



Arthroscopic evaluation of failed primary type II SLAP lesion repair in patients with high physical activity over 40 years of age and the outcomes of tenotomy

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Superior labrum anterior posterior (SLAP) lesions involve some degree of separation of the long head of the biceps tendon from where it attaches to the glenoid and classification is made according to the degree of separation.^[1] The prevalence, associated abnormal findings, and clinical features of different types of SLAP lesions differ according to the patient population.^[2] Treatment of SLAP lesions is either conservative or surgical.^[3] Conservative treatment is limited.^[4] Recommendations include rest from painful activities, the use of non-steroidal anti-inflammatory drugs (NSAIDs) and rehabilitation.^[4-6]

Primary repair is recommended as the surgical treatment for patients under 40 years of age with SLAP lesions.^[1] As an alternative to arthroscopic repair, biceps tenotomy and tenodesis have also been widely used recently.^[1] There are many studies comparing

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ABSTRACT

Objectives: In this study, we aimed to examine patients over 40 years of age who underwent failed primary isolated type II superior labrum anterior posterior (SLAP) repair arthroscopically and to evaluate the outcomes of tenotomy.

Patients and methods: Between March 2011 and December 2019, a total of 32 patients (19 males, 13 females; median age: 55.1 years; range, 41 to 59 years) who underwent primary repair for SLAP due to high activity levels and in whom the treatment failed were retrospectively analyzed. Biceps tenotomy was applied to all patients. The Constant-Murley Score (CMS), Visual Analog Scale (VAS) pain scores, and muscle strength before and after re-arthroscopy were compared.

Results: The median follow-up time was 27 (9-84) months after biceps tenotomy. During arthroscopy, failure was detected in three (9.37%) patients and additional pathologies were detected in five (15.62%) patients. Patients with biceps tenosynovitis were 29 (90.62%). The mean pre- and postoperative CMS scores were 40.5±11.1 and 86.3±8.1, respectively ($p<0.001$). The mean pre- and postoperative VAS-pain scores were 7.3±1.5 and 2.1±0.8, respectively ($p<0.001$).

Conclusion: Although the primary repair technique has been successfully performed in patients with SLAP lesions over 40 years of age and high physical activity, the clinical outcomes are unsatisfactory. Biceps tenotomy improves functional and clinical results in patients with SLAP lesions who do not benefit from primary repair.

Keywords: Physical activity, repair, shoulder arthroscopy, shoulder injuries, tenotomy.

arthroscopic SLAP repair and biceps tenotomy and tenodesis.^[7-9] Repair is recommended for patients with SLAP lesions under the age of 40.^[1] However, it is still controversial to whom the repair would be made. The repair decision depends on the age of the patient, physical activity level, and the sports activity performed.^[1] Tenodesis or tenotomy are the treatment options for older and laborers, or individuals with

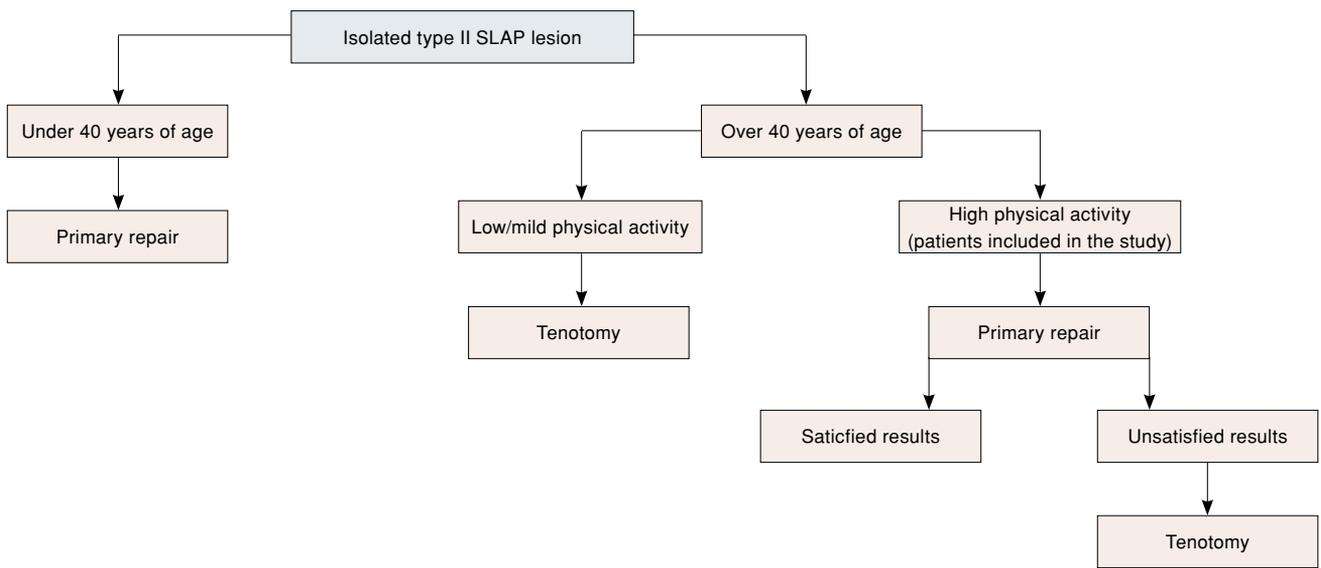


FIGURE 1. Study flow chart.
SLAP: Superior labrum anterior posterior.

accompanying rotator cuff tears. Despite tenodesis and tenotomy, there is no consensus on what the age limit should be in making the decision for repair.^[1,8,10,11]

Although it has been reported in many studies in recent years, the success rate of primary repair has been low and no detailed study has been conducted investigating the underlying cause of the low success rate of primary repair.^[1,7,8,11] In the present study, we aimed to examine patients over 40 years of age who underwent failed primary isolated type II SLAP repair arthroscopically and to evaluate the outcomes of tenotomy.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Adnan Menderes University

Faculty of Medicine, Department of Orthopedics and Traumatology between March 2011 and December 2019. In our clinic, patients who were operated due to isolated SLAP type II lesions were screened. Pendular exercises were applied to the patients for two to four weeks following the primary SLAP repair. Active range of motion (ROM) exercises were started after four weeks. Strengthening exercises were performed after eight weeks. The patients without complete resolution of complaints after both medical (NSAIDs) and physical treatment for an average of 9.4 months further underwent revision arthroscopy. The patients who did not benefit from the treatment clinically after isolated primary SLAP repair and underwent arthroscopy were included in the study. Initially, 52 patients over the age of 40 with isolated

TABLE I Physical activity level according to IPAQ	
Category	
1	This is the lowest level of physical activity. Those individuals who not meet criteria for categories 2 or 3
2	3 or more days of vigorous activity of at least 20 min per day 5 or more days of moderate-intensity activity or walking of at least 30 min per day 5 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum of at least total 600 MET-min/week.
3	Vigorous-intensity activity on at least 3 days and accumulating at least total 1500 MET min/week 7 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum of at least total 3000 MET-min/week.
<small>IPAQ: International Physical Activity Questionnaire; MET: Metabolic equivalent task; TOTAL MET min/week=(1.5 MET × Weekly sitting minutes)+(3.3 met × Weekly walking minutes)+(4 met × Weekly moderate physical activity)+(8 met × Weekly vigorous physical activity).</small>	

type II SLAP lesions who underwent primary repair (International Physical Activity Questionnaire [IPAQ] Category 3) with an average metabolic equivalent task (MET) (hour-week) of 2,597.11 were screened. Fourteen of these patients who benefited from the treatment and six patients who were lost to follow-up were excluded from the study.

Finally, a total of 32 patients (19 males, 13 females; median age: 55.1 years; range, 41 to 59 years) whose complaints did not improve were included. The study flow chart is shown in Figure 1. A written informed consent was obtained from each patient. The study protocol was approved by the Adnan Menderes University Faculty of Medicine

TABLE II
Demographic characteristic and clinical outcomes of the patients with SLAP lesion

Number	Age/Sex	Preop. Const.	Postop. Const.	Preop. VAS	Postop. VAS	Preop. Supination	Postop. Supination	Preop. Flexion	Postop. Flexion	Opposite side supination	Opposite side flexion
		n	n	n	n	n	n	n	n	n	n
1	58/F	52	88	7	2	2	4	1	5	4	5
2	57/M	48	86	8	3	2	4	2	5	5	4
3	56/M	46	98	7	3	2	4	2	4	4	5
4	41/M	44	96	8	2	3	5	2	4	5	5
5	57/F	34	90	9	4	1	4	1	5	4	5
6	59/M	50	84	6	2	1	5	3	4	5	5
7	55/M	49	85	8	1	2	3	2	5	5	4
8	49/M	48	91	9	3	1	4	0	4	5	4
9	57/F	24	93	7	4	1	3	2	5	4	5
10	58/M	52	83	8	0	3	4	3	4	4	3
11	55/M	38	91	9	4	2	5	2	5	5	5
12	59/F	56	87	6	3	3	4	3	3	4	5
13	44/M	46	87	6	2	2	5	5	5	5	5
14	49/F	50	96	5	3	1	5	3	3	4	3
15	58/M	48	97	4	5	4	5	2	4	5	4
16	56/M	32	86	7	3	3	4	1	5	5	3
17	59/F	42	89	4	4	2	4	3	4	4	5
18	59/M	24	90	8	2	2	2	4	4	4	4
19	55/M	36	92	9	1	2	4	0	4	5	5
20	50/F	26	93	7	3	2	5	2	5	4	5
21	56/F	49	90	6	1	3	4	3	4	5	4
22	54/M	51	89	8	5	2	3	2	5	3	4
23	58/M	32	91	9	1	3	5	3	4	5	4
24	57/M	58	89	7	3	1	4	5	3	5	4
25	59/F	28	72	9	2	1	5	3	5	4	5
26	58/M	45	62	6	4	2	4	1	4	5	5
27	55/F	24	78	5	3	2	4	2	5	3	5
28	57/F	28	76	8	1	3	3	1	5	4	4
29	54/M	32	81	10	2	1	4	3	4	5	5
30	55/F	55	84	9	3	2	5	1	4	5	5
31	55/M	26	76	8	1	3	5	2	5	4	4
32	54/F	24	72	7	1	3	4	3	4	5	4

SLAP: Superior labrum anterior posterior; Preop.: Preoperative; Postop.: Postoperative; VAS: Visual Analog Scale.

TABLE III
Medical research council scale

0	No contraction
1	Flicker or trace contraction
2	Active movement, with gravity eliminated
3	Active movement against gravity
4	Active movement against gravity and resistance
5	Normal power

Ethics Committee (No: 2020/209). The study was conducted in accordance with the principles of the Declaration of Helsinki.

The IPAQ criteria were accepted as reference for the activity level (Table I).^[12] All operations were performed by a single surgeon arthroscopically. Shoulder sling was applied for one week postoperatively. Shoulder movement was started immediately. Before the revision, the Constant-Murley Score (CMS), Visual Analog Scale (VAS)-painscore, and muscle strength were compared with values at a median of 27 (range, 17 to 38) months after revision. Before biceps tenotomy, by performing supination and flexion, biceps muscle strength was compared with the values at a median of 27 (range, 17 to 38) months after biceps tenotomy. After tenotomy, muscle strength of the biceps was compared to the opposite side (Table II). Muscle strength of the biceps was evaluated by the Medical Research Council (MRC) Scale (Table III).^[13]

Statistical analysis

Statistical analysis was performed using the PASW version 18.0 software (SPSS Inc., Chicago, IL, USA).

Descriptive data were expressed in mean \pm standard deviation (SD), median (min-max) or number and frequency, where applicable. The compatibility of the variables to normal distribution was examined using the Kolmogorov-Smirnov test. The paired samples t-test was used for pre-test and post-test comparisons. A *p* value of <0.05 was considered statistically significant.

RESULTS

The median follow-up between the first and second operation was 9.46 (range, 6 to 14) months. The average MET (hour-week) value of the patients included in the study was 2,589.68 and all were in Category 3. The preoperative dynamic shear test was positive in 32 (100%), the speed test was

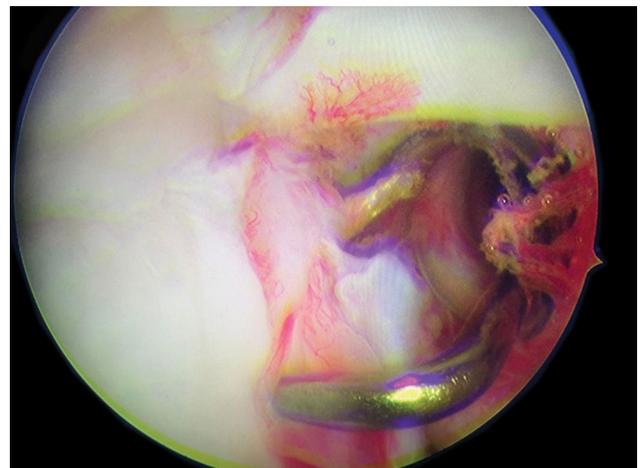


FIGURE 3. Bicipital hyperemia and synovitis.

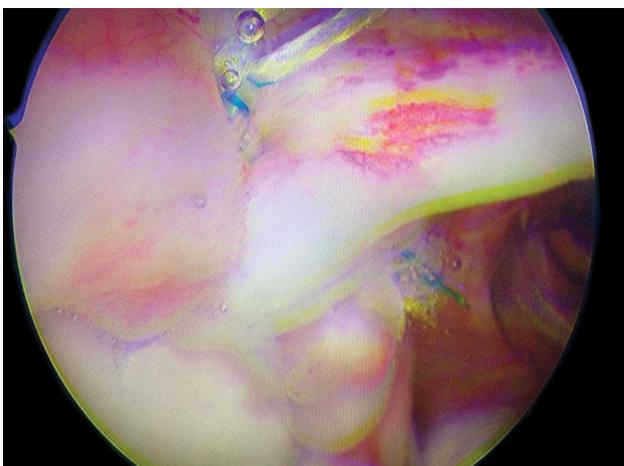


FIGURE 2. Bicipital hyperemia and synovitis.

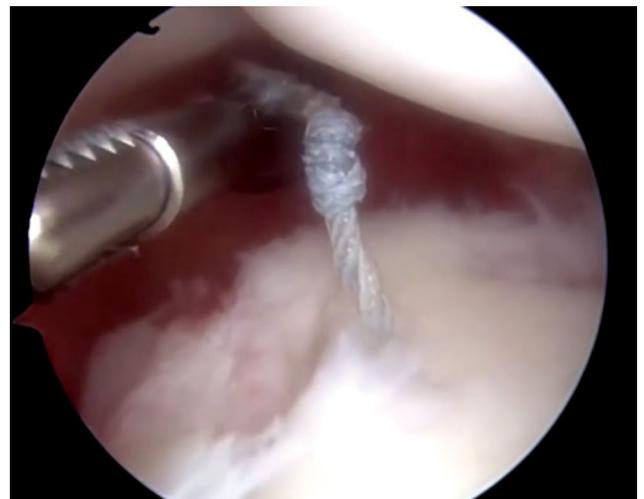


FIGURE 4. Re-rupture after SLAP repair (9.37%).

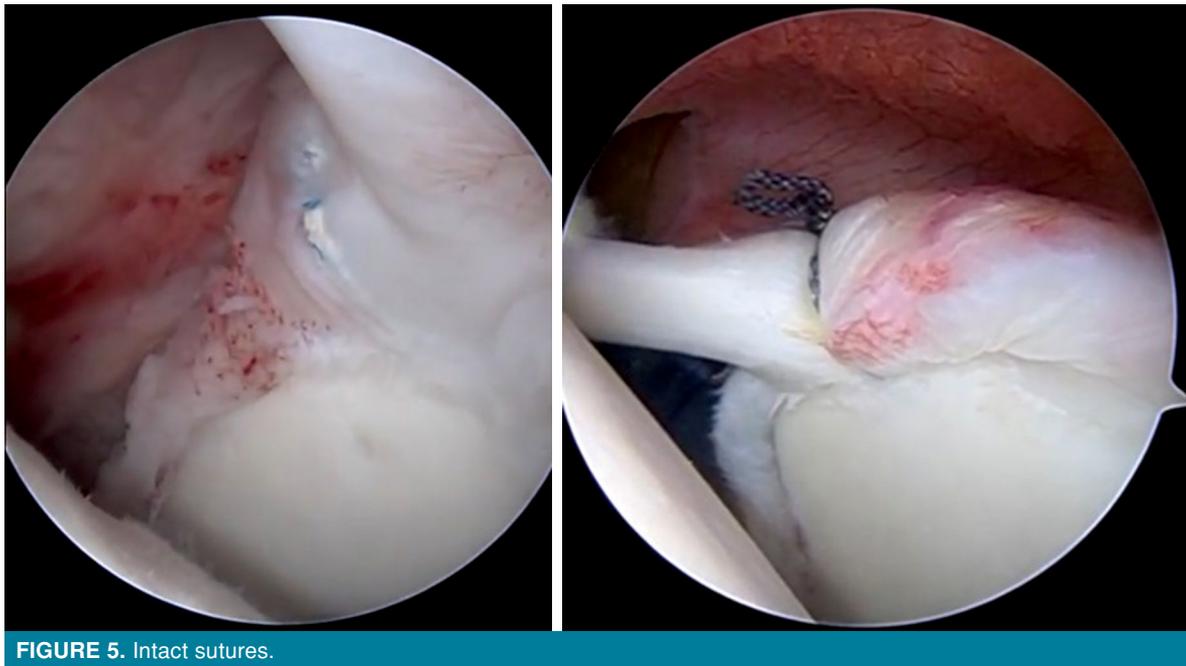


FIGURE 5. Intact sutures.

positive in 29 (90.62%), O'Brien test was positive in 28 (87.5%), and the Yergason's test was positive in 28 (87.5%) patients. There was effusion in the bicipital groove in 30 (93.75%) patients' preoperative magnetic resonance imaging (MRI) scans before revision. During arthroscopy, hyperemia was observed around the biceps tendon, extending up to the bicipital groove in 29 (90.62%) patients (Figures 2 and 3). Loosening and rupture of the sutures in three (9.37%) patients (Figure 4) and an additional pathology in five (15.62%) patients (Bankart, impingement lesion) were detected. The sutures were intact in 24 (75%) patients (Figures 5a b). Biceps tenotomy was performed in 32 patients (Figure 6). The median operation time was 32 (range, 23 to 66) min.

The mean preoperative CMS and VAS-pain scores were 40.5 ± 11.1 and 7.3 ± 1.5 , respectively. The mean postoperative CMS and VAS-pain scores were 86.3 ± 8.1 and 2.5 ± 1.3 , respectively ($p < 0.001$ for both) (Table IV). The postoperative dynamic shear test was positive in two (6.25%), the speed test was positive in two (6.25%), O'Brien test was positive in five (15.62%), and the Yergason's test was positive in three (9.37%) patients (Table V). The mean preoperative biceps muscle strength in flexion and supination was 2.3 ± 1.2 points and 2.1 ± 0.8 points, respectively ($p < 0.001$). The mean postoperative biceps muscle strength in flexion and supination was 4.3 ± 0.7 points and 4.2 ± 0.8 points, respectively

($p < 0.001$ for both). The mean opposite side biceps muscle strength in flexion and supination was 4.4 ± 0.7 points and 4.5 ± 0.6 points, respectively ($p = 0.583$). The mean postoperative biceps muscle strength was not statistically significant compared to the opposite side during flexion and supination ($p = 0.745$ and $p = 0.872$, respectively).

In three patients who underwent tenotomy, a cosmetic problem was detected as a complication due to swelling caused by the retracted biceps

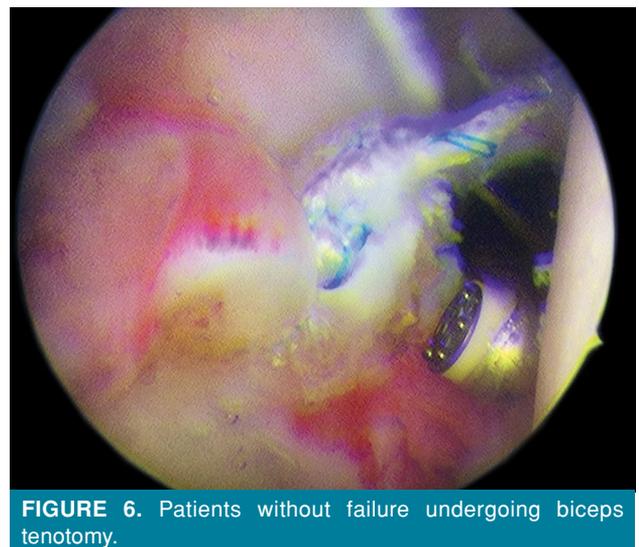


FIGURE 6. Patients without failure undergoing biceps tenotomy.

TABLE IV Clinical outcomes of the patients with SLAP lesion				
	Constant score	VAS score	Biceps muscle strength (Supination)	Biceps muscle strength (Flexion)
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Preoperative	40.5±11.1	7.3±1.5	2.1±0.8	2.3±1.2
Postoperative	86.3±8.1	2.1±0.8	4.2±0.8	4.3±0.7
<i>p</i>	<0.001	<0.001	<0.001	<0.001

SLAP: Superior labrum anterior posterior; VAS: Visual Analog Scale; SD: Standard deviation.

TABLE V Comparison of pre-, intra-, and postoperative variables			
	Preoperative	Intraoperative	Postoperative
Accordinging IPAQ physical activity score (MET)	2,589.68		
Dynamic test (n)	32		2
Speed test (n)	29		2
Yergason's test (n)	28		3
O'Brien test (n)	28		5
Effusion in the bicipital groove (MRI) (n)	30		
Effusion in the bicipital groove (arthroscopy) (n)		29	
Loosening and rupture of the sutures (n)		3	
Additional pathology (n)		5	
Intact sutures (n)		24	

MET: Metabolic Equivalent Task (hour-week); MR: Magnetic resonance imaging.

muscle in the forearm. No other complications were encountered.

DISCUSSION

The main finding of this study is the poor clinical outcomes of patients with isolated type II SLAP lesions between the ages of 40 and 60 years undergoing primary repair due to high physical activity levels. In addition, the tenotomy results of these patients are clinically satisfactory and tenotomy seems to be a good alternative for revision SLAP repairs. To the best of our knowledge, this is the first study to evaluate primary repair in patients with high activity SLAP lesions.

In general, conservative and surgical treatment is indicated in the management of SLAP lesions.^[3] Conservative treatment includes rest from painful activities, NSAIDs and rehabilitation. Edwards et al.^[6] reported that conservative care significantly improved pain, function, and quality of life of patients in 49%. They recommended that patients

should be referred for surgical interventions, if significant pain and functional limitations were persistent after three months of conservative care. Although surgical treatment of SLAP lesions in patients under 40 years of age is suggested as fixing the upper labrum to the superior glenoid with suture anchors, SLAP lesion repair is currently controversial in patients after the fourth decade of life.^[1] In the earlier studies on the primary repair, successful results were obtained in terms of reducing pain and returning to sports.^[2,10,14] In their study on the repair of 102 type II lesions, Morgan et al.^[14] reported that the success rate was 97%. Similarly, Brockmeier et al.^[15] reported a success rate of 74%, Sayde et al.^[16] of 73%, Samani et al.^[17] of 88%, and Schröder et al.^[18] of 90% in their studies.

Although it has been shown in previous studies that primary repair yields good results in athletes, Kim et al.^[19] reported that the satisfaction rate after SLAP lesion repair was 94%, but isolated repairs were significantly more unsuccessful in those who did

sports than in those who did not. After arthroscopic repair of type II SLAP lesions, Neri et al.^[20] examined 23 top-level athletes for more than one year and found that only 50% of the patients could return to their previous activity level.

In later studies, the results of SLAP repair were not found to be as good as in earlier studies, and tenotomy or tenodesis was preferred as an alternative treatment. Boileau et al.^[7] compared the results of 15 patients who underwent biceps tenodesis and 10 patients who underwent type II SLAP repair. The satisfaction rate of the patients in the tenodesis group (87%) was higher than in the other repair group (40%). In another study, the rate of patients returning to sports in the tenodesis group (87%) was higher compared to the SLAP repair group (20%).^[5] Denard et al.^[8] and Weber^[10] also reported similar results in their studies. In our study, the constant score increased in all 32 patients who underwent tenotomy after failed repair.

According to the literature, various factors should be considered while deciding upon tenotomy or repair.^[1] While it is usually recommended to repair SLAP lesions in individuals who are engaged in sports involving overhead activities, treatment options are tenodesis or tenotomy for older individuals or those with accompanying pathologies.^[7,8] Huri et al.^[1] conducted a meta-analysis on the treatment of SLAP lesions and reported that tenotomy should be performed in patients with rotator cuff tears in SLAP lesion treatments. They also emphasized that the role of tenotomy in athletes engaged in sports with overhead activity was controversial. In the aforementioned study, age was an important factor and tenotomy or tenodesis was recommended instead of SLAP repair in patients over the age of 40. We applied primary repair to patients over the age of 40 with high physical activity, as, according to the literature, the level of physical activity should be evaluated while making a primary repair decision.^[8] Since our patients had a high physical activity, we preferred primary repair instead of tenodesis or tenotomy. Primary repair was decided for patients with moderate-to-high activity by calculating the total time spent on weekly physical activities according to IPAQ criteria. In our study, we found that the clinical results of patients with isolated type II SLAP lesions in whom we preferred primary repair between the ages of 40 and 60 years due to high physical activity level were unsatisfactory.

There are studies evaluating the results of re-arthroscopy due to unsuccessful SLAP lesion repair. Katz et al.^[21] examined patients with pain, stiffness, and mechanical symptoms after SLAP repair.

Stiffness (75%) and loosening of the stitches (19%) were observed in all patients. Park and Glousman^[22] performed revision arthroscopy in 12 patients who underwent SLAP repair due to limited clinical results. There was no loosening in the suture in 11 patients, and there was loosening in the suture in one patient. Kriens et al.^[23] showed that, in 38% of the patients who underwent arthroscopy for tenodesis after repair, the biceps anchor did not heal completely to the superior glenoid. Nadeem et al.^[24] concluded that the rate of return to activity after biceps tenodesis was significantly higher than the rate after revision SLAP repair. In our study, loosening of the sutures was observed in 9.37% of the patients.

Although the success rate of the primary repair has been reported to be low in most studies, no comprehensive study has been conducted to examine the underlying reasons. In general, mechanisms of failure for SLAP repairs can be categorized as failure to treat concomitant pathology; development of a new pathology; technique-related failure; biological failure, including failure to heal and development of postoperative stiffness; and implant-related failure.^[25] In their studies, Boileau et al.^[7] and Neri et al.^[20] reported that failure after primary repair in SLAP lesions was associated with stiffness, persistent pain, and failure of the labrum that healed the superior glenoid. In our study, in eight of 32 patients who did not benefit from arthroscopic repair and underwent revision, loosening of the sutures or a new tear was observed. During arthroscopy, arthroscopic appearance similar to tenosynovitis and synovitis was observed in 29 (90.62%) patients. The sutures were intact in 24 (75%) patients. Despite the intact sutures in 24 patients, clinically poor results may be due to appearance similar to tenosynovitis and synovitis after primary repair. The study conducted by Turan et al.^[26] strongly supports our hypothesis. The authors histologically examined the joint capsule and synovium in patients with isolated type II SLAP lesions and reported a correlation between histopathological findings and postoperative clinical results. Before tenotomy, the majority of the patients included in our study had clinical stiffness in the shoulder, limited elbow flexion strength, supination strength, and pain extending from the shoulder to the anterior arm with movement. These clinical findings support possible biceps tenosynovitis and synovitis. Friedman et al.^[27] compared 42 patients who underwent tenodesis and tenotomy (22 tenotomy, 20 tenodesis) with a mean age of 49.9 years. They found no significant difference

between them and concluded that almost half of patients in the tenodesis group reported pain at the bicipital groove, as well as general pain. The hypothesis on biceps tenosynovitis and synovitis in our study is consistent with the study of Friedman et al.^[27]

Currently, there is no standard guidelines available for the management of failed SLAP repair and, therefore, the selection of a particular treatment method is primarily based on the pathology encountered, patient-related factors, and surgeon's preference.^[25] Weber^[10] showed that the results of tenodesis and tenotomy were better in patients who underwent SLAP revision due to unsuccessful primary repair (loosening). Conservative treatment was associated with poor results in 81% of patients expressing dissatisfaction.^[27] McCormick et al.^[28] evaluated the efficacy of biceps tenodesis for failed repair of type II SLAP tears and concluded that biceps tenodesis was a predictable, safe, and effective treatment for failed arthroscopic SLAP repair.

Apart from the study of Friedman et al.,^[27] there is almost no study for tenotomy, particularly in SLAP revision. In the present study, we applied tenotomy to the patients with unsuccessful isolated type II SLAP lesions. Tenotomy results were satisfactory. We believe that tenotomy has many advantages such as simplicity, lower surgical morbidity, shorter operation time, and ease of postoperative rehabilitation. Reoperation is not required after tenotomy in unsuccessful SLAP revisions. However, there are studies reporting that 15% of redo surgeries are performed after tenodesis.^[29] The main disadvantages of tenotomy are cosmetic deformity, subjective cramps, and decreased supination.^[30-32] In our study, Popeye deformity was observed in one (3.12%) patient.

In the current study, positive examination tests, preoperative clinical findings, and MRI scans, the arthroscopic appearance made us think of biceps tenosynovitis and synovitis. The clinical improvement after the revision of biceps tenotomy in patients whose clinical signs did not improve despite successful repair also supports that the pain is caused by biceps tendinitis. Attempting to perform overhead movements that have not been done for a long time after the repair and forcing the biceps tendon may also cause biceps tendinitis. Therefore, while deciding on tenotomy or repair, patients should be evaluated based on their preoperative shoulder joint movements and how much they would be compliant to postoperative exercises.

The main limitation of this study is its single-center, retrospective design with a relatively small sample size. The main strength of this study is that it is the first study in the literature to arthroscopically investigate the cause of poor clinical outcomes in patients with isolated SLAP lesions and to evaluate the results of revision tenotomy after successful primary repair. Although we attributed poor clinical results to biceps tenosynovitis and synovitis after successful primary repair, we would investigate the reason for this in future studies. The results should not be interpreted as inadequate repair or complications; instead, intolerable biceps tenosynovitis and synovitis should be considered. In cases with SLAP lesions that do not benefit from primary repair, revision biceps tenotomy improves functional and clinical results.

In conclusion, the clinical results of primary repair are limited in patients with SLAP lesions over 40 years of age and high physical activity. Although the primary repair technique is successfully applied to cases with SLAP lesions, clinical results are unsatisfactory. Biceps tenotomy improves functional and clinical results in patients with SLAP lesions who do not benefit from primary repair. Tenotomy is a good alternative for revision SLAP repairs.

Declaration of conflicting interests

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