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# Comparison between SLAP Repair and Biceps Tenodesis with Concomitant Rotator Cuff Repair in Patients Older Than 45 Years: Minimum 2-Year Clinical and Imaging Outcomes

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**Background:** There is controversy over how to surgically treat symptomatic superior labrum anterior to posterior (SLAP) tears in middle-aged patients with concomitant rotator cuff tears. The aim of the study was to compare the clinical and imaging outcomes of SLAP repair versus biceps tenodesis (BT) each combined with arthroscopic rotator cuff repair (ARCR).

**Methods:** We retrospectively reviewed 35 patients older than 45 years who underwent arthroscopic surgery to manage concomitant SLAP tears and rotator cuff tears. In addition to ARCR, 17 patients underwent SLAP repair, whereas 18 patients underwent BT. Shoulder range of motion (ROM), visual analog scale (VAS) for pain, American Shoulder and Elbow Surgeons (ASES) score, Constant score, and University of California at Los Angeles (UCLA) score were used for clinical assessment. The integrity of rotator cuff repair and change of superior labrum-biceps complex were evaluated by postoperative magnetic resonance imaging (MRI).

**Results:** There was significant improvement in the pain VAS and all functional scores in both groups ($p < 0.001$) at a mean follow-up of 29.4 ± 11.4 months (range, 24–84 months) postoperatively. Shoulder ROM showed significant improvement postoperatively ($p < 0.05$). No significant difference in outcomes could be found between the 2 groups after surgery. The retear rate of rotator cuff repair on MRI was 11.8% in the SLAP repair group and 11.1% in the BT group.

**Conclusions:** In middle-aged patients with combined SLAP lesions and rotator cuff tears, both SLAP repair and BT can be safe adjuncts to ARCR.

**Keywords:** *Arthroscopic rotator cuff repair, SLAP tears, Clinical outcomes, Long head of biceps tendon, Tenodesis*

Superior labral lesions have been a topic of interest in shoulder surgery since they were first reported in throwing athletes by Andrews et al.[1] and Snyder et al.[2] coined the term SLAP (superior labrum anterior to posterior) lesions. Over the past 2 decades, there has been a marked increase in surgical treatment of SLAP lesions. In the young, active population, SLAP repair has been reported to provide relief of pain and restoration of function.[3-5] However, the results of SLAP repair in patients over 40 years of age have been described as inferior in some studies, as they experience more complications and higher failure rates.[6-9]

In this middle-aged population, it is common to encounter combined SLAP lesions with rotator cuff tears. The concomitant treatment of SLAP lesions during ar-

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throscopic rotator cuff repair (ARCR) is controversial. Since the long head of the biceps tendon and labrum play a role in stabilizing the humeral head,[10-12] it may be more reasonable to fix the unstable SLAP lesion, which was defined by Getelman and Snyder[13] as (1) a detachment between the edge of the superior glenoid and the biceps anchor, (2) an arching of the biceps-labral complex greater than 5 mm off the glenoid when traction is applied to the biceps tendon, and (3) granulation tissue beneath the biceps-labral anchor. However, there are concerns about the development of pain or stiffness after SLAP repair. Recently, biceps tenodesis (BT) has been gaining attention as a primary procedure in both isolated and concomitant SLAP lesions.[8,14-19] BT resulted in high satisfaction rates and return to the previous level of sport,[14,20] although complications such as postoperative bicipital pain, cosmetic deformity, and proximal humerus fracture have been reported.[21,22] However, only a limited number of studies have compared the outcome of different types of SLAP operations with concomitant ARCR.[8,23-26] The aim of this study was to compare the clinical and imaging outcomes of 2 types of SLAP surgery (SLAP repair vs. BT) performed during ARCR in patients aged 45 years or older. Our hypothesis was that there would be no significant differences in terms of functional outcomes and rotator cuff healing rate between the 2 methods.

## METHODS

### Subjects of Study

After obtaining approval from the Institutional Review Board (IRB No. KC17OESI0118), patients who had undergone combined ARCR and SLAP surgery between 2005 and 2014 were retrospectively reviewed from the prospectively collected surgical database at a tertiary university hospital. The inclusion criteria for the study were (1) patients aged 45 years or older at the time of the surgery, (2) SLAP lesions confirmed by both physical examination (positive O'Brien active compression test) and magnetic resonance arthrogram (MRA) preoperatively, (3) SLAP repair or BT performed with concomitant ARCR, (4) availability for postoperative MRA to evaluate the structural integrity, and (5) minimum 24-month follow-up after surgery. We excluded patients with any previous shoulder surgery, additional surgery other than ARCR and SLAP repair such as Bankart repair.

### Surgical Technique

All patients underwent arthroscopic surgery by a senior surgeon (YSK) under general anesthesia in the lateral decubitus position. A diagnostic arthroscopic examination was performed using the standard posterior portal. A mid-glenoid anterior portal through the rotator interval was created as the working portal. After confirmation of SLAP lesions and other pathologic lesions, the choice of surgical procedures for SLAP lesions was made. SLAP repair was carried out in those who had type II or IV lesions with good tissue condition that could be reattached to the biceps anchor footprint. The superior glenoid biceps anchor footprint and the superior aspect of the glenoid were prepared with a shaver, and 1 to 3 bioabsorbable anchors were placed at the biceps anchor footprint. The sutures were passed through the labral tears and then tied using a non-sliding knot with alternating hitches (Fig. 1). If the SLAP lesion had fragile tissue condition that was not suitable for repair, BT was performed. The biceps tendon was released from the superior labrum with a cautery device, and the tendon was then removed from the joint through the anterior portal. After placing bilateral whip stitches with FiberWire sutures (Arthrex, Naples, FL, USA) on the tenotomized biceps tendon, the sutures were tied to the eyelet of a 7.0-mm BioComposite SwiveLock interfer-

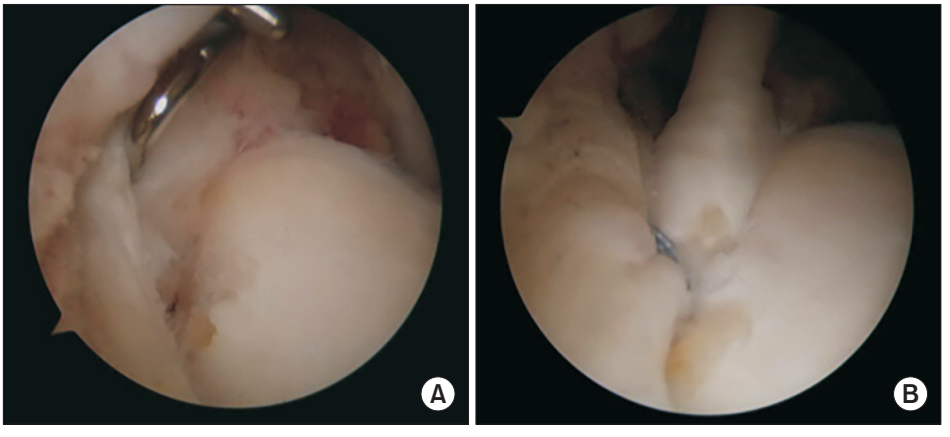


**Fig. 1.** Superior labrum anterior to posterior (SLAP) repair with a suture anchor. Type II SLAP lesion (A) after repair (B).

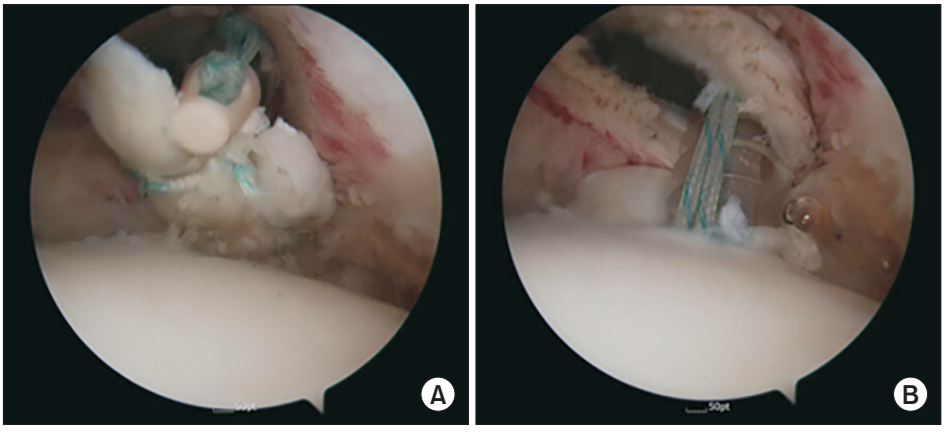


**Fig. 2.** Biceps tenodesis. (A) The tenotomized tendon is tied to the SwiveLock interference screw. (B) The tendon is inserted into the bicipital groove at the level of subscapularis insertion.

ence screw (Arthrex) (Fig. 2). A drill hole was made in the bicipital groove on the level of subscapularis tendon insertion, and the biceps tendon was inserted through the hole with the interference screw. A routine subacromial decompression was performed, and the rotator cuff tears were repaired using either the single-row or double-row technique, according to the tear size and configuration.

**Postoperative Rehabilitation**

Postoperatively, patients wore an abduction brace for 4 weeks with no active use of the biceps. After weaning from the brace, active and passive motion was initiated. Rotator cuff and periscapular muscle strengthening exercises were initiated after full recovery of range of motion (ROM). All sports activities were permitted after 6 months.

**Outcome Evaluation**

The clinical outcome measures included visual analog scale (VAS) pain score, American Shoulder and Elbow Surgeons (ASES) score, University of California at Los Angeles (UCLA) shoulder score, and Constant score. The ROM, including forward flexion, external rotation at side, external rotation at 90° of abduction, and internal rotation, was measured with a goniometer. Internal rotation was evaluated by the tip of the thumb reaching the vertebral level in a sitting position. The vertebral level was converted to serial numbers as follows: 0 for any level below the sacrum, with 1 point added for each level above the sacrum.

To assess the clinical outcomes, patients were evaluated at 3 months, 6 months, and 1 year after surgery, and then annually. To evaluate the cuff integrity, the patients underwent magnetic resonance imaging (MRI) or MRA at 6 months to 1 year after surgery. The evaluation results were reviewed by a fellowship-trained shoulder specialist surgeon (SL) who was not involved in the treatment and was blinded to the patient's information. The repair integrity of the rotator cuff was assessed by using Sugaya classification.[27] Any abnormal findings around the biceps groove and superior labrum-biceps complex were evaluated.

**Statistical Analysis**

Continuous data were described as means and standard deviations or ranges with 95% confidence intervals. A Wilcoxon signed-rank test was used to assess the difference between the preoperative and the last follow-up scores within groups. To analyze the results between the 2 groups, a Mann-Whitney test was used for numerical data and a chi square test was used for categorical data. All statistical analyses were performed using IBM SPSS ver. 21 (IBM Corp., Armonk, NY, USA). The significance level was set at a $p$-value of 0.05.

## RESULTS

**Demographics**

Between 2005 and 2014, 49 patients aged 45 years or older underwent ARCR with concomitant treatment of SLAP tears. Three patients who had additional Bankart repair and 1 patient who had previous shoulder surgery were excluded from the study, leaving 45 patients eligible for study. Ten patients were lost to follow-up. At a mean follow-up of 29.4 ± 11.4 months (range, 24–84 months), a total of 35 patients (78% follow-up, 17 in the SLAP repair group and 18 in the BT group) comprised the final cohort in the study. The study group consisted of 14 females and 21 males, with a mean age of 54.8 years (range, 45–72 years). The dominant extremity was more frequently involved (24/35, 68.6%). There were no significant differences in demographic data between the SLAP repair group and the BT group.

### Operative Findings

In the SLAP repair group, 15 patients had a type II SLAP lesion and 2 patients had a type IV SLAP lesion. Four patients had biceps tendinopathy, but no tendon tear was noted. A mean of 1.8 anchors (range, 1–3 anchors) were used for repair of the SLAP tears. In the BT group, the most common SLAP lesion was type II with 12 patients, followed by type IV (6 patients). Seven patients had biceps lesions (3 partial tears, 4 tendinopathy). Supraspinatus tear was the most common type of lesion, followed by subscapularis tear. BT group had more frequent involvement of subscapularis tendon than SLAP repair group. The single-row repair for rotator cuff tears was the most commonly used technique in both groups. The demographics and operative findings are summarized in Table 1.

### Subjective and Objective Assessment

At the final follow-up visit, there was significant improvement in VAS pain, ASES, Constant, and UCLA scores in both groups ($p < 0.001$). ROM increased in both groups after surgery ($p < 0.05$). When comparing the postoperative outcome of each parameter between the 2 groups, no significant differences were found (Table 2). On the postoperative follow-up MRI, there was a similar rate of retear of the repaired cuff: 11.8% (2/17) in the SLAP repair group and 11.1% (2/18) in the BT group. No biceps rupture was found on MRI after SLAP repair. There were no complications related to surgery such as infection or neurologic injury. One patient in the BT group had a Popeye deformity, but the patient did not complain of biceps cramping or groove pain.

## DISCUSSION

In the current study, SLAP surgery with concomitant ARCR resulted in successful relief of pain and restoration of function as well as rotator cuff healing in patients aged 45 or older, regardless of the surgical methods used for the SLAP lesions. We confirmed our hypothesis that there would be no significant differences in clinical and imaging outcomes between the 2 methods (SLAP repair vs. BT). Contrary to the general concern that concomitant SLAP repair during ARCR may lead to postoperative stiffness, there was no pa-

**Table 1.** Comparison between the SLAP Repair Group and BT Group

| Variable | SLAP repair (n = 17) | BT (n = 18) | *p*-value* |
|---|---|---|---|
| Age (yr) | 54.9 ± 6.5 | 54.8 ± 7.9 | 0.684 |
| Sex (male : female) | 11 : 6 | 10 : 8 | 0.581 |
| Involved side (D : ND) | 12 : 5 | 12 : 6 | 0.803 |
| SLAP types (II : IV) | 15 : 2 | 12 : 6 | 0.129 |
| LHB tendinopathy | 4 (23.5) | 7 (38.9) | 0.328 |
| Involved tendon (SP : SP+SC : SC) | 12 : 2 : 3 | 5 : 11 : 2 | 0.010 |
| Repair method (SR : DR) | 12 : 5 | 13 : 5 | 0.875 |

Values are presented as mean ± standard deviation or number (%) unless otherwise indicated.
SLAP: superior labrum anterior to posterior, BT: biceps tenodesis, D: dominant, ND: nondominant, LHB: long head of the bicep, SP: supraspinatus tear, SC: subscapularis tear, SR: single-row, DR: double-row.
*Mann-Whitney test for age, chi-square test for the rest.

**Table 2.** Comparison of Postoperative Clinical Outcomes between the SLAP Repair Group (n = 17) and BT Group (n = 18)

| Variable | Preoperative | | | Postoperative | | | *p*-value† | |
|---|---|---|---|---|---|---|---|---|
| | SLAP | BT | *p*-value* | SLAP | BT | *p*-value[a)] | SLAP | BT |
| VAS pain | 5.4 ± 2.0 | 4.6 ± 1.1 | 0.287 | 1.6 ± 2.3 | 1.7 ± 1.5 | 0.273 | < 0.001 | < 0.001 |
| ASES score | 60.4 ± 15.9 | 64.2 ± 9.7 | 0.318 | 84.5 ± 15.4 | 84.0 ± 8.8 | 0.463 | < 0.001 | < 0.001 |
| Constant score | 63.5 ± 11.9 | 61.1 ± 8.5 | 0.660 | 83.4 ± 11.4 | 80.1 ± 8.8 | 0.134 | < 0.001 | < 0.001 |
| UCLA shoulder score | 22.6 ± 4.4 | 22.9 ± 5.4 | 0.782 | 30.1 ± 4.8 | 30.2 ± 4.2 | 0.782 | < 0.001 | < 0.001 |
| ROM, FF (°) | 138 ± 25 | 138 ± 19 | 0.757 | 147 ± 8 | 147 ± 5 | 0.546 | 0.048 | 0.049 |
| ROM, ER (°) | 73 ± 20 | 75 ± 16 | 0.961 | 84 ± 8 | 86 ± 7 | 0.961 | < 0.001 | 0.011 |
| ROM, ER (90°) | 69 ± 18 | 71 ± 17 | 0.909 | 84 ± 9 | 85 ± 7 | 0.613 | < 0.001 | 0.002 |
| ROM, IR (°) | 8.0 ± 3.7 | 7.3 ± 3.9 | 0.546 | 10.2 ± 2.3 | 9.5 ± 2.7 | 0.443 | 0.003 | 0.028 |

Values are presented as mean ± standard deviation.
SLAP: superior labrum anterior to posterior, BT: biceps tenodesis, VAS: visual analog scale, ASES: American Shoulder and Elbow Surgeons, UCLA: University of California at Los Angeles, ROM: range of motion, FF: forward flexion, ER: external rotation, IR: internal rotation.
*Mann-Whitney test. †Wilcoxon signed-rank, the pre- and postoperative values within each group.

tient who complained of significant stiffness (loss of ROM over 50% on the contralateral side) at the last follow-up.[9,28]

Currently, there are no clear guidelines for treatment of combined SLAP lesions in rotator cuff tears. Although the majority of previous studies focused on SLAP lesions in overhead athletes or young, active patients, SLAP lesions can also be frequently encountered in middle-aged patients who have rotator cuff tears. The surgical treatment of symptomatic SLAP lesions in this setting has been controversial. Forsythe et al.[24] compared the outcomes of a cohort of patients who had repairs of both SLAP lesions and rotator cuff tears with those of a cohort of patients who had repairs of isolated rotator cuff tears. The ROM and functional scores increased in both groups postoperatively. The authors concluded that the concomitant repair of SLAP lesions and rotator cuff tears can achieve comparable outcomes to those of repair of isolated rotator cuff tears. The alternative surgical technique for SLAP repair has been extensively studied recently. Abbot et al evaluated 38 patients aged 45 years or over who were randomized to debridement or repair for type II SLAP lesions during ARCR.[23] The debridement group (20 patients) had significantly better postoperative UCLA scores and ROM than the SLAP repair group (18 patients) at 2-year follow-up. Franceschi et al.[26] randomized patients older than 50 years undergoing ARCR to have SLAP repair or biceps tenotomy for combined SLAP II lesions. Although both groups achieved significant improvement after surgery, the tenotomy group had significantly better UCLA scores and ROM than the SLAP repair group.

The overall results of the current study are comparable to those of previous studies. Both treatment options resulted in significant improvement of shoulder functional scores and showed a similar healing rate of the rotator cuff. The BT group as well as SLAP repair group achieved excellent ROM. This finding can be explained by the following factors. First, we used a surgical technique to repair the biceps-labrum complex with minimal tension. The sutures were passed through the torn biceps-labrum tissue, taking care to avoid suturing the superior glenohumeral ligament and capsule. The position of the arm was in full elbow extension under traction, which can maximize the length of the biceps muscle-tendon. Also, the patients followed a standardized postoperative rehabilitation protocol, which emphasizes recovery of ROM.

The superior labrum-biceps complex has been reported to contribute to the stability of the humeral head, and thus it would be biomechanically beneficial to restore the anatomy. However, biceps tendinopathy or tears, if present, can be a source of persistent anterior shoulder pain after the reinsertion of the labrum. Releasing the biceps tendon from the origin can be the better option for significant biceps lesions. In our series, the BT group tended to have more frequent biceps lesions and more frequent involvement of subscapularis tears when compared to SLAP repair group. BT has the advantage of preserving the tension of the long head of the biceps muscle, thus maintaining supination strength and minimizing muscle fatigue. However, it requires extra procedures and is associated with persistent bicipital groove tenderness.[29,30] Since there was no considerable difference in results between 2 treatment groups in the current series, the choice of treatment for concomitant SLAP lesions may be up to the surgeon's experience and preferences for the procedures and the presence of biceps lesions.

This study has several limitations. First, the procedures were not randomized, and the results were retrospectively evaluated. Although a single surgeon performed the procedures based on the predetermined indications, there could be selection bias involved. Second, there were uncontrolled variable factors associated with surgical treatment. The rotator cuff repair methods involved both double-row and single-row repair in small-to-medium sized tears. Although these factors may have affected the outcomes of the surgery, cuff tears were relatively small and minimally retracted and could therefore be completely repaired using either technique. Third, the follow-up period was relatively short. The results may deteriorate over time and a longer follow-up period could help to determine the prognosis of each procedure. Lastly, the number of patients included in each group was relatively small, which makes the subgroup analysis underpowered. Further study with larger population may be needed to exclude the possibility of type II errors.

In patients aged 45 years or above who presented with combined SLAP lesions and rotator cuff tears, both SLAP repair and BT in addition to ARCR provided comparable clinical and imaging outcomes. The choice of treatment for SLAP lesions can be made based on the pathology of the biceps tendon and the surgeon's preferences.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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