder Test scores were collected. The active ranges of abduction, flexion, and cross-body adduction were measured by a research assistant (AW) using the observer-independent Kinect Motion Capture System as previously described and validated [74–76]. For the patients who were able to return for a 6-week postoperative visit, we repeated the Simple Shoulder Test and, when possible, the Kinect active motion measurements.

The surgical technique was as previously described [68]. The shoulder is approached through a deltoid split near the acromion in the raphe between its anterior and middle thirds; there is no detachment of the muscle origin; acromioplasty is avoided to preserve the integrity of the coracoacromial arch. The shoulder is thoroughly inspected to determine the extent of the rotator cuff defect and to verify that the tear is irreparable, i.e., good quality tendon could not be securely fixed to the normal insertion site with the arm at the side. All hypertrophic bursal tissue, adhesions, suture and exposed suture anchors are removed along with ragged tendon edges and prominent tuberosity bone (Fig. 2). The surgeon's index finger is passed through the humeroscapular motion interface [67] to assure that all adhesions, including those between the subscapularis and the coracoid muscles, have been released. Biceps tenotomy is performed if the tendon is frayed or subluxated. The shoulder is gently manipulated through a full range of motion to resolve any capsular contracture. An experienced shoulder therapist (SEJ) instructs the patient in postoperative full range of motion stretching and deltoid strengthening exercises on the day of surgery. Patients are encouraged to resume their usual activities progressively as their shoulder comfort allows (Figs. 3 and 4) (Appendix Video—Function at 6 weeks after a smooth and move. Same patient as in Figs. 1, 2, 3, and 4).

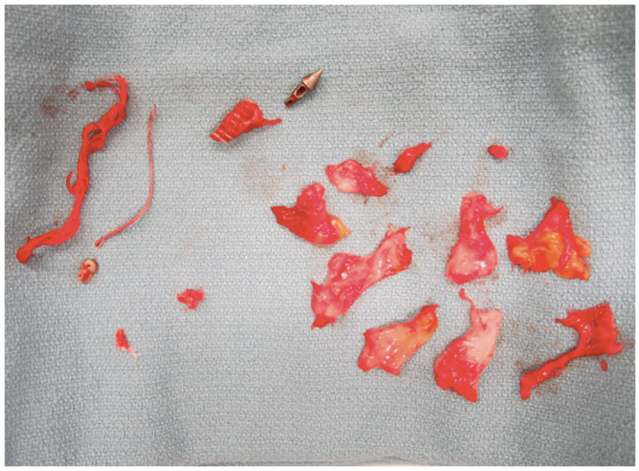

Fig. 2 The debris removed from the humeroscapular motion interface of the shoulder shown in Fig. 1. At the time of the smooth and move procedure, the complete absence of reparable supraspinatus and infraspinatus tendons was documented

The status of the rotator cuff was documented at surgery; as we suspected preoperatively, all 48 patients were found to have rotator cuff defects that were not reparable. Of these 48, 40 (83%) were able to return for a 6-week follow-up visit at which time the Simple Shoulder Test was repeated. The characteristics of the 8 patients who were unable to return were compared to those of the 40 patients who returned for follow-up using the unpaired *t* test. For the 40 patients with 6-week follow-up, the preoperative and 6-week SST scores were compared using the paired *t* test. Subgroup analyses were carried out for those patients with irreparable tears of the supraspinatus only and those having irreparable tears of the supraspinatus and infraspinatus.

We were able to obtain 6-week postoperative active range of motion measurements in 30 patients (63%). For these 30 patients, the preoperative and postoperative active motions were compared using the paired *t* test.

This study was approved by our Institutional Review Board STUDY00004686.

Source of funding

There was no extramural funding for this investigation.

Results

Of the 48 patients who were prospectively enrolled in this study, 19 (40%) were male; the average age was 64 ± 9 years (Table 1). These patients had substantial loss of shoulder comfort and function as indicated by an average preoperative SST score of 3.6 out of a possible 12. Prior cuff repair had been attempted in 34 (71%). An irreparable tear confined to the supraspinatus was found in 26 (54%) while both the

supraspinatus and infraspinatus were involved in 22 (46%). Biceps tears were found in 15 (31%); one patient had biceps tendon fraying requiring tenotomy.

For the 40 patients who were able to return to clinic for follow-up at 6 weeks, the SST score improved from an average of 3.4 ± 2.8 preoperatively to 5.7 ± 3.5 at 6 weeks after surgery ($p < 0.001$) (Table 1). This average improvement in the SST at 6 weeks exceeded the published value of 2 for the minimal clinically important difference [69, 70]. The improvement in each of the 12 individual functions of the SST is shown in Fig. 5. The average improvement in the SST was not worse for the 18 (45%) of the shoulders with irreparable tears of both the supraspinatus and infraspinatus than for the 22 (55%) of shoulders with tears confined to the supraspinatus (Table 1).

The preoperative and surgical findings for the 8 patients (17%) unable to return to clinic for a 6-week clinical follow-up were not significantly different from those of the 40 patients (83%) with 6-week clinical follow-up (Table 1).

For the 30 shoulders with preoperative and 6-week postoperative range of motion measurements, active abduction improved from 93 ± 43 to 123 ± 47° ($p = 0.005$), active flexion from 102 ± 46 to 126 ± 44° ($p = 0.023$), and active cross-body adduction from − 5.5 ± 2.3 to − 3.6 ± 2.6 cm from the midline ($p = 0.003$) (Table 2).

There were no intraoperative complications or any postoperative complications within the first 6 weeks of this procedure.

Discussion

In addition to the previously documented long-term benefits of the smooth and move procedure, this prospective cohort study demonstrates that patients with irreparable rotator cuff tears and retained active motion can realize improvement in self-assessed shoulder comfort and function that exceeds the minimal clinically important difference as early as 6 weeks after the smooth and move procedure. These results complement those of the prior report demonstrating the clinically significant long-term improvement realized at an average of

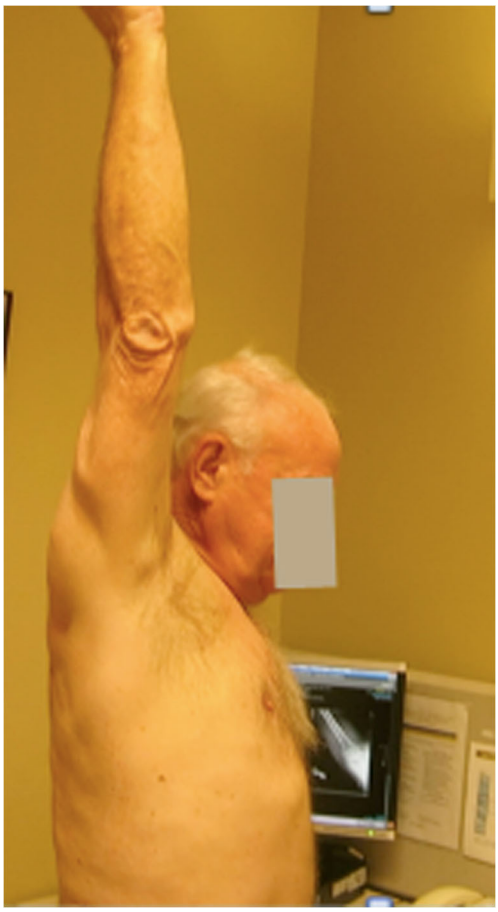

Fig. 3 The active flexion of the shoulder shown in Fig. 1, 6 weeks after the smooth and move procedure. Eight weeks after surgery the patient was able to photograph polar bears north of the Arctic Circle

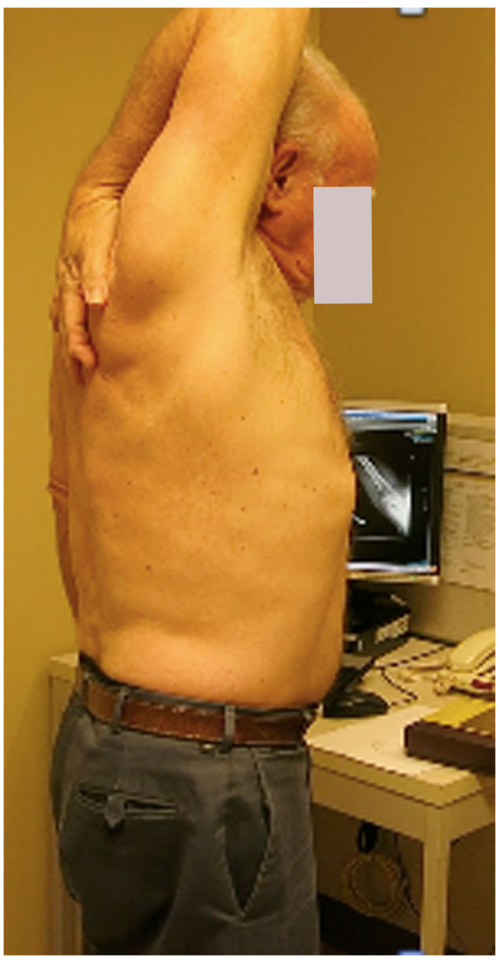

Fig. 4 The active backward reach of the shoulder shown in Fig. 1, 6 weeks after the smooth and move procedure

Table 1 Characteristics of all patients with irreparable cuff tears

	All 48 enrolled shoulders	All shoulders with follow up (40/48 (83%))	Follow-up shoulders with irreparable supraspinatus tear only (22/40 (55%))	Follow-up shoulders with irreparable supraspinatus and infraspinatus tears (18/40 (45%))	Shoulders without follow-up (8/48 (17%))
Male	19 (40%)	16 (40%)	11 (50%)	5 (28%)	3 (38%)
Age (years)	64 ± 9	65 ± 10	64 ± 10	66 ± 9	61 ± 7
Right shoulders	33 (69%)	27 (68%)	15 (68%)	12 (67%)	6 (75%)
Prior repair attempt	34 (71%)	28 (70%)	17 (77%)	11 (61%)	6 (75%)
Supraspinatus tear only	26 (54%)	22 (55%)			4 (50%)
Percent supraspinatus and infraspinatus tear	22 (46%)	18 (45%)			4 (50%)
Percent biceps torn	15 (31%)	12 (30%)	6 (27%)	6 (33%)	3 (38%)
Percent subscapularis torn	3 (6%)	3 (8%)	2 (9%)	1 (6%)	0 (0%)
Preoperative SST	3.6 ± 2.8	3.4 ± 2.8	3.6 ± 2.8	3.22 ± 2.8	4.6 ± 3.2
6 weeks postoperative SST		5.7 ± 3.5	5.4 ± 3.4	6.1 ± 3.6	
p value (paired *t* test)		< 0.001	0.007	< 0.001	

over 7 years after the smooth and move procedure for symptomatic irreparable rotator cuff tears in shoulders with retained active elevation [68]. In the prior study, 77 shoulders with previously unrepaired irreparable tears improved from an SST average of 4.6 to 8.5 ($p < 0.001$), and 74 shoulders with irreparable tears after a prior repair attempt improved from an SST average of 4.0 to 7.5 ($p < 0.001$).

The smooth and move is a conservative procedure that offers the opportunity for early resumption of shoulder activities without concern for disrupting the integrity of a reconstructive procedure, such as superior capsular reconstruction, tendon augmentation, or tendon transfer. Because it does not compromise essential shoulder structures, the smooth and move procedure does not preclude any of the other options that might be subsequently offered to patients with irreparable rotator cuff tears, should it prove unsuccessful. While there are other reports of non-repair surgeries for addressing irreparable cuff tears [60, 61, 77–81], it is not apparent that these procedures yield outcomes that are superior to those of the simple smooth and move procedure for patients with retained active elevation.

This study needs to be viewed in light of certain limitations. First, the purpose of the investigation was only to explore the early (6-week) improvements in shoulder comfort, function and active range of motion, realizing that a principal advantage of this procedure is that it allows early return to active use of the shoulder; the longer-term (7-year) outcomes for this procedure have been documented previously [68]. Secondly, this study does not compare the 6-week outcomes of the smooth and move to the 6-week results of other surgical approaches, such as graft augmentation, superior capsular reconstruction, or tendon transfers. Third, our definition of "irreparable" may

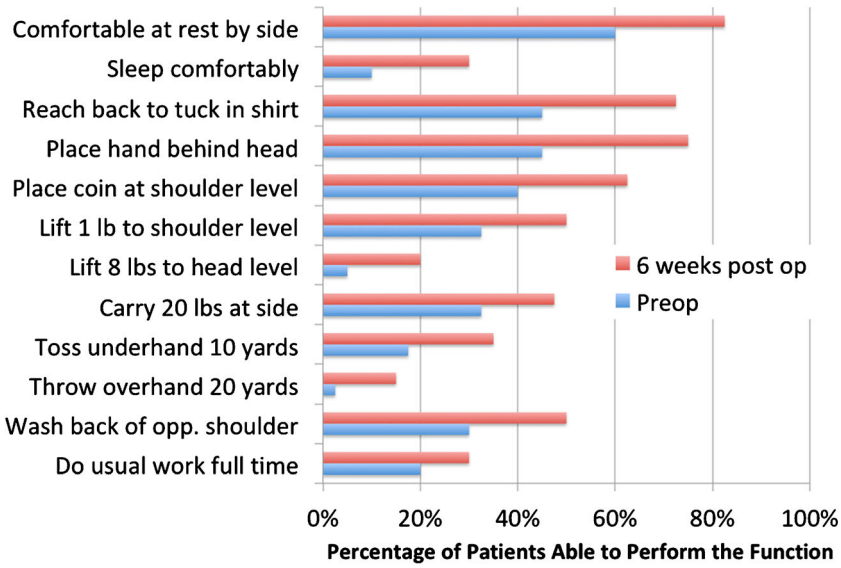

Fig. 5 The percentage of shoulders able to perform each of the 12 functions of the Simple Shoulder Test before and 6 weeks after the smooth and move procedure

Table 2 Preoperative and 6-week postoperative active motion in 30 patients having the smooth and move procedure for irreparable cuff tears

	Preoperative	6 weeks postoperative	*p* value
Active abduction (°)	93 ± 43	123 ± 47	0.005
Active flexion (°)	102 ± 46	126 ± 44	0.023
Cross-body adduction (cm from midline)	− 5.5 ± 2.3	− 3.6 ± 2.6	0.003

differ from that of other surgeons; it is of note, however, that 71% of the shoulders in this cohort study had failed prior attempts at surgical repair. Finally, the number of cases in this analysis was relatively small; however, the number was sufficient to show clinically and statistically significant improvement in comfort, function, and objectively measured motion at 6 weeks after the smooth and move procedure.

Conclusion

The long-term effectiveness of the smooth and move procedure has been previously documented. This study complements the prior report by demonstrating that the smooth and move procedure provides clinically significant improvement as early as 6 weeks after surgery. This conservative procedure minimizes activity limitations during the patient's recovery and does not preclude subsequent more complex reconstructions in the uncommon situation where the outcome of the smooth and move is not satisfactory.

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Compliance with ethical standards

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This was a Level II prospective cohort study approved by our Institutional Review Board (STUDY00004686). For this type of study, formal consent is not required.

Informed consent N/A.

Conflict of interest The authors declare that they have no conflict of interest.

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