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Recent Trends in Rehabilitation and Return to Sports Criteria Post SLAP Lesion in Overhead Athletes - A Systematic Review

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ABSTRACT

Introduction: Overhead athletes frequently have SLAP lesions, which can be difficult to diagnose because of vague exam results and related shoulder disorders. Advances in arthroscopic procedures have drawn attention to the intricate anatomy at play, underscoring the importance of an accurate diagnosis. Classification systems facilitate the knowledge of SLAP pathology, and diagnostic techniques like as ultrasound and MRI improve the precision of detection. Customized rehabilitation plans are feasible, but little is known about the rates of healing and return to sport for overhead athletes following SLAP injuries, which calls for a systematic review to close this knowledge gap.
Aim: To review the past rehabilitation and return to sport rates studies in overhead athletes with SLAP tear/lesion.
Objective: To compile recent rehabilitation methods and return to sports criteria and rates in post-SLAP tear overhead athletes.
Methodology: A systematic review with a focus on papers published in the past ten years was carried out, adhering to PRISMA principles. To evaluate the quality, the Methodological Index for Non-Randomized Studies (MINORS) tool was used. Studies describing RTS rates and rehabilitation strategies in overhead athletes following SLAP injuries met the inclusion criteria. Rehab efficacy and RTS results were assessed through data extraction and analysis.
Conclusion: An overall RTS rate of 67.25% was found in the review, underscoring the difficulties and developments in the therapy of SLAP lesions. While rehabilitation procedures varied, certain themes surfaced, including phased programs with an emphasis on strengthening the rotator cuff and sport-specific training. To improve treatment methods and guarantee a safe return to sport for overhead athletes with SLAP lesions, more studies are necessary. The significance of evidence-based rehabilitation catered to the specific requirements of each athlete is highlighted by this study.

Keywords: *Rehabilitation post slap lesion, SLAP lesion in overhead athletes, return to sports rates, and RTS criteria.*

INTRODUCTION

Superior labral anterior-posterior (SLAP) lesions are acute or chronic shoulder injuries caused by repeated overhead activities. The upper (superior) portion of the labrum is hurt in a slap injury. The biceps tendon joins

to the labrum in this region as well; lesions can be found both anteriorly and posteriorly of this attachment. A deeper comprehension of the intricate anatomical region known as the superior biceps labral complex has been made possible by arthroscopic techniques [1]. Overhead athletes with labral injuries can now go through their physical therapy thanks to advancements in surgical techniques [1]. Additionally, non-specific provocative diagnostic techniques and the existence of concurrent shoulder diseases make correct diagnosis challenging [2].

26% of shoulder arthroscopies result in common labral anterior-posterior (SLAP) tears, which were first described by Andrews et al. [3] and then classified by Snyder et al [4]. Shoulder pain and disability could result from SLAP tears. Though Snyder et al. (1986) [4] provided the first illustrations of SLAP injuries in the early 1980s, our knowledge of these injuries has grown over time. Since then, symptomatic treatments including advanced imaging techniques and arthroscopic interventions have made unimaginable progress toward enabling a more precise diagnosis and characterization of SLAP injuries. The documented environment creates the framework for appreciating the contemporary difficulties and advancements in managing these wounds.

A four-part classification system was first developed by Snyder et al. [4] to characterize the pathology of the superior labrum: Types I and II are fraying, Type III is a bucket-handle tear, and Type IV is similar to Type III but the rip extends into the biceps tendon. Type II is the most frequent and involves the separation of the bicep's tendon with or without fraying. Maffet et al. [5] revised this classification scheme to be even more inclusive by including three more common variations: Type VII, which extends anteriorly beneath the MGHL; Type VI, which is an unstable flap tear with a separation of the biceps anchor; and Type V, which is an anterior-inferior Bankart lesion that propagates superiorly to the biceps tendon. According to these writers, Type I lesions are indicative of typical aging. Additionally, three subclassifications of Type II lesions were defined by Burkhart et al. [6]: anterior, posterior, and mixed anterior and posterior. A posterior-dominant biceps attachment would result in posterior or combination anterior and posterior labral avulsions under a tensile strain. These subclassifications were linked to the location of the biceps anchor on the superior labrum.

In recent years, the emphasis has switched on maximizing rehabilitation procedures to help overhead athletes recover to their pre-injury levels of performance. In their discussion of the most recent ideas in SLAP tear rehabilitation, LeVasseur et al. [2] emphasized the changing standards for returning to employment and sports. Moreover, Manske et al. recognized the particular demands placed on this population and offered insightful information about SLAP rehabilitation specifically designed for overhead athletes.

Additionally, the peel-back process was presented by Burkhart [6], who also explained its significance for rehabilitation as well as how it contributes to the development and extension of posterior type II SLAP lesions. Comprehending these mechanisms is crucial to formulate tailored rehabilitation regimens that maximize results for overhead sportsmen suffering from SLAP lesions.

The goal of this review is to combine previously documented return-to-sports rates and provide insights into their recovery following a slap lesion/tear. The purpose of this research is to ascertain the rate of return to sport among athletes (more especially, overhead athletes) following SLAP tears and to examine the rehabilitation strategies used in this regard.

MATERIALS & METHODS

Protocol: This systematic review is done to compile recent rehabilitation methods and return to sports rates in post-SLAP repair athletes

Eligibility Criteria:

Inclusion criteria

1. Articles written in English
2. Study published in the last 10 years
3. Study that includes a search strategy of all types of literature which includes PubMed, Google Scholar, and ResearchGate
4. Articles describing rehabilitation interventions and return to sports rates in athletes post SLAP lesions in overhead athletes
5. Non- randomized studies.

Exclusion criteria-

1. Studies or articles have been published more than the last 10 years back
2. Articles published in a language other than English
3. Articles not reporting any outcome measures
4. Abstracts or articles without enough information about the return to sports rates.
5. Duplicate articles
6. Case reports
7. Randomized control trials
8. Systematic reviews

Search strategy:

The following databases were searched: Pub Med, Google Scholar, Science Direct, and Research Gate. The search keywords utilized were rehabilitation post slap lesion in overhead athletes, and return to sports.

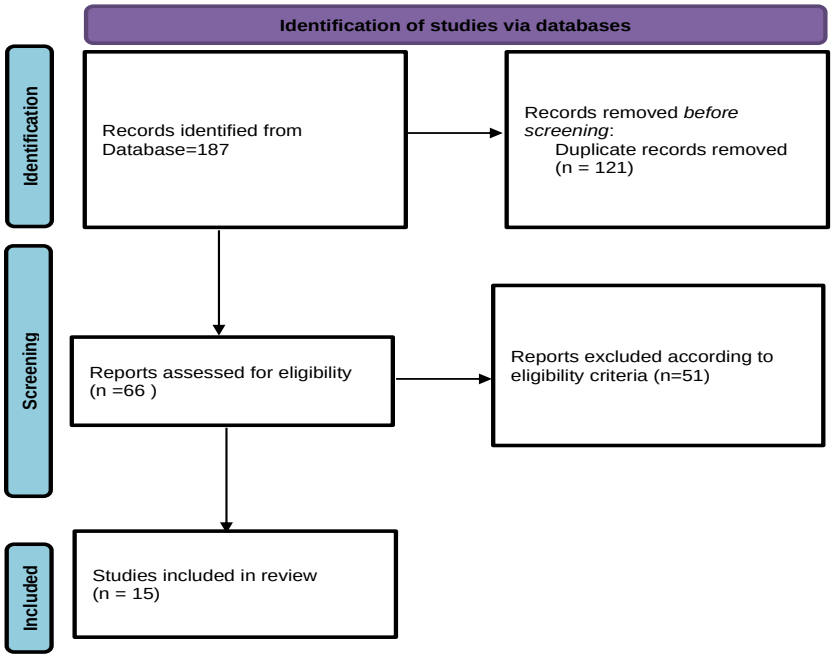
Study selection:

There were 187 items found in the literature search. Sixty-six articles were deemed appropriate for full-text examination after 121 articles were screened by title and abstract and duplicates were removed. Out of 51 studies, none met the eligibility requirements. Ultimately, 15 papers satisfied the review's inclusion requirements. These articles were all eligible for inclusion.

METHODOLOGY:

The study was conducted and reported according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement. The assessment of the methodological quality of the included studies was done using the Methodological Index for Non-Randomized Studies (MINORS) tool for all nonrandomized studies.

Procedure:



RESULT

The literature search generated 187 articles. After removing duplicates, 121 articles were screened by title and abstract, leaving 66 eligible articles for full-text review. According to the eligibility criteria 51 studies were excluded. Finally, 15 articles met the inclusion criteria of this review. All of these articles met inclusion criteria.

Return to sports criteria:

The requirements for returning to sports following shoulder surgery are complex and dependent on the particular technique as well as the patient, especially in the case of injuries like SLAP tears or biceps tenodesis. The return to play (RTP) success criteria for professional baseball players are outlined by Fedoriw et al. They place a strong emphasis on finishing spring training, playing in competitive games, and comparing performance data before and after injury [7]. Hurley et al. and Bosmuller et al. stress the significance of functional recovery, pain management, rehabilitation tailored to the specific sport, strength and endurance, functional testing, and psychological preparation[8,9]. Bosmuller et al. recommend waiting at least six months following surgery before contemplating a return to sports[9]. All of these factors point to the need for a comprehensive approach that takes into account an athlete's psychological and physical preparedness, customized rehabilitation, and close observation to guarantee that they can safely return to their sporting activities without running the danger of re-injury[8].

Rehabilitation and Rates of return to sports:

After the SLAP lesion, we observed a collective return to sport rate of 67.25% (269/400 overhead athletes). There were variations in the rehabilitation regimens and postoperative care procedures among studies involving athletes who underwent biceps tenodesis or SLAP repair surgeries. Park et al. documented a 50% rate of return to play after SLAP repair using a regimen consisting of active assistance exercises, range-of-motion exercises, and throwing programs after the initial gradual passive forward flexion [10]. Using an internal rotating sling and progressive physical therapy to restore the range of motion and strengthen the shoulder, Maier's study showed a 64% return to play rate following SLAP surgery [11]. Fedoriw's research revealed a 62% return to play rate, with a graded throwing program, rotator cuff training, core strengthening, and scapular stabilization as key components of rehabilitation [7]. Following subpectoral biceps tenodesis, Gottschalk and Bosmuller obtained high return-to-play rates of 81% and 100%, respectively, by implementing standardized rehabilitation protocols that emphasized functional rehabilitation, strengthening, and range of motion [9,12]. On the other hand, Gupta found that a rehabilitation protocol consisting of sling immobilization, passive to active range of motion, and restricted strengthening resulted in a reduced return to play rate of 43%[13]. While Pogorzelski focused on sling immobilization and avoiding resisted elbow flexion, Chalmer highlighted customized rehabilitation regimens for SLAP repair and tenodesis surgery [14,15]. All things considered; the research highlighted how crucial customized recovery plans are to helping players get back into the game after shoulder surgery.

A number of the publications from the data set either did not provide comprehensive rehabilitation protocols or only stated that rehabilitation was given without providing any specific information. Chalmer [16] focused only on baseball pitchers and reported a 100% return rate; it did not elaborate on the post-surgery rehabilitation procedure. Similarly, there is no clear information about the rehabilitation program used in Smith's 2017 study on biceps tenodesis in baseball pitchers [17]. Baseball players' biceps tenodesis was the subject of Chalmer's 2018 study, which cites a return rate but doesn't go into detail on the rehabilitation techniques used [18].

However, Griffin's 2019 study, which included biceps tenodesis in different athletes, cites physical therapy but doesn't elaborate on the type of rehabilitation protocol used [19]. Gilliam's research, which emphasizes the value of postoperative rehabilitation for baseball players after SLAP repair surgery, likewise only makes reference to the availability of rehabilitation without providing particulars about the protocols that were adhered to. All these articles were included as they gave insight on the return to sports rates specifically in overhead athletes.[20]

DISCUSSION

The purpose of this systematic review was to determine and overview the return to sports rates and rehabilitation protocols opted in overhead athletes after suffering slap tears/lesions also stating the surgery performed for slap lesions in the last 10 years. Athletes with SLAP injuries, particularly those who perform overhead, have considerable sporting limits. After the SLAP lesion, we observed a collective return to sport rate of 67.25% (269/400 overhead athletes).

The management of SLAP tears continues to evolve. We meticulously screened and analyzed 15 relevant studies meeting our inclusion criteria, stating the return to sports rates and shedding light on the management of this prevalent injury in athletes. The results of these investigations highlight the various rehabilitation approaches and rates at which athletes who play overhead sports but have SLAP injuries return to their sport. The absence of established methods in the field is reflected in these protocols' variances in timing, intensity, and particular exercises. Nonetheless, the literature presents several recurrent patterns.

Rehabilitation procedures, first and foremost, usually consist of several stages, ranging from passive range of motion exercises to active-assisted and finally active range of motion. To address the frequent muscle imbalances seen in overhead athletes with SLAP injuries, the first phases of treatment focus on scapular stabilization, rotator cuff strengthening, and posterior capsular stretching. Additionally, to address the unique demands of the athlete's sport and position, a sport-specific training program is frequently incorporated into the rehabilitation process. Exercises designed to improve performance and restore functional movement patterns while lowering the chance of re-injury are included in this.

The rates at which overhead athletes with SLAP injuries return to sports differ amongst studies. While Bosmuller et al. saw a 100% return-to-sports rate among their patient population, Gottshalk et al. reported an overall return-to-play rate of 81% [12]. On the other hand, lower return-to-sports rates of 35% and 81%, respectively, were recorded by Chalmer and Pogorzelski [8,14]. These discrepancies could be the result of disparities in the patient groups, surgical methods, and procedures for rehabilitation used in different research.

Recent research by Pogorzelski et al. and Griffin et al. showed that isolated BT done in younger overhead athletes, even those under the age of 25, has a high success rate in terms of clinical results and return to sports [14,19]. Smith et al. claimed a 92% return to play among elite pitchers [17] . These figures represent the minimum and maximum of this spectrum among high-level sportsmen. A perplexing aspect to consider is that Chalmers et al. were the only researchers to include patients undergoing concurrent surgery, such as rotator cuff repair [18]. The investigators did, however, divide these groups and reported a return-to-play percentage of 25% in the case of concurrent surgery and 44% in the absence of it.

Sr. no.	Author (year)	Study design	No. of Athletes (overhead)	Sports Played	Surgery performed	Return to play/sport rates %(n)	REHABILITATION
1.	Park (2013)	Case series	(24)	16 baseballs, 3 javelin, 3 volleyballs, 2 badmintons (all overhead)	Isolated SLAP repair	50 (12/24)	- Six weeks post-surgery: Gentle passive forward flexion initiated and maintained for three weeks. - Nine weeks post-surgery: Exercises for range of motion with active assistance began and continued for three weeks. - Three months post-surgery: Follow-up CT arthrography conducted to assess repair integrity. - Following CT arthrography, strengthening activities were approved. - Six months post-surgery: Throwing programs commenced. - Nine months post-surgery: Complete recovery anticipated. - Once athletes resumed pre-injury activity levels, they underwent a follow-up CT arthrogram at the hospital to assess labrum healing. - Throughout rehabilitation, patients attended private, specialist sports rehabilitation facilities.
2.	Maier (2013)	a comparative study	24(17)	2 volleyball, 4 soccer (2 goalkeepers, 2 field players), 1 boxing, 1 climbing, 4 tennis, 1 badminton, 3 fitness (weightlifting), 1 basketball, 3 swimming, 2 cycling, 1 running, 1 Nordic walking	Isolated SLAP Repair	64 (11/17)	- internal rotation sling for two weeks during the day and four weeks at night. - After two weeks, transitioned to a knitwear bandage allowing vigorous abduction and external rotation during the daytime for two weeks. - For six weeks post-surgery, glenohumeral abduction was limited to 90 degrees. - First six weeks, patients were limited to mildly active elbow flexion and forearm supination without weight load. - week seven, Active and passive physical aiming to restore full range of motion. - Rotator cuff and scapula stabilizer muscle strengthening performed isometrically and isokinetically. - Specific muscle imbalances and deficiencies were addressed through tailored exercise

							regimens. - All athletes returned to competitive sports within three months post-surgery.
3.	Fedoriw (2014)	Retrospective case series	68(45)	Pitchers 45 Positional players 23	overhead athletes with specifically SLAP lesions, underwent nonsurgical treatment. Surgical treatment was considered for those athletes who did not respond to nonsurgical interventions(SLAP repair with suture anchors or debridement)	62(28/45)	- The rehabilitation regimen for professional baseball players with SLAP tears includes a two-phase therapy method. - The first phase of therapy is all-encompassing and includes posterior capsular stretching, rotator cuff strengthening, and scapular stabilization. - Phase two is overseen by a licensed physical therapist and focuses on posture correction, awareness of scapular positioning, and core strengthening during throwing. - Based on position played, amount of time off from throwing, and pain thresholds, a graded throwing program is customized to meet the demands of each player. - During rehabilitation, cortisone injections and nonsteroidal anti-inflammatory medications are given as needed.
4.	Gottschalk (2014)	Case series	29(16)	Weightlifting 6, tennis 3, racquetball 2, baseball softball 2, swimming 1, cricket 1, gymnastics 1	subpectoral biceps tenodesis	Overall, 13 of 16 (81); recreational, 11 of 12 (92); competitive/ collegiate, 1 of 2 (50)	- Rehabilitation protocol consisted of 3 phases. - Phase 1 (weeks 1-3): Immobilization in a sling for 3 weeks, passive elbow range of motion, and active shoulder range of motion. - Phase 2 (weeks 4-8): Added gentle isometric biceps exercises and a rotator cuff strengthening program. - Phase 3 (weeks 9-16): Involved progressive strengthening and functional rehabilitation. - Patients were released at 4 to 5 months postoperatively.
5.	Gupta (2015)	Retrospective case series	8(7)	Baseball-softball (4) (1 pitcher), volleyball (1), basketball (1), swimming (1)	subpectoral biceps tenodesis	Overall, 3 of 7 (43); recreational, 0 of 4 (0); competitive/collegiate, 3 of 3 (100)	- Patients required to wear a sling for the initial four weeks post-surgery, even during sleep and public activities. - Therapy commenced with passive range of motion exercises, progressing to active-assisted and then active range of motion

							exercises. - Grip strengthening and elbow range of motion exercises were integral components of the therapy regimen. - For a duration of six weeks, specific strengthening exercises, particularly resisted elbow flexion and forearm supination, were prohibited to facilitate optimal healing of the biceps tenodesis.
6.	Chalmer (2015)	retrospective comparative cohort study	86(32)	NR	SLAP repair, biceps tenodesis	21/32(65)	1.Post-Surgery Protocol for SLAP Repair: - Restricted range of motion initially, especially for specific movements, for the first four weeks. - Gradual advancement to strengthening exercises tailored to the patient's sport. - Emphasis on protecting the repaired area during early stages. 2. Strengthening Program for Tenodesis and Combined Procedures: - Similar protocol to SLAP repair for the initial four weeks. - Restrictions on resisted elbow flexion or forearm supination to safeguard the tenodesis. - Progression to more intensive strengthening exercises over time, as tolerated.
7	Bosmuller(2017)	Prospective study	11	volleyball (5), climbing (2), tennis (2), hockey (1), and yoga (1)	Isolated SLAP Repair	11 (100)	- Activities involving hand gripping are allowed while recovering from surgery on the shoulder. - Weeks 3–4: Passive range-of-motion activities in the scapular plane were progressed to 60 degrees of elevation and approximately 45 degrees of internal rotation. - From then on, flexion was increased every two weeks. - Absence of resistant biceps exercises and external rotation for eight weeks. - After achieving complete range of motion,

							isometric exercises were added for strengthening and stretching (8–12 weeks). - At-home routines and rotator cuff strengthening exercises with a theraband are recommended. - In the fourth and sixth months following surgery, patients select their own self-planned fitness programs or physiotherapy appointments. - Following the department's strength rehabilitation program, the majority of athletes returned to the game after six months of pain-free function restoration. - Gradual return to activity following a two-week period of immobility using an abduction sling. - After the sling was removed, more physical therapy sessions were required.
8	Pogorzelski (2018)	therapeutic case study	16(11)	Weightlifting (3), baseball softball (2), volleyball (2), basketball (1), martial arts (1), rock climbing (1), fishing (1)	Open subpectoral biceps tenodesis	Overall, 9 of 11 (81)	- immobilization with a sling for two weeks following surgery. -The entire range of motion, both passive and dynamic, is permitted. - For the first six weeks, avoid forced elbow flexion. Immobilization with a sling aids in the healing process. - A full range of motion facilitates healing and helps to avoid stiffness. - Reducing resistance when flexing the elbow aids in avoiding strain on the healing tissues.
9	Dunne (2021)	retrospective comparative cohort study	53(30)	baseball, basketball, gymnastics, fast pitch softball, slow pitch softball, swimming, triathlon, tennis, volleyball, water polo, competitive weight lifting, and wrestling	SLAP repair(13), biceps tenodesis(17)	overall, 19 of 30(65), SLAP repair was (45) biceps tenodesis (70)	1. Rehabilitation for Biceps Tenodesis: Using a sling to provide comfort after surgery. - A gradual shift during the first six weeks from passive to active range of motion. - During this time, the elbow and shoulder were given complete range of motion. - In week 7, weight exercise (such as bicep curls) is introduced. - Beginning weight training in week eight while staying away from overhead exercises. - After eight weeks, non-overhead sports may resume. - After twelve weeks, permission to resume overhead sports is granted.

							2. Rehabilitation following SLAP Repair: - Use of slings for four weeks following SLAP repair. - Limitations on abduction, internal and external rotation, and shoulder flexion during the first six weeks. - Range of mobility maintained within limitations with passive and active assistance. - In week seven, isotonic strengthening was started. - For now, mild resistance exercise is allowed for the biceps. - A shift towards increasingly strenuous strengthening exercises between weeks 10 to twelve. - After 12 to 16 weeks, permission to resume non-overhead sports is allowed. - After 16–24 weeks, returning to overhead sports is authorized.
10	hurley 2022)	retrospective comparative study	131(56)	Baseball 25 Pitcher 9 Position player 16 Softball 5 Volleyball 3 Rock climbing 4 Boxing 1 Tennis 3 Handball 3 Swimming 6 CrossFit 5 Golf 1	SLAP repair, biceps tenodesis	overall, 46 of 56 (82)	- Postoperative rehabilitation: immobilization time in a sling. - A progressive range-of-motion (ROM) and shoulder strengthening treatment is started after immobilization. Regaining full range of motion and shoulder strength is the aim. - A sport-specific training regimen is started after complete range of motion and strength have been attained. - After six months, patients who satisfy all rehabilitation conditions can return to play. - Before returning to play, the rehabilitation method entails phases of immobilization, ROM and strength exercises, and sport-specific training.
11	Gilliam (2017)	retrospective case series	133	Pitchers 95 Catcher 10 Infielder 18 Outfielder 10	SLAP repair with rotator cuff debridement if needed	Overall, pitchers 56(59%)	NR (does not include detailed information about the recovery procedures) - the focus in the early postoperative weeks on limiting passive external rotation and abduction. Reducing tension at the SLAP repair location. - After that, gradually resume your range-of-

							motion workouts. - Gradual strengthening activities aimed at improving shoulder stability. - Including, to the extent tolerated, sport-specific drills and exercises. - medical professionals' close supervision to guarantee appropriate recovery and a gradual return to play.
12	griffin (2019)	therapeutic case series	36(23)	Baseball-softball 17, volleyball 6, swimming 4, basketball 2, gymnastics 1; some participated in multiple sports	biceps tenodesis	Overall, 17 of 23 (77)	NR does not particularly outline a comprehensive physical rehabilitation program for individuals who have undergone biceps tenodesis surgery and are younger than 25. It does, however, emphasize the importance of physical therapy in the overall care of these patients by noting that it was a part of the nonoperative treatment in each case.
13	Chalmer (2014)	Controlled laboratory study	5(5)	Baseball pitchers 5	NR	100	NR
14	Smith (2017)	descriptive epidemiological study	13(13)	Baseball pitchers 13	biceps tenodesis.	Overall, 12 of 13 (92); professional, 12 of 13 (92)	NR
15	Chalmer (2018)	therapeutic study, a case series	17(17)	Baseball pitchers 12, baseball position players 7	biceps tenodesis.	Overall, 6 of 17 (35); professional, 6 of 17 (35)	NR

When comparing the effectiveness of SLAP repair to biceps tenodesis in athletes, the current data points to different results. Research such as those conducted by Hurley et al. and Gottshalk et al. show that after biceps tenodesis, return to play rates are favorable[8,12]. Hurley et al. reported an overall return rate of 82%. On the other hand, the results of SLAP repairs differ according on the study; Park et al. (2013) and Maier et al. (2013) reported return rates of 50% and 64%, respectively [10,11]. Individual considerations, such as the athlete's sport, the severity of the injury, and postoperative rehabilitation regimens, must be taken into account. While biceps tenodesis may provide advantages in terms of a quicker return to play and possibly better long-term outcomes, as proven by the greater return rates found in some studies, SLAP repair may be required for some forms of labral tears. The best surgical strategy for each athlete's specific situation will require more investigation and professional judgment.

Pitchers and non-pitchers of baseball made up the majority of the included studies', mixed populations of overhead athletes of all ages and furthermore, professional athletes as well as amateur high school and collegiate athletes were included in certain studies. These were some limitations to this review.

CONCLUSION

To sum up, this systematic research offers insightful information about the rehabilitation procedures and rates of return to sports for overhead sportsmen who have had SLAP lesions in the last ten years. The research found a 67.25% overall return to sport rate, highlighting the difficulties and advancements in the treatment of these injuries. Common themes that emphasized phased rehabilitation regimens with an emphasis on rotator cuff strengthening, scapular stabilization, and sport-specific training surfaced despite differences in rehabilitation techniques and return rates. Additionally, different return rates were found when SLAP repair and biceps tenodesis were compared, emphasizing the necessity for customized treatment plans. The review emphasizes how crucial it is to follow rehabilitation recommendations and take into account athlete-specific considerations to facilitate a safe return to play. The study's deficiencies, such as the variability of the athlete populations among the included studies, highlight the need for more research to improve treatment strategies and call for caution when extrapolating results.

Declaration by Authors

Ethical Approval: Approved (Dr. APJ AK COPT/BPT/UG/2023/19)

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