Trans-Rotator Cuff Portal Is Safe for Arthroscopic Superior Labral Anterior and Posterior Lesion Repair: Clinical and Radiological Analysis of 58 SLAP Lesions

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Trans-Rotator Cuff Portal Is Safe for Arthroscopic Superior Labral Anterior and Posterior Lesion Repair

Clinical and Radiological Analysis of 58 SLAP Lesions

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Background: There are numerous accessory portals for the arthroscopic repair of superior labral anterior and posterior lesions. Many surgeons are reluctant to make a portal through the cuff because of concern about iatrogenic injury to the cuff.

Hypothesis: An arthroscopic superior labral anterior and posterior lesion repair procedure using the trans-rotator cuff portal may yield favorable clinical and radiological outcomes, and cuffs may heal properly.

Study Design: Case series; Level of evidence, 4.

Methods: Fifty-eight consecutive patients undergoing superior labral anterior and posterior lesion repair using the trans-rotator cuff portal, who had available both functional and radiological outcomes after 1 year of the operation, were enrolled. We evaluated the structural outcomes for the labrum and cuff using computed tomographic arthrography and measured various clinical outcomes (the supraspinatus power, visual analog scale for pain and satisfaction, American Shoulder and Elbow Surgeons shoulder evaluation form, University of California–Los Angeles shoulder score, Constant score, and Simple Shoulder Test) at the final visit.

Results: All functional outcomes were improved significantly ($P < .001$). On computed tomographic arthrography, labral healing to the bony glenoid was achieved in all patients. Subacromial leakage of contrast media was observed in 3 patients (5.2%) through the muscular portion without any retraction or gap of the tendon. Two of 3 had preoperative cuff pathologic changes, and they were older than 45 years of age. Partial articular cuff tears were observed in 6 patients (10.3%), and 4 had the lesion preoperatively. There were no statistical differences in functional scores according to the presence of preoperative lesion, postoperative leakage, or partial cuff tear.

Conclusion: The data demonstrate favorable outcomes for arthroscopic superior labral anterior and posterior lesion repair using the trans-rotator cuff portal. We suggest that the trans-rotator cuff portal is an efficient and safe portal for superior labral anterior and posterior lesion repair, although there are some valid concerns of damaging the cuff in patients with a superior labral anterior and posterior lesion with concurrent cuff disorders, as well as in older patients.

Keywords: trans-rotator cuff portal (TRCP); superior labral anterior and posterior (SLAP) lesion; computed tomographic arthrography (CTA)

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Injuries to the biceps tendon and the superior labrum were first reported by Andrews et al.[1] Snyder et al[22] further identified a spectrum of lesions and named it the superior labrum anterior and posterior (SLAP) lesion (type I-IV). Several authors have added subtypes of SLAP lesions, and there are 10 types currently.[11,19] The accepted treatment of the SLAP lesion is to arthroscopically reattach the unstable

biceps anchor to the original insertion site. The management of the lesion has improved along with the evolution of arthroscopic technique. Traditionally, 3 portals have been used in SLAP repair: a posterior viewing portal, an anterior portal located just above the lateral border of the subscapularis tendon, and an anterosuperior portal just lateral to the anterolateral corner of the acromion.[3] Fixation of the anterosuperior quadrant can be easily achieved using a standard anterosuperior portal.

However, access to the posterosuperior quadrant in posterior SLAP lesions is problematic with a conventional anterosuperior portal.[3,17,24] The aiming angle of anchor is usually poor, so slippage or inadequate bony purchase of the anchor frequently occurs. Furthermore, posterior SLAP lesions, called "throwers' SLAP lesions," are common and are related to the pathologic peel-back phenomenon described by Burkhart et al[3] or internal impingement. The authors insisted that posterior labral repair is the key procedure of SLAP repair; they called it the "money stitch." Vangsness et al[25] also reported 4 types of the origins of biceps long head from the anatomical study. In type I, the labral attachment is entirely posterior (22%); type II, most of the labral contribution is posterior with some anterior component (33%); type III, there is equal contributions from both the anterior and posterior labrum (37%); type IV, most of the contribution is anterior (8%). According to this study, the biceps tendon attachment to the labrum receives a major contribution from the posterior labrum in 55% (type I and II), and only 8% of cases (type IV) are from the anterior labrum.[25]

Therefore, some authors advocate using other accessory portals through the rotator cuff for the repair of SLAP lesions.[10,16,17] Nevertheless, there have been concerns with regard to using portals through the cuff, as well as some reports of unfavorable outcomes with a trans-rotator cuff portal (TRCP).[4,6] The purpose of the current study was to evaluate the clinical and radiological outcomes of arthroscopic SLAP repair using TRCP, and to determine whether this portal is safe when used properly. The hypothesis was that an arthroscopic SLAP repair procedure using the TRCP may yield favorable clinical and radiological outcomes, and cuffs may heal properly.

MATERIALS AND METHODS

Demographics

Fifty-eight consecutive patients with SLAP lesions between July 2004 and June 2006 were included, all of whom had undergone arthroscopic SLAP repairs using TRCP, and whose various functional outcome measurements and computed tomographic arthrography (CTA) after 1 year of operation were available. Patients with concomitant partial-thickness rotator cuff tear (either bursal or articular) and preoperative stiffness were included. Included partial tears were mainly fraying of the tendon, and the involvement of the footprint was minimal (<30%). To those who had concomitant stiffness, we encouraged patients to mobilize the shoulder during the period of waiting for surgery and educated them about the importance of postoperative rehabilitation. Patients with concomitant full-thickness rotator cuff tear, instability, an acromioclavicular problem, arthroscopic SLAP repair without TRCP, previous shoulder surgery, and/or accompanying psychological problems were excluded. Diagnosis of a SLAP lesion was determined by physical tests, magnetic resonance arthrography (MRA) or CTA preoperatively and ultimately by arthroscopic findings.

There were 46 male (79.3%) and 12 female patients. The mean age was 45.5 years (range, 20-68). The dominant arm was involved in 37 patients (63.8%). Their chief symptom was shoulder pain when the arm was held at a certain position, especially during abduction and external rotation. Twenty-five patients (43.1%) recalled the beginning of symptoms after a traumatic event, such as a car accident or injury during muscle-building exercise or parallel bar exercise. Twenty-two patients (37.9%) revealed symptoms after repeated shoulder motions, such as throwing and hammering. However, 11 patients (19.0%) denied any history of trauma to or overuse of their shoulders. On admission, every patient was asked to mark their levels of sports participation and shoulder activity on a 3-graded scale: high, moderate, and low. A high level of sports participation was defined as enjoying dynamic or contact sports (eg, boxing, rugby, basketball, tennis, volleyball, football), while the moderate level was defined as enjoying static sports (eg, golf, yoga, swimming, skiing, bicycle, running), and low level was listed as rarely joining in sports. Twelve patients (20.7%) reported a high level of sports participation; 17 (29.3%) patients admitted to a moderate level; and 29 patients (50%) claimed a low level of participation. A high level of shoulder activity during work was defined as heavy manual labor, for example, construction and manufacturing work; a moderate level was experienced by manual laborers with less activity, for example, housework; and sedentary work was defined as having a low level of shoulder activity. Eight patients (13.8%) answered that they worked at a high level of shoulder activity, 11 (19.0%) at a moderate level, and 39 (67.2%) at a low level. Data collection and all protocols were approved by the Institutional Review Board of the authors' institution, and written informed consent was obtained from all patients.

Preoperative Assessment

Comprehensive physical examination was performed on all patients upon admission, including range of motion (ROM), manual muscle strength, and tests for impingement syndrome, SLAP lesion, acromioclavicular joint instability, and scapular dyskinesia. Data were recorded prospectively on the day before the operation by the senior author. Examination for the SLAP lesion consisted of the Speed test, Yergason test, compression rotation test, active compression (O'Brien) test, modified Jobe's apprehension and relocation test, anterior slide (Kibler) test, Whipple test, and biceps load II test. An impingement test was done to confirm subacromial impingement. All patients underwent simple radiographs and a special imaging study with either MRA or CTA. A musculoskeletal radiologist confirmed the imaging diagnosis of the SLAP lesion. A single examiner

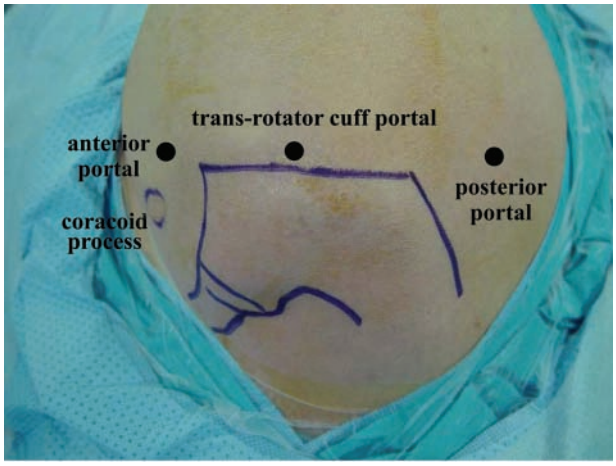

Figure 1. Conventional anterior and posterior portals were used, and a trans-rotator cuff portal (TRCP) was made at a lateral or slightly posterolateral aspect to the shoulder, staying just lateral to the acromion.

who was blinded to the study prospectively checked questionnaires for functional evaluation.

Surgical Procedure and Rehabilitation

All procedures were performed in an arthroscopic manner by the senior author. The patient was placed in the lateral decubitus position under general anesthesia. Traction was applied in approximately 30° of abduction and 10° of flexion. An approximately 10-pound weight was applied according to the constitution of the patients. Before the arthroscopic procedure, examination under anesthesia was performed to identify any subtle instability in comparison with the opposite extremity. In those patients with concomitant stiff shoulder, gentle manipulation under anesthesia was carried out before the SLAP repair.

Diagnostic arthroscopy was performed with a standard posterior viewing portal and anterior working portal. The superior labrum complex was palpated with a probe to determine the type of SLAP lesion.[3] When the pathologic "peel back" phenomenon was observed during abduction and external rotation position, the superior labrum was elevated more than 5 mm with a cartilaginous crack, and hemorrhagic spots or inflammatory granulation tissues beneath detached superior labrum were observed, the lesion was diagnosed as a type II SLAP lesion.[15] Additionally, we systematically evaluated the glenohumeral joint to determine whether there was damage other than the SLAP lesion, especially the articular side of the rotator cuff and whole labrum status. In those with articular-side partial-thickness cuff tear or stiff shoulder, we performed debridement of the partial tear or selective capsular release of the rotator interval and middle glenohumeral ligament.

All SLAP repair was performed using TRCP. At the outset of placement of the TRCP, a spinal needle was inserted from the lateral or slight posterolateral aspect of the shoulder just lateral to the acromion (Figure 1). The needle was placed around the 11-o'clock to 12-o'clock position of the glenoid for the right shoulder. To avoid violation of the supraspinatus tendon, the entry point was created through the muscular portion near the glenoid rim. The insertion angle was made about 60° to the superior glenoid tubercle. With a No. 11 blade, a horizontal incision approximately 1 cm in length was made on the skin, and a straight mosquito clamp was used to split and enlarge the portal through the deltoid, supraspinatus muscle, and capsule (Figure 2A), then an 8-mm cannula was introduced into the joint through the portal (Figure 2B).

After the release of adhesion between the superior portion of the labrum and the capsule, the subchondral bone of the supraglenoid tubercle was exposed with a high-speed bur through the TRCP or anterior portal. Typically, 2 holes were drilled through the TRCP at the 10-o'clock or 11-o'clock position and the base of the biceps anchor around the 12-o'clock or 1-o'clock position (Figure 2C). A suture hook loaded with No. 2 Polydioxanone (PDS) (Ethicon, Somerville, NJ) was introduced through the TRCP and pierced the posterosuperior labrum at the base of the biceps tendon. Then, a strand of the PDS (blue strand) was retrieved through the anterior portal (Figure 2D). An open utility loop (green loop) of bioabsorbable knotless suture anchors (Bioknotless anchor system; Mitek, Norwood, Mass) was retrieved from the TRCP through the anterior portal with the shuttle relay technique with PDS. The anchor was introduced from the TRCP with proper tension of the utility loop and balance loop (No. 2 PDS), and inserted into the drilled hole by capturing one strand of the closed anchor loop (white loop). The balance loop was hooked at the anchor loop to ensure the proper insertion length of the anchor loop (Figure 2E), and the anchor was inserted.

For type II SLAP lesions, additional second anchor fixation of the superior labrum was performed. At the time of finishing the repair, we checked for firm reattachment of the labrum to the glenoid with a probe (Figure 2F). A bursal scope was introduced when subacromial impingement or partial bursal-side rotator cuff tear had been suspected preoperatively. We confirmed the site of TRCP through the cuff muscle (Figure 3) and performed subacromial decompression and acromioplasty for those who had bursal-sided cuff lesions or subacromial impingement.

Postoperative Rehabilitation

The same rehabilitation protocol was applied to all patients. For 4 weeks, patients wore an abduction brace (Acro Assist 50A1; Ottobock, Duderstadt, Germany) with neutral rotation and 30° of abduction, but intermittently took off the brace while in the supine position to begin passive shoulder motion and scapulothoracic exercises the first day after surgery. After patients were weaned from the brace, active ROM exercises were allowed, and the gaining of full ROM was encouraged until 2 months after the operation. Then muscle-strengthening exercises were started with the Theraband (The Hygienic Corp, Akron, Ohio), and sports activity was allowed 5 to 6 months after the operation.

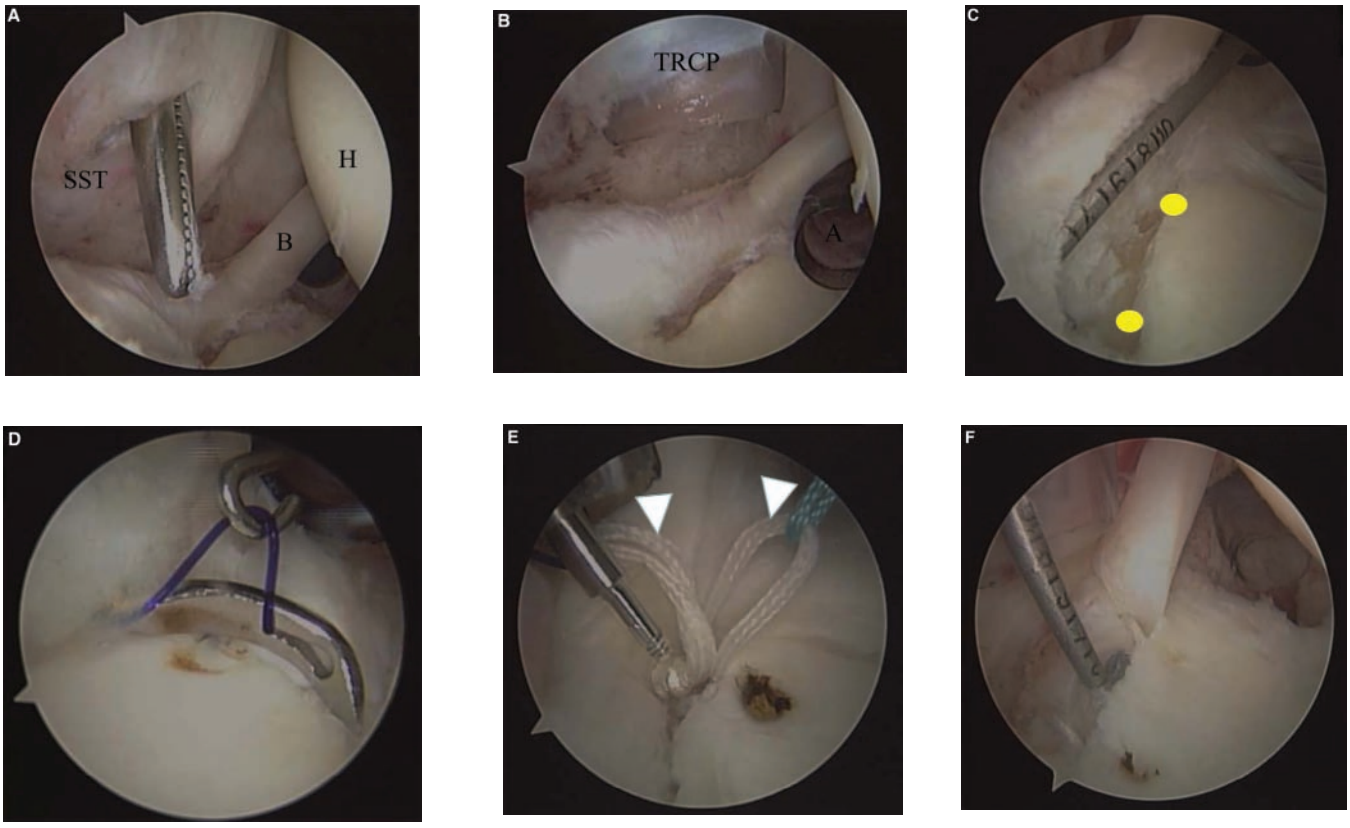

Figure 2. A, trans-rotator cuff portal (TRCP) was created through the muscular portion of supraspinatus near the glenoid rim. The insertion angle was made approximately 60° to the superior glenoid tubercle, and medial to the rotator cable. B, the cannula was inserted from the TRCP. C, after the preparation of the bone bed, the site of the anchor insertion was marked (yellow dots). D, a suture hook was introduced through the TRCP and sutured the superior labrum with biceps anchor. One strand of the PDS was retrieved to the anterior portal. E, bio-absorbable knotless suture anchor was inserted after catching 1 strand of the utility loop. Note that the balance and anchor loop are maintained at equal length (arrowheads). F, the stability of the repair was checked by a probe. SST, supraspinatus; B, biceps tendon; H, humeral head; A, anterior portal.

Outcome Evaluation

We evaluated structural outcomes for the labral status and leakage of the contrast media through the rotator cuff using CTA 1 year after the operation, and measured the clinical outcomes by means of the supraspinatus power, visual analog scale (VAS) for pain and satisfaction, American Shoulder and Elbow Surgeons (ASES) shoulder evaluation form, University of California–Los Angeles (UCLA) shoulder score, Constant score, and Simple Shoulder Test (SST) at a final visit 1 year after the operation. All radiological interpretations were done by a single musculoskeletal radiologist, and preoperative and various follow-up functional outcome measurements were evaluated by a single clinical examiner who was blinded to the study. Healing of the lesion was decided by no leakage of contrast media through the biceps anchor with firm attachment to the bony glenoid. However, dye filling at the anterosuperior quadrant labrum, especially below the 1-o'clock position, was not considered a failure. Articular-side partial-thickness rotator cuff tears were identified by dye filling through the supraspinatus attachment and/or fuzziness at the border.

Statistical Analysis

All statistical analyses were performed using SPSS software version 12.0 (SPSS Inc, Chicago, Ill). Chi-square, Fisher's exact, paired *t*, Wilcoxon signed-rank, and Kruskal-Wallis tests were used, and a *P* value of less than .05 was considered statistically significant.

RESULTS

The mean follow-up was 13.81 months (range, 12-24). The type II SLAP lesion was most common (51 patients, 87.9%) followed by type V (3, 5.2%), type IV (2, 3.4%), type III (1, 1.7%), and type VIII (1, 1.7%). There were neither dislocation histories nor instability symptoms in any type of SLAP lesion in the study.

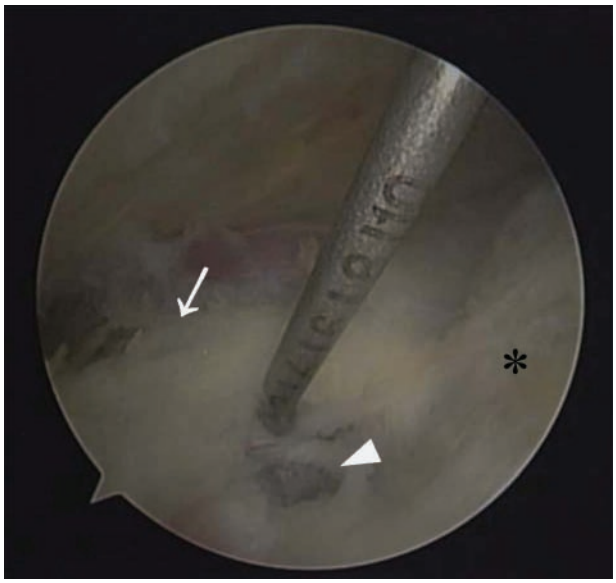

Figure 3. This subacromial view after SLAP repair demonstrates that TRCP was made through the muscular portion of the supraspinatus. Arrowhead, slit made by TRCP; Arrow, muscular portion of the supraspinatus; Asterisk, tendinous portion of the supraspinatus.

Accompanying lesions were found in 33 patients (56.9%). Articular-side partial-thickness rotator cuff tear (Figure 4) was identified in 18 patients (31%), and debridement of the partial cuff was performed in all. Bursal-side partial-thickness rotator cuff tear was found in 9 patients (15.5%), and all of these had positive response in impingement sign and impingement test (lidocaine injection test). Marked improvement of pain after a lidocaine injection into the subacromial space helped to distinguish the subacromial impingement pain from the glenohumeral pain by SLAP lesion, and subacromial decompression and acromioplasty were performed only on these patients with bursal-side lesions. All partial-thickness tears (either articular or bursal side) showed fraying of the tendon and did not involve the attachment at the footprint. Therefore, repairing the cuff was not necessary. The stiffness of the shoulder was combined with the SLAP lesion in 6 patients (10.3%), and manipulation under anesthesia with selective arthroscopic capsular release was conducted. Full recovery of ROM was achieved in all patients, including those who had concomitant stiffness.

All functional scores were improved significantly after arthroscopic repair of the SLAP lesion (Table 1, $P < .001$). For manual muscle testing, supraspinatus muscle grading was 5 in all cases, and physical evidence for the SLAP lesion was not apparent at the final follow-up. There were no statistical differences ($P > .05$) of the functional outcomes (VAS for pain and satisfaction, ASES score, UCLA score, Constant score, and SST) according to the presence of concurrent injuries (Table 2). However, these results did not reach an acceptable level of power (0.8) from power analysis due to the small number of the cohort.

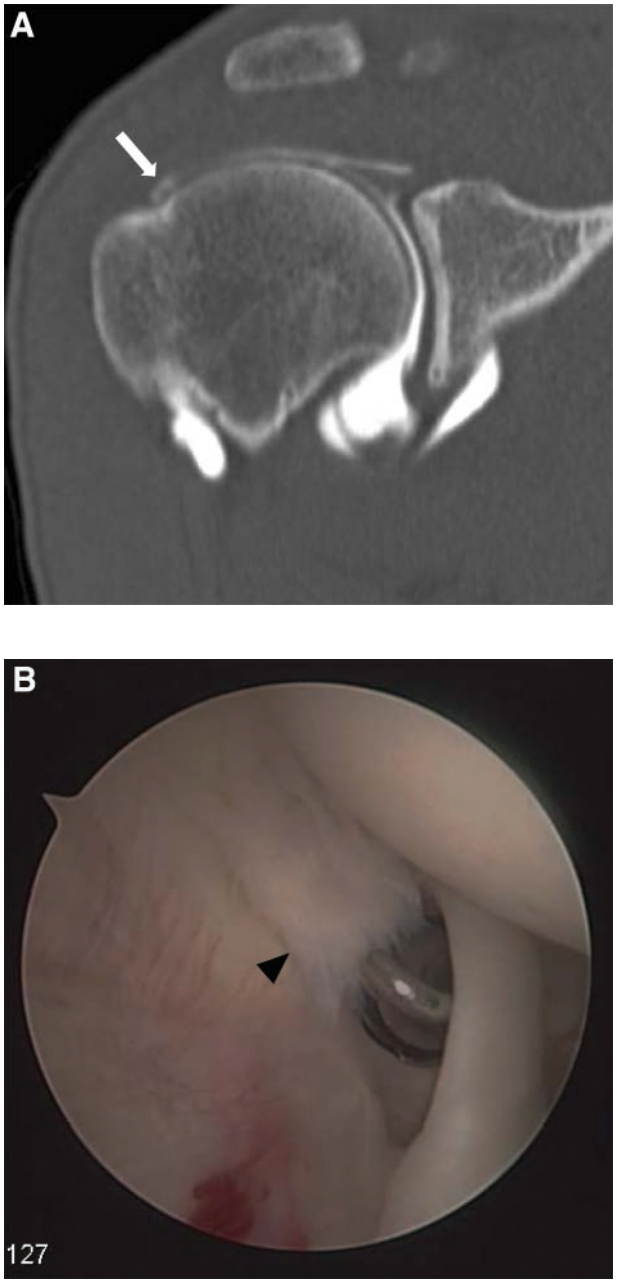

Figure 4. A, articular-side partial-thickness cuff tear was seen on CT arthrogram (white arrow). B, fraying of articular surface of the supraspinatus was identified in the arthroscopy (arrowhead).

On postoperative CTA 1 year after the operation, appropriate labral healing to the bony glenoid had been achieved in all patients. Radiological evidence for the recurrence of the SLAP lesion (the leakage of contrast media under the superior labrum) was not identified (Figure 5). Subacromial leakage of the contrast media was observed in 3 patients (5.2%). A retraction or gap in the tendon was not identified, but the leakage was only seen through the muscular portion near the muscle-tendon junction of the rotator cuff

TABLE 1
Functional Outcomes After the Arthroscopic Repair of SLAP Lesion[a]

	Preoperative[b]	Postoperative[b]
Satisfaction, VAS	–	8.97 ± 1.93
Pain, VAS	6.03 ± 2.37	1.11 ± 1.95
ASES	53.38 ± 17.58	89.86 ± 14.09
UCLA	21.50 ± 4.45	33.31 ± 2.7
Constant	79.82 ± 9.99	95.81 ± 5.04
SST	5.45 ± 3.08	9.45 ± 2.84

[a]Data represent mean ± SD. VAS, visual analog scale; ASES, American Shoulder and Elbow Surgeons shoulder evaluation form; UCLA, University of California–Los Angeles shoulder score; SST, Simple Shoulder Test.
[b]All postoperative functional outcomes (except satisfaction) demonstrated a statistical difference compared with preoperative scores ($P < .001$).

(Figure 6). Two of 3 patients with leakage had preoperative cuff lesions (articular- or bursal-side rotator cuff tear), and the remaining 1 had displayed a stiff shoulder preoperatively. The ages of the patients who had leakage of the contrast media into the subacromial space were 47, 50, and 52 years. Articular-side partial-thickness rotator cuff tears were observed in 6 patients (10.3%, Figure 7) on postoperative CTA 1 year after the operation. Four of 6 patients with partial cuff tears had the lesion preoperatively. Their ages were 20, 32, 35, 42, 50, and 68 years, and 4 patients less than 45 years of age had preoperative cuff lesions. There was no statistical difference in the functional scores between the patients with or without postoperative cuff abnormalities, although power did not reach 0.8 due to the small number of the cohort (Table 3).

DISCUSSION

These data indicate that the SLAP repair with a bioabsorbable knotless anchor using a TRCP shows comparable clinical and radiological outcomes to those using other

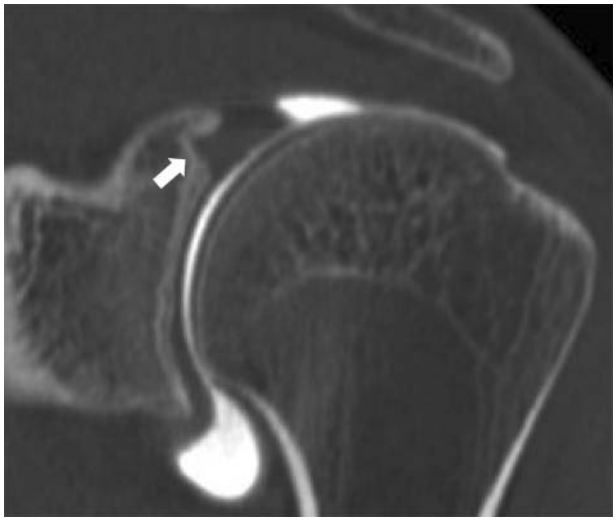

Figure 5. CT arthrogram 1 year after the operation demonstrated anatomical healing of the superior labrum to the bony glenoid (white arrow).

techniques or portals.[4,21] It is a classic method to make 2 working portals for the arthroscopic SLAP repair technique. There are 2 common ways to make an additional portal other than the anterior portal: through the rotator interval or with TRCP, including the Neviaser portal and the Port of Wilmington.[10,16] The main reason surgeons are reluctant to use a TRCP is the potential risk for damaging the normal cuff. Nevertheless, to prevent the "peel back" phenomenon, as Burkhart et al[3] have emphasized, it is important to fix the posterosuperior quadrant of the labrum, which is hard to access from an anterosuperior portal. Cohen et al[4] reported the result of type II SLAP repair using a bioabsorbable tack. They compared the functional outcome between 11 patients using an interval portal and 22 patients using a TRCP; the ASES score and satisfaction were inferior in the TRCP group. On the other hand, since O'Brien et al[17] reported the efficiency of TRCP for SLAP lesion, certain studies have

TABLE 2
Comparison of Postoperative Functional Outcomes Between Patients of Isolated SLAP Lesions and SLAP Lesions With Concurrent Injuries[a]

	Only SLAP Lesion (n = 25)	Concomitant Stiffness[b] (n = 6)	Concomitant A-PTRCT[b] (n = 18)	Concomitant B-PTRCT[b] (n = 9)
Satisfaction, VAS	8.46 ± 2.72	9.48 ± 0.43	9.44 ± 0.86	9.11 ± 1.05
Pain, VAS	1.79 ± 2.53	0 ± 0	0.97 ± 1.44	0.31 ± 0.93
ASES	84.10 ± 17.78	98.62 ± 1.62	92.18 ± 9.4	94.73 ± 9.85
UCLA	32.60 ± 3.51	33.33 ± 3.20	33.78 ± 1.4	34.33 ± 1.00
Constant	94.67 ± 6.17	98.00 ± 3.16	96.50 ± 3.96	96.00 ± 4.53
SST	8.96 ± 2.88	10.50 ± 1.64	10.28 ± 2.24	8.33 ± 3.97

[a]Data represent mean ± SD. A-PTRCT, articular-side partial-thickness rotator cuff tear; B-PTRCT, bursal-side partial-thickness rotator cuff tear; VAS, visual analog scale; ASES, American Shoulder and Elbow Surgeons shoulder evaluation form; UCLA, University of California–Los Angeles shoulder score; SST, Simple Shoulder Test.
[b]Note that manipulation under anesthesia and arthroscopic selective capsular release were done to the stiffness group, the debridement of the frayed cuff to the A-PTRCT group, and the subacromial decompression and acromioplasty to the B-PTRCT group.

Figure 6. Subacromial leakage of the contrast media was identified in CT arthrogram. Note that the leakage was through the muscular portion, not through the tendon itself. Arrowhead, dye accumulation at the subacromial space; Arrow, site of the leakage.

Figure 7. Suspicious partial-thickness articular-side cuff tear seen on CT arthrogram (white arrow).

reported a favorable outcome using a TRCP.[5,8] Coleman et al[5] conducted an outcome comparison using a TRCP and a rotator interval portal and concluded there was no difference between the 2 groups. However, all of these studies evaluated only functional outcomes and did not include radiological and structural outcomes. To our knowledge, this is the first study to present data on the anatomical status and functional results of the cuff after using a TRCP. Some authors have advocated using a TRCP without a cannula in knot-tying anchors to minimize damage to the cuff.[2,6] The main reason we used 2 working portals with cannula was to use a bioabsorbable knotless anchor, which has a comparable outcome to other fixation techniques[23] and has advantages in preventing knot-induced complications after SLAP repair.[20] The anchor was introduced using a utility loop and a balance loop by the shuttle relay technique. Therefore, at least 2 portals were needed for the placement of the anchor. And, working without a cannula is more bothersome because of soft-tissue interposition during the passage of a suture hook, anchor, or sutures. Moreover, the leakage of fluid through the noncannula portal interferes with maintaining distension pressure by fluid, which often leads to severe soft tissue swelling.

TABLE 3
Comparison of Functional Outcome Between Patients With Postoperative Cuff Lesions and Those With Intact Cuff[a]

	Cuff Lesion (n = 9)[b]	Intact Cuff (n = 48)[b]
Satisfaction, VAS	8.28 ± 1.68	9.10 ± 1.96
Pain, VAS	2.00 ± 2.35	0.94 ± 1.85
ASES	86.66 ± 15.14	90.46 ± 13.98
UCLA	33.44 ± 2.19	33.29 ± 2.8
Constant	94.11 ± 6.23	96.13 ± 4.80
SST	10.88 ± 2.10	9.21 ± 2.9

[a]Data represent mean ± SD. VAS, visual analog scale; ASES, American Shoulder and Elbow Surgeons shoulder evaluation form; UCLA, University of California–Los Angeles shoulder score; SST, Simple Shoulder Test.
[b]All postoperative functional outcomes demonstrated no statistical difference between the 2 groups ($P > .05$).

Our anatomical and radiological study supported the claim that the posterolateral accessory portal is safe for tack placement to the posterior portion of SLAP lesion, and abduction of the shoulder to 30° allows the portal to be placed easily through the muscular portion of the rotator cuff instead of the tendon.[24] Therefore, those who worry about suprapinatus tendon damage by TRCPs might maintain the shoulder in 30° of abduction during the arthroscopic procedure, as we did. Several other reports also support the safety of TRCPs. In an anatomical cadaveric study,[13] the Nevaiser portal to the suprascapular nerve was measured at 26 mm, but the mean distances to the axillary nerve and suprascapular nerves from the TRCP were measured as 53 mm for both.

In terms of the structural outcomes of the data, there were 3 cases of leakage of contrast media into the subacromial space and 6 suspected articular-side partial-thickness rotator cuff tears. The sites of leakage were located at the muscular portion of the supraspinatus in all cases, and there were no gaps or retractions of the tendon in the CTA images. We are closely following these patients with periodic ultrasonography, but none have shown any evidence of

rotator cuff tear to date. Although it was not statistically demonstrable due to the small number of patients, the leakage of contrast media did have a tendency to correlate with preoperative cuff lesions and patient age. According to our data, two thirds of leakage patients had preexisting cuff lesions, and all patients were older than 45 years. Also, two thirds with a partial-thickness cuff tear had preoperative rotator cuff lesions. Actually, we are not sure why patients who had cuff lesions tended to show dye leakage after using a TRCP at this time, and further study is needed to verify this question. Nevertheless, a possible hypothesis, according to the current data, is that the biologic healing potential of cuff muscle may be altered in high-risk patients (coexisting preoperative partial-thickness tear, tendinopathy, or advanced age), so the iatrogenic portal might fail to heal completely even though it is through the musculotendinous junction. Many authors have reported a high rate of concurrent injury with SLAP lesions, especially impingement syndrome.[11,20,22] Furthermore, other reports have demonstrated that patient age can be a contributing factor in comorbid rotator cuff injuries.[9,14] Although our results indicated that concomitant injuries and additional procedures did not affect the functional outcomes as in a previous result,[5] there is still reason to be concerned about the integrity of rotator cuff by TRCPs in patients with SLAP lesions who have cuff lesions. We are considering the repair TRCP site with side-to-side suture in high-risk patients. This might prevent postoperative dye leakage as seen in our study.

The mean age of our study population was 45.5 years. Generally, the SLAP lesion is known to be an injury of the younger generation and to be asymptomatic in patients older than 40 years of age. However, we suspect SLAP lesions might be symptomatic in patients older than 40 years of age depending on the pathomechanism, such as compressive or distractive force by trauma and/or repetitive overhead activities. In the present study, most patients (more than 80%) showed the reasonable cause of symptoms to be trauma or repetitive shoulder motions. We also strictly followed the diagnostic criteria of the SLAP lesion by means of the physical test,[18] imaging criteria, and objective arthroscopic findings[15] in symptomatic patients. The SLAP lesion in older patients was carefully diagnosed after thorough exclusion of other disorders. Other studies have also reported a similar age group as ours.[7,9,12] We believe that the SLAP lesion is not exclusively a pathological condition of young throwing athletes, so care should be taken with regard to the rotator cuff status when arthroscopic SLAP repair using TRCPs is performed in older patients.

Stiffness is one of the well-known complications of SLAP repair. Luckily, we did not confront such complications in this series. We have some strategy on the matter of stiffness. First, when we meet patients with a SLAP lesion who have concomitant stiffness preoperatively, they are encouraged to mobilize their shoulders while awaiting the operation. If remaining stiffness is present, we do gentle manipulation under anesthesia and selective arthroscopic capsular release during the SLAP repair. We confirmed that full ROM was achieved intraoperatively. Second, during the repairing procedure, we tried not to repair the anterosuperior quadrant of the labrum to avoid the tightening of the rotator interval and subsequently limiting external rotation. In addition, the shoulder should be in the neutral or slightly external rotation position in the brace. Lastly, the strict rehabilitation protocol was conducted immediately after the operation. All rehabilitation programs were supervised by the team of authors and the Department of Rehabilitation. We believe that the stiffness after SLAP repair could be minimized through care of the surgeon and education of the patient.

There are some limitations to the current study. There was not a control group because this was a retrospective study with prospectively collected data. A prospective, randomized, controlled comparative study would be ideal, but the relatively low incidence of SLAP lesions leads to case series study. Another related limitation is the statistical power, which compared outcomes between the 2 groups. The SLAP lesion is not a common disorder. Furthermore, the number of SLAP lesions with cuff pathology or associated pathology in older patients is much smaller. It might be difficult and take a long time to get the proper power set in this kind of rare disorder. Also, we strictly included the patients who had taken both postoperative CTA and functional evaluations after a minimum of 1 year after surgery. Therefore, some of the statistical analysis did not reach the acceptable value of power.

In conclusion, the present study demonstrates the favorable clinical and radiological outcomes of arthroscopic SLAP repair using a TRCP. We believe that TRCP is an efficient and safe portal for the repair of SLAP lesions, although there are some concerns of damaging the cuff in patients with a SLAP lesion with concurrent cuff disorders as well as in older patients.

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