

Repair versus biceps tenodesis for the slap tears: A systematic review

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Abstract

Purpose: The ideal treatment algorithm is still controversial for Superior Labral Anterior-Posterior (SLAP) tears. In this systematic review, we aimed to clarify and ascertain which treatment modality is effective and more usable in which conditions. **Methods:** In this systematic review, we used the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines established for systematic reviews and meta-analysis. “SLAP or Superior Labral Anterior-Posterior” and “biceps tenodesis” search terms were used in The Cochrane Library database and Pubmed from their inception to the 30th of September 2020. A total of 2326 titles were screened and 2069 articles were removed because of their ineligibility. Full texts of 14 studies were screened and finally, six were suitable for the present systematic review. Demographic details and study characteristics, patient satisfaction, functional outcomes, return to preinjury sports level, reoperation, stiffness, sling time and rehabilitation protocols were reviewed and compared between SLAP repair and biceps tenodesis groups. **Results:** A total of 2326 titles were screened and six studies were detected eligible. Results of 287 patients (SLAP repair: 160, Biceps Tenodesis: 127) were reviewed in included six studies. Biceps tenodesis was showed as more satisfied technique in four of the studies but the statistical comparing results of two groups were not significantly different in each study. Different functional scoring systems used in the studies were not statistically significantly different between the groups. The percentage of return to sport and preinjury level is higher in biceps tenodesis in the five studies. The total reoperation rate for SLAP repair was 19/160 (12%) and biceps tenodesis was 7/127 (6%). **Conclusion:** The biceps tenodesis has a higher return to preinjury sports level, higher patient satisfaction and lower reoperation rates but functional scores are similar between SLAP repair groups in patients with SLAP tear.

Keywords

Biceps tendon, biceps tenodesis, long head of biceps, repair versus tenodesis, SLAP repair, SLAP tear

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Introduction

Superior labrum anterior-to-posterior (SLAP) tears were first described by Andrew¹ in 1985 and classified into four subtypes by Snyder² in 1990. Sports activities especially throwing and overhead sports like baseball are related in etiology,^{3,4} but falling on the outstretched upper extremity, heavy lifting, hyperextension and direct trauma also have been reported.^{2,4} The patient may suffer serious pain and glenohumeral instability after the pathological disruption of the SLAP complex.⁵

Type II (55%) is the most common type of SLAP tears which were classified under 4 subtypes by Snyder.^{2,6}

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Non-operative treatment was the first focused treatment modality for SLAP tears but the low rate of return to play and return to previous level led it to surgical solutions.⁷

Arthroscopic debridement, biceps tenodesis and SLAP repair are included in surgical treatment options of the SLAP tears. The SLAP repair has been the most commonly used technique but biceps tenodesis has gained popularity in recent years.⁸ Repair of the SLAP tears frequently preferred and performed for acute tears, younger patients with no associated long head of the biceps tendon pathology. Older patients with degenerative structures, associated long head of the biceps tendon are usually required for performing biceps tenodesis.^{8–10}

The ideal treatment algorithm is still controversial for SLAP tears. In this systematic review we aimed to clarify and ascertain which treatment modality, SLAP repair or biceps tenodesis, is effective and more usable in which conditions.

Materials and methods

In this systematic review, we used the guidelines established for systematic reviews and meta-analysis: PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses).¹¹

Search strategy

Literature search was performed by the three independent reviewers (O.C, K.B, M.K) according to PRISMA¹¹ and the search results were evaluated with senior author (A.M.O) for eligibility criteria. “SLAP or Superior Labral Anterior-Posterior” and “biceps tenodesis” search terms were used in *The Cochrane Library* database and *Pubmed* from their inception to 30th of September 2020. After reviewing the abstract and the titles full texts were reviewed for the eligibility.

Eligibility criteria

The studies included in the present systematic review were selected according to following criteria: (1) Full text available articles, (2) Full text published in English language, (3) minimum 1 year follow-up, (4) comparing the results of SLAP repair and biceps tenodesis for SLAP tears. Exclusion criteria were as follows: (1) review studies, (2) associated injuries, (3) biomechanical or cadaveric studies, (4) radiologic studies, (5) technical notes, (6) demographic studies, (7) studies in related just SLAP repair of biceps tenodesis, (8) editorial commentaries, letter to the editors, author’s response, (9) written in a language other than English, (10) full text or abstract is not available, (10) not completed studies, (11) case reports, (12) studies about physical examination, physical therapy and scoring

systems, (13) course letters and (14) not related studies (Table 1).

Data extraction

The authors, the time intervals which the study was conducted, design of the study, minimum follow-up times, number of the patients included in the study, mean ages and sex of the population, scoring system used in follow-ups, patient reported outcomes and type of the SLAP tears included in the studies and the type of biceps tenodesis surgical procedure were extracted from the studies. Oxford Centre for Evidence-Based Medicine guideline was used to determine the evidence level of the study (Table 1). Information about rehabilitation protocols, sling periods, comparative results of the functional outcome scores, return to preinjury level of sports, stiffness, if a secondary operation needed or not were also extracted from the included studies (Table 2).

Results

Search results

The literature search included 2326 results and after duplications were removed we had 2083 abstracts. Following investigation of the abstracts for eligibility 2069 were excluded for reasons and we had 14 studies. Full texts of these 14 studies were detected and eight of them were excluded because of the reasons listed in Figure 1. At last we included six studies^{12–17} meeting the criteria (Figure 1).

Demographic details and study characteristics

Level of evidence was I for one study and III for five studies. The six studies meeting the criteria included 160 patients with performed SLAP repair and 127 patients performed biceps tenodesis. Sex and age distribution according to groups are reported in Table 1. Five of the studies included just type II SLAP tears. One of the studies included type I, II, III and IV. All of the SLAP repair procedures were performed arthroscopic but biceps tenodesis was performed via both arthroscopic (3 studies) and open procedures (3 studies). Demographic information of the patients and the study characteristics are listed in Table 1.

Patient satisfaction

Four of the six included studies mentioned about patient satisfaction.^{12–14,17} These four studies included 75 patients in SLAP repair group and 65 patients in biceps tenodesis group. Three of these studies^{12–14} including 42 patients with SLAP repair and 45 with biceps tenodesis mentioned about “satisfaction or very satisfaction” of a patient via using percentage and one used¹⁷ a mean score value of the population. In all four studies, the biceps tenodesis was

Table 1. Study characteristics.

Study	Level of Evidence/ Study Design	Time Interval	SLAP Repair					Biceps Tenodesis						
			Type of SLAP	Number	Age (Mean)	Scoring (Pre/Post operative)	Patient Reported Outcome	Type of SLAP	Number	Age	Scoring (Pre/Post operative)	Patient Reported Outcome	Technique	Follow-up period
Boileau et al., 2009	III, Prospective	2000–2004	II	10	37 Y (19–57 Y)	Constant: 65/83	40% satisfied; 60% dissatisfied (pain, inability to perform previous sport level)	II	15	52 Y (28–64 Y)	Constant: 59/83	93% satisfied; 7% dissatisfied	Arthroscopic	Minimum 24 M (24–69 M)
Denard et al., 2014	III, Retrospective	2003–2009	II	22	45.2 Y	ASES: 47.5/87.4 UCLA: 18.5/31.2 SANE: 88.7 (PO) VAS: 6.3/1.5	86.3% satisfied	II	15	52 Y	ASES: 43.4/89.9 UCLA: 19.0/32.7 SANE: 91.2 (PO) VAS: 6.9/1.2	100% satisfied	Arthroscopic	Minimum 22 M
Ek et al., 2014	III, Retrospective	2008–2011	II	10	31 Y (21–43 Y)	ASES: 93.5 (PO) SSV: 51%/84% VAS: 6.5/0.8	90% satisfied or very satisfied	II	15	47 Y (30–59 Y)	ASES: 93.5 (PO) SSV: 44%/85% VAS: 6.2/0.9	93% satisfied or very satisfied	Open Subpectoral	Minimum 25 M
Chalmers et al., 2016	III, Retrospective	2004–2013	II	45	35 Y (15–64 Y)	ASES: 69/87 VAS: 2.7/1.5 SST: 9.2/10.2	—	I, II, III, IV	23	45 Y (19–67 Y)	ASES: 61/84 VAS: 3.8/1.5 WOSI: 6.5/9.4	—	Open Subpectoral	Minimum 1 Year
Schröder et al., 2017	I, Prospective	2008–2014	II	40	42 Y (22–57 Y)	WOSI: 62.7/85.8 Rowe: 1044/340	29/35 (83%) good to excellent	II	39	40 Y (18–64 Y)	WOSI: 60.3/86.8 Rowe: 1155/436	34/38 (89%) good to excellent	Mini open	24 M
Dunne et al., 2020	III, Retrospective	2009–2016	II	33	30.4 Y (15.5–40.8 Y)	ASES: 45.8/86.4 Dash-Sport: 73.0/22.5 VAS: 6.64/1.64	PRO - Mean Satisfaction 8.00	II	20	26.9 Y (18.4–39.8 Y)	ASES: 55/86.3 Dash-Sport: 60.1/11.0 VAS: 5.56/1.85	PRO - Mean Satisfaction 8.5	Arthroscopic	Minimum 24 M

Y: Years, **M:** Months, **ASES:** American shoulder and elbow surgeons score, **UCLA:** University of California Los Angeles., **SANE:** Single Assessment Numeric Evaluation, **PO:** Postoperative, **SSV:** Subjective Shoulder Value, **VAS:** Visual Analog Scale, **SST:** Simple Shoulder Test, **WOSI:** Western Ontario Shoulder Instability Index, **PRO:** Patient Reported Outcome.

Table 2. Postoperative protocols and follow-up parameters.

Study	Postoperative Repair	Postoperative Rehabilitation for SLAP Tenodesis	Sling Time (Week)	Healing at outcome scores/ Satisfaction	Time to return to sports	Return to preinjury level of sports	Return to Sport	Required reoperation after SLAP repair		Conclusion
								19/160	7/127	
Boileau et al., 2009	*Pendulum first day *passive- and active-assisted range of motion exercises after 3rd week	*Pendulum first day *passive- and active-assisted range of motion exercises after 3rd week	4 weeks for both	Constant Score: Not significant difference between SLAP repair and BT/ SLAP Repair: 40% Satisfied, BT: 93% Satisfied	—	SLAP Repair 2/10 (20%) BT: 13/15 (87%)	—	4/10 40%	0/15 0%	Arthroscopic biceps tenodesis can be considered an effective alternative to the repair of a type II SLAP lesion,
Denard et al., 2014	*Passive external rotation was allowed as tolerated. *Strengthening was initiated at 6 weeks postoperatively. *Allowed to work at 3 months postoperatively and were out in a gym. *For throwing athletes, an interval throwing program was started at 4th months postoperatively. *Full return to activity was allowed at 7th months	*Active elbow flexion, extension and passive forward elevation, external rotation were allowed immediately as tolerated. *Strengthening was delayed until 12 weeks postoperatively. *Full return to activity was allowed when strength was regained, usually at 4 months postoperatively.	4 weeks for Repair, 6 for BT	ASES, UCLA VAS ROM Not significant difference/ SLAP Repair 86.3% Satisfied- BT 100% Satisfied No significant difference	—	—	SLAP Repair 86.3 / BT 100%	2/22 9% BT: 0/15	0/15 0%	Biceps tenodesis is preferable to biceps repair for isolated type II SLAP lesions in nonoverhead athletes older than 35 years.
Ek et al., 2014	*Gentle passive- and active-assisted range-of-motion exercises from day 1. *Strengthening starts at 6th week *Free after 6 months	*Allowed to start both passive- and active-assisted range-of motion exercises of the shoulder from day 1. *Strengthening starts at 6th week *Free after 10th week	4 weeks for Repair, 2 for BT	ASES, SSV, VAS and satisfaction not significant	SLAP repair: 6.8 months (mean) BT: 8.2 months (mean) (Not significant)	SLAP Repair: 60% BT: 73%	—	0/10 0%	0/15 0%	In younger patients (<35 years) who are active and/or show healthy-looking labral tissue at the time of arthroscopy, SLAP repair if patient (>35 years) and less active who exhibit a degenerative or frayed labrum, biceps tenodesis Combined procedure is worse
Chalmers et al., 2016	*Immediate range of motion *Isometric strengthening at 8th week *Eccentric strengthening at 12th week	*Patients immediately began with ROM without limitations avoided resisted elbow flexion or forearm supination for the first 4 weeks.	4 weeks	SST, VAS, or ASES scores not significant between two groups	Overhead throwers began throwing at 4.5 months and began throwing from the mound at 6 months.	SLAP Repair: 64% Biceps Tenodesis: 75%	no difference in *return to play, *return to work, *pain *functional outcomes	8/45 18%	1/23 4%	

(continued)

Table 2. (continued)

Study	Postoperative Rehabilitation for SLAP Repair	Postoperative Rehabilitation for Biceps Tenodesis	Sling Time (Week)	Healing at outcome scores/ Satisfaction	Time to return to sports	Return to preinjury level of sports	Return to Sport	Stiffness	Required reoperation after SLAP repair 19/160 12%	Required reoperation after biceps tenodesis 7/127 6%	Conclusion
Schröder et al., 2017	*Pendulum first day *Biceps loading: 12 weeks	*Pendulum first day *Biceps loading: 12 weeks	3 weeks	No difference of Rowe and WOSI	—	—	—	5 after Repair 4 after tenodesis 1 after Sham surgery	4/40 10%	6/39 15.4%	No difference between groups
Dunne et al., 2020	Passive- and active-assisted ROM with restricting flexion, internal and external rotation and abduction at first six weeks. *Weeks 10–12 involved more aggressive strengthening exercises and progression of external rotation. *Allowed to return to non- overhead sport at 12–16 weeks, and overhead sport at 16–24 weeks	*Passive progressing to active ROM with full ROM at the first 6 weeks *Resistance exercises began at week 7. Weight training began at week 8, avoiding overhead activities. *Allowed to return to non- overhead sport at 8 weeks and overhead sport at 12 weeks.	4 weeks in SLAP Repair, As tolerated for BT	No difference of ASES, DASH- sport, VAS, and satisfaction between groups	—	50% for SLAP Repair 63% for BT Not significant	—	—	1/33 3%	0/20 0%	In a young active population, primary arthroscopic biceps tenodesis is a viable surgical alternative to labral repair for type II SLAP lesions

SST: Simple Shoulder Test, **VAS:** Visual Analog Scale, **ASES:** American shoulder and elbow surgeons score, **WOSI:** Western Ontario Shoulder Instability Index, **BT:** Biceps Tenodesis, **SSV:** Subjective Shoulder Value, **UCLA:** University of California Los Angeles, **ROM:** Range of Motion

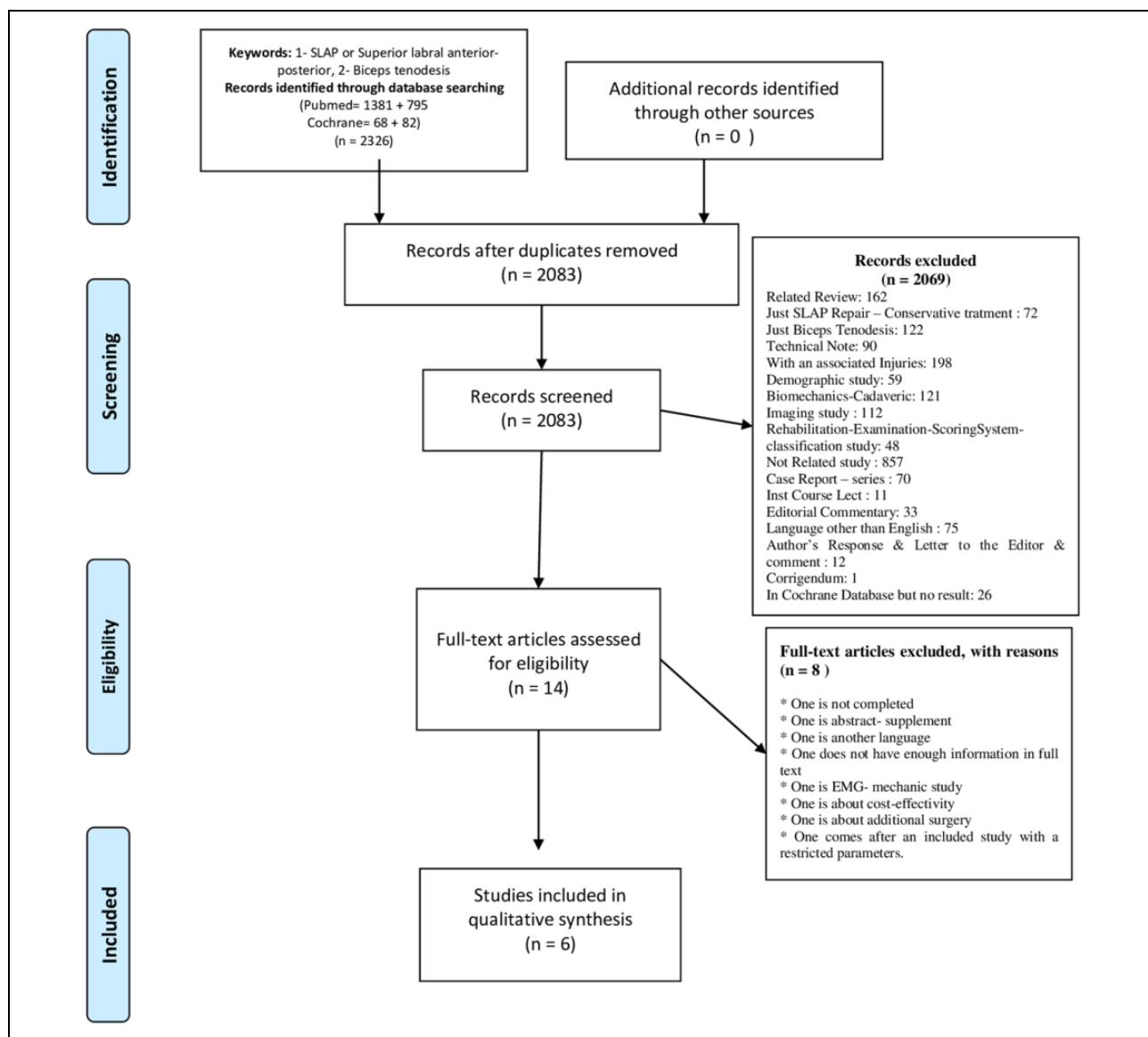


Figure 1. PRISMA diagram.

showed as more satisfied technique but the statistical comparing results of two groups was not significant in each studies.

Functional outcomes

Included six studies mentioned about different functional scoring systems that they used. American shoulder and elbow surgeons score (ASES) was the most commonly used one in the included studies.^{13–15,17} Comparing of the ASES results for the two methods in each group did not show significantly different results. Western Ontario Shoulder Instability Index (WOSI) and Rowe¹⁸ scores were used in the study established by Schröder et al. and the comparing results were not significantly different.¹⁶ Visual Analog Scale (VAS) was used to determine the

development of the pain in four studies.^{13–15,17} These four studies reported no significant difference of VAS scores between two methods. Constant was used only in one study¹² to evaluate the functional status. General Constant score was not statistically different between the biceps tenodesis and SLAP repair group. But the “activity” subscore was statistically higher in the biceps tenodesis group ($p < 0.001$).¹² Denard et al.¹³ used University of California Los Angeles (UCLA), Single Assessment Numeric Evaluation (SANE) and VAS for the evaluation and they did not mention any significant difference between groups. Ek et al.¹⁴ used Subjective Shoulder Value (SSV) as an addition to the ASES and VAS. They did not report any significant difference.¹⁴ Chalmers et al.¹⁵ used Simple Shoulder Test (SST), ASES and VAS for the clinical evaluation and reported no significant difference.

Return to sport

Five of six studies reported about return to sportive activities.^{12–15,17} These five studies included 120 of the SLAP repair group and 88 of the biceps tenodesis. The percentage of return to sport and preinjury level was higher in biceps tenodesis in all five groups (Table 2). Boileau et al.¹² reported statistically significant difference between biceps tenodesis and SLAP in related to return preinjury level of sportive activities.

Reoperation

All six studies reported about their reoperation rates for each methods.^{12–17} Total reoperation rate for SLAP repair was 19/160 (12%) and biceps tenodesis was 7/127 (6%). Reoperation rate was high in SLAP repair group in four studies,^{12,13,15,17} equal in one¹⁴ and high in biceps tenodesis in one study.¹⁶

Stiffness, sling time and rehabilitation

Three out of six studies including 72 SLAP repair and 69 biceps tenodesis mentioned about *stiffness* (Table 2).^{13,14,16} In these three studies, stiffness was reported 9/72 (12.5%) in SLAP repair group and 4/69 (5.8%) was reported in biceps tenodesis group.

The *sling time* was mentioned in all studies.^{12–17} It was reported 4 weeks in five studies^{12–15,17} and 3 week in a study¹⁷ for SLAP repair group. The time period of using a sling was variable in biceps tenodesis group. It was reported from “as tolerated” to 6 weeks.^{12–17}

The *rehabilitation* steps were very variable in all studies^{12–17} and some critical steps are listed in Table 2. Some studies^{12,16} reported that they performed the same protocol for each group and some^{13–15,17} was quick for biceps tenodesis group.

Discussion

The present systematic review showed that both biceps tenodesis and SLAP repair are effective for the treatment of SLAP tears. The functional outcomes were higher for each group individually but the scores were not significantly different between SLAP repair and biceps tenodesis groups. The mean age of the patients whom biceps tenodesis was performed to, become lower over the years and there is a tendency toward biceps tenodesis instead of SLAP repair for the SLAP tears.

The *age* of the patient is still one of the controversial topics about treating SLAP tears. Some authors declare that SLAP repair should be reserved for young patients and suggest to perform SLAP repair if patients under 40 years of age according to their institute algorithm.¹⁹ Some prefer biceps tenodesis if patient is older than 35 and the biceps tendon is degenerative.²⁰ Schröder et al.²¹ compared the SLAP repair results between under and older 40 years of

age and reported that the results were independent of age and gender. In the randomized controlled trial that included in the present systematic review, Schröder et al.¹⁶ investigated three groups with a mean age of 40 years in biceps tenodesis, 40 years in sham surgery group and 42 years in SLAP repair group. They found no difference between the objective and subjective scores of three groups. Dunne et al.¹⁷ reported the comparative results of biceps tenodesis and SLAP repair between the 15–40 years old of age. They found no difference in functional outcomes and reported that arthroscopic biceps tenodesis is a viable alternative to SLAP repair in young active population.¹⁷

However, Constant, UCLA, SSV, SST, WOSI and DASH-Sport were also used in the included studies, the most commonly used *functional assessment* scoring system were ASES and VAS.^{13–15,17} They both were used in the same four studies. All of the studies showed improvement of the scores in each treatment group but the last evaluating results were not significantly different. Any of the studies did not mention about significant difference between SLAP repair and biceps tenodesis groups. Schröder et al.,¹⁶ only randomized controlled trial of the included studies, also reported no significant functional improvement between the groups even in the sham group. The results of Schröder et al.¹⁶ may lead to an idea of performing what they did in the sham group for the SLAP tears: *diagnostic arthroscopy*.

Returning to preinjury level is one of the most important expectations of people, especially athletes with SLAP tears. Boileau et al.¹² reported a huge difference between SLAP repair and biceps tenodesis group in returning to preinjury level percentage. It was 20% for SLAP repair group and 87% for the biceps tenodesis group. Except one studies performed by Schröder et al.¹⁶ all studies^{12–15,17} reported higher rate of return to preinjury sports level in biceps tenodesis group. But it is not easy to state biceps tenodesis is favorable for returning to preinjury that sports level in overhead athletes because the studies were not only performed on the overhead athletes. A study²² including Major League Baseball (MLB) players showed that the effect of the type of surgery is also related to the position of the baseball players. Biceps tenodesis would be more favorable for a MLB position player and may have a higher rate (80%) of returning to preinjury level but it is not true for a MLB pitcher (17%).²² The difference between groups lead us to think about SLAP repair for overhead athletes as reported with high return to preinjury levels in a systematic review.²³ However the need for a randomized controlled trials including the playing position of overhead athletes should not be forgotten.

Stiffness and reoperation are the specific complications after treatment of SLAP tears. Stiffness was reported in three of the included studies^{13,14,16} and the rate was always higher in the SLAP repair group. Reoperation rate changed between 0% and 40% in the SLAP repair groups of the

included studies^{12–17} and always equal or higher from the biceps tenodesis group except one study.¹⁶

Rehabilitation protocol was different in all included studies and this difference makes it difficult to compare the results. But it is clear that included studies performed more aggressive therapies^{13–15,17} or equal^{12,16} to the SLAP repair and biceps tenodesis groups. It's important to recover in a short time with a potential lower risk of stiffness is important factors especially in older populations.¹⁴ The quality of the biceps tendon and the presence of the tendinitis always have to be taken into consideration.²⁴

Four of included six articles were retrospectively designed cohort studies.^{13–15,17} Two were prospectively designed and one of these two was Level I¹⁶ and one was Level III¹² cohort study. The parameters that could not be standardized and the level of included studies are the **limitations** of the present systematic review. Randomized controlled trials for both athletes and normal population with homogeneous treatment methods at the same ages and longer follow-up periods are needed to determine an algorithmic approach to the treatment of SLAP tears.

Conclusion

This systematic review showed that the biceps tenodesis has higher return to preinjury sports level, higher patient satisfaction and lower reoperation rates but functional scores are similar between SLAP repair groups in patients with SLAP tear.

Author contributions

Conception or design of the work: OC, KB, and AMÖ. Analysis or interpretation of data: OC, KB, MK, and AMÖ. Revised the manuscript critically for important intellectual content: OC, KB, MK, and AMÖ.

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