Original research

Shoulder rotator strength and torque steadiness in athletes with anterior shoulder instability or SLAP lesion

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**A B S T R A C T**

Objectives: To investigate shoulder rotator strength and steadiness in athletes with anterior instability and superior labrum anterior posterior (SLAP) lesion.

Design: Cross-sectional laboratory study.

Methods: Athletes with anterior shoulder instability (instability group, \( n = 10 \)) and a SLAP lesion (SLAP group, \( n = 10 \)) were compared with healthy athletes matched by age, anthropometrics and sport (control group for shoulder instability, \( n = 10 \) and control group for SLAP, \( n = 10 \)). Torque steadiness was evaluated with three 10 s submaximal isometric contractions (35% of peak torque) with the arm at 90° of shoulder abduction and 90° of external rotation. The mean isometric torque, standard deviation and coefficient of variation were measured from the steadiness trials. To evaluate shoulder rotator strength, concentric isokinetic tests (90/180 °/s) were performed at the 90–90° position and peak torque to body mass and shoulder external to internal rotation ratio variables were analyzed. The variables were tested with the instability and control groups with respect to shoulder instability and between the SLAP and control groups for SLAP lesion using the Mann–Whitney test.

Results: The SLAP group presented a higher coefficient of variation than the SLAP control group (\( p = 0.003 \)). Regarding shoulder strength, the internal and external shoulder rotators were weaker in the instability group than in the instability control group (\( p < 0.05 \)).

Conclusions: Athletes with anterior shoulder instability presented shoulder rotation weakness, while athletes with a SLAP lesion showed higher torque fluctuation during internal rotation. These results indicate that there are different alterations to strength and sensory motor control in each condition.

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1. Introduction

During sports activities, shoulder joint ligaments and muscles are constantly challenged to maintain glenohumeral joint stability via passive bony and soft-tissue restraints and dynamic stability via the rotator cuff and scapular muscle. If any disruption occurs in the static restraints, the synergistic relationship that results in glenohumeral stability can be compromised, overloading the dynamic stabilizers.

Losses in static stability are present in superior labrum anterior posterior (SLAP) lesions and in recurrent shoulder instability after traumatic first-time shoulder dislocation, which are the most common injuries among young athletes. These lesions represent a real challenge in sports medicine rehabilitation, since they produce persistent symptoms that interfere in regular sports participation. Considering that these conditions are associated with deficits in the static stabilizers of the shoulder, it follows that the dynamic stabilizers would also present some adaptation in order to maintain functional joint stability.

Rotator cuff muscles are essential to dynamic shoulder stability by preventing excessive translations of the humeral head at the glenoid fossa. Studies have found a tendency toward a lower shoulder external-to-internal rotation ratio, as well as rotator cuff weakness in athletes with recurrent anterior shoulder instability. With respect to SLAP lesions, however, there are only reports on shoulder rotator strength after arthroscopic repair. Besides muscle strength, joint stability also depends on proper muscle balance, which can be evaluated during steady submaximal isometric contractions. The ability to perform muscle contractions with a minimum of force fluctuation during a constant-force task, i.e., torque steadiness, is considered an integrated sensorimotor...
Athletes with shoulder instability or SLAP lesion n=31

Athletes excluded Limited external rotation range of motion n=4
More than ten episodes of dislocations n=7

Healthy athletes without previous shoulder lesion n=20

Instability Group
Athletes with shoulder instability n=10

SLAP Group
Athletes with SLAP lesion n=10

Control group for shoulder instability
Athletes paired with instability group by age, height, mass and sport n=10

Control group for SLAP
Athletes paired with instability group by age, height, mass and sport n=10

Fig. 1. Injured athletes and respective control group selection.

control evaluation. Although restoring neural and muscle function is essential to shoulder rehabilitation, no study, to our knowledge, has yet described the steadiness pattern in SLAP lesions or shoulder instability.

Strength, stability and motion are the components of shoulder function that should be focused on rehabilitation, which should be specifically directed to the alterations present in an injury. The damaged structures and the referred symptoms are diverse in SLAP lesions and anterior shoulder instability. However, current recommendations for conservative treatment of these lesions are similar, including rotator cuff resistance and sensorimotor training to improve dynamic joint stability. The lack of studies evaluating muscle strength and control in SLAP and shoulder instability makes specific rehabilitation planning more difficult. In order to establish specific rehabilitation strategies, it is fundamental to investigate possible alterations in the strength and control of rotator cuff muscles in these injuries.

Therefore, the aim of this study was to investigate shoulder rotation strength and torque steadiness in athletes with anterior shoulder instability or SLAP lesion compared with healthy athletes. A better understanding of possible alterations in maximal strength and submaximal strength control of these muscles may help clinicians plan specific rehabilitation strategies for each injury, thus optimizing recovery and sports participation.

2. Methods

Athletes with anterior shoulder instability or SLAP lesion were recruited at an orthopedic clinic. All of them agreed to participate in the study on a voluntary basis and provided written informed consent. This study was approved by the University Human Research Ethics Committee.

The inclusion criteria for participants of the anterior instability group were a minimum of one episode of traumatic anterior shoulder dislocation, a positive apprehension test, sulcus sign and the anterior load-and-shift test. The inclusion criteria for the SLAP lesion group were the following: positive O’Brien test, anterior tenderness by palpation and MRI documentation of SLAP type II, III, IV or V. All diagnoses were given by the same orthopedic surgeon. The exclusion criteria included generalized joint laxity, bilateral shoulder lesion, multidirectional instability, signs of rotator cuff lesion, degenerative arthritis, systemic or neurological illnesses, previous shoulder or neck surgery or physical therapy treatment in the 12 months prior to the study. Athletes with limited external shoulder rotation (less than 95°) and with more than 10 episodes of shoulder dislocation were excluded, since they were unable to achieve the shoulder positions used in the study without pain or apprehension.

Healthy athletes with no history of shoulder pain or injury were paired with injured participants by anthropometric characteristics and sport type. Fig. 1 describes the group selection.

Four groups of male athletes were evaluated: an instability group (n = 10; 22.6 ± 3.4 years; 1.8 ± 0.05 m; 83.8 ± 7.7 kg); a shoulder instability control group (n = 10; 22 ± 3.4 years; 1.8 ± 0.08 m; 82 ± 9.2 kg); a SLAP group (n = 10; 26.9 ± 4.7 years; 1.7 ± 0.05 m; 77.4 ± 14.9 kg) and a SLAP control group (n = 10; 26.4 ± 4.5 years; 1.7 ± 0.04 m; 78.1 ± 8.5 kg). Information regarding age, affected side (dominant side = preferred arm during sports), trauma and sport type from the instability and SLAP groups are presented in Table 1.

Athletes involved in different sports were included from professional (15%), competitive (70%) and recreational (15%) levels. According to the Walch (1987) classification for shoulder risk in sport, 60% of the athletes in our sample were involved in sports with cocking or high risk (cocking and blocking) and 40% were involved in contact sports.

The isometric and isokinetic evaluations were performed during internal and external shoulder rotations with a Biodex Multi-Joint System 3 isokinetic dynamometer (Biodex Medical System Inc., New York). Evaluations were preceded by a series of shoulder warm-up exercises consisting of 15 free flexion–extension, adduction–abduction and circumduction movements that were supervised by the principal investigator.

For the instability and SLAP groups, the injured shoulder was tested. The arm evaluated in healthy athletes was paired with the injured (dominant or non-dominant) arm of the matched injured athlete. Athletes were assessed in the seated position, and trunk stabilization was provided by diagonal and pelvic straps. The evaluated arm was positioned with the shoulder abducted to 90° and the elbow flexed to 90°. The olecranon was aligned over the machine’s rotational axis. This 90–90° position was chosen because it challenges the dynamic stabilization of shoulder.

The isometric maximal and submaximal tests were performed before the isokinetic tests. The internal and external isometric rotations were assessed with the shoulder positioned at 90° of external rotation. For both rotation movement types, three 5 s maximal voluntary isometric contractions were performed with a 1 min interval between each contraction to determine the isometric peak torque.
For torque steadiness assessment, 35% of the maximal isometric peak torque value (target torque) was displayed as a horizontal line on the computer screen.\textsuperscript{14} The participants were instructed to maintain the exerted torque line at the target torque line and keep it there as steadily as possible for 10 s while receiving visual feedback.\textsuperscript{14} After one familiarization trial, the participants performed five trials for each movement with a 1 min rest between each trial.

Isokinetic evaluations were performed in a 90° range of motion, from neutral rotation to 90° of external rotation. Correction for gravity was performed with the arm relaxed in 90° of shoulder abduction and neutral rotation since this position generates the highest rotation moment. The tests were performed in the concentric mode at the angular velocities of 90°/s and 180°/s in ascending order. After the procedures were explained, the participants performed three submaximal repetitions at each test velocity in order to familiarize themselves with the equipment and conditions. After one minute of rest, five maximal reciprocal repetitions of external and internal shoulder rotations were performed, during which the participants received standardized verbal encouragement to achieve maximum strength in each contraction. A two-minute rest period was allowed between test velocities.

Data from the isokinetic dynamometer were collected with a sampling frequency of 100 Hz and then exported and reduced using Matlab\textsupersoft{} software (version 7.0.1, MathWorks Inc., Natick, USA). For the submaximal isometric tests, the standard deviation (SD) and coefficient of variation (CV = SD/mean torque × 100) were calculated for the torque steadiness variables. The SD of torque is an absolute measure of amplitude while the CV of torque is a measure of relative fluctuation. The first two seconds of contraction were discarded to avoid the initial and adjustment phases.

The calculated isokinetic variables were peak torque to body mass (N m kg\textsuperscript{-1} 100) and shoulder external-to-internal rotation ratio (ER/IR ratio, %). Isokinetic peak torque was determined from the range in which the target velocity was constant. Isokinetic peak torque was determined and normalized by individual body mass. The external-to-internal rotator peak torque ratio was then calculated for each angular velocity.

The statistical analyses were carried out with SPSS 13.0 for Windows. Considering that the majority of variables were not normally distributed according to the Shapiro–Wilk test, non-parametric tests were used for the analysis. The variables were tested between the instability and control groups for shoulder instability and between the SLAP and control groups for SLAP lesion using the Mann–Whitney test. Furthermore, a Chi-square test was performed to compare the frequencies of ER/IR ratio imbalance between the injured groups and their respective control groups. The significance level was set at \( \alpha \leq 0.05 \).

### Results

No differences were found between injured athletes and their matched controls regarding age, height or weight (\( p > 0.05 \)).

For isometric shoulder torque steadiness, the only observed difference was that the SLAP group presented impaired internal shoulder rotation force steadiness (i.e., higher CV force) compared with the corresponding control group (Table 2).

For the isokinetic evaluations, the instability group presented a lower peak torque than the corresponding control group for all conditions (Table 2). No differences were found for ER/IR ratio.

### Discussion

This study showed that athletes with anterior shoulder instability present deficits in shoulder rotator strength, while athletes with a SLAP lesion have decreased internal rotation strength control. Although abnormalities in rotator cuff performance are expected due to the complexity of these injuries,\textsuperscript{4,5} little information about this issue can be found in the literature.

Although the purpose of nonoperative treatment for instability lesions is frequently to restore deficits in strength and sensorimotor control,\textsuperscript{5} previous studies are not conclusive about these insufficiencies. Warner et al.\textsuperscript{10} evaluated a group of non-athletes with both micro- and macrotraumatic instability and found no significant alterations compared to healthy subjects, while Edouard et al.\textsuperscript{11} found reduced internal and external rotator strength in recurrent anterior shoulder instability. Although these studies evaluated non-athletes, our results agree with Edouard et al.,\textsuperscript{11} which demonstrates the need for shoulder rotator strength training in athletes with shoulder instability. Even before surgery, improving rotator cuff strength is a demanding task,\textsuperscript{2} considering that shoulder rotator weakness is still present in athletes after surgical repair and compromises sports training and activities of daily living.\textsuperscript{5}

### Table 1

Age (years), injury and sports characteristics in athletes with instability or SLAP lesion.

<table>
<thead>
<tr>
<th>Injured athletes</th>
<th>Age</th>
<th>Affected side</th>
<th>Trauma/machinery of injury</th>
<th>Sport</th>
<th>Type of sport and shoulder risk</th>
<th>Level</th>
<th>Cessation of sports activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instability 1</td>
<td>20</td>
<td>D</td>
<td>Traumatic contact in game</td>
<td>Rugby</td>
<td>With contact</td>
<td>C</td>
<td>Yes</td>
</tr>
<tr>
<td>Instability 2</td>
<td>19</td>
<td>D</td>
<td>Traumatic fall during training</td>
<td>Gymnastics</td>
<td>With cocking</td>
<td>C</td>
<td>Yes</td>
</tr>
<tr>
<td>Instability 3</td>
<td>27</td>
<td>D</td>
<td>Traumatic fall while biking</td>
<td>Swimming</td>
<td>With cocking</td>
<td>C</td>
<td>No</td>
</tr>
<tr>
<td>Instability 4</td>
<td>22</td>
<td>ND</td>
<td>Traumatic fall during training</td>
<td>Handball</td>
<td>High risk</td>
<td>P</td>
<td>No</td>
</tr>
<tr>
<td>Instability 5</td>
<td>22</td>
<td>ND</td>
<td>Traumatic blocked overhead throw</td>
<td>Water polo</td>
<td>High risk</td>
<td>C</td>
<td>No</td>
</tr>
<tr>
<td>Instability 6</td>
<td>21</td>
<td>D</td>
<td>Traumatic blocked overhead throw</td>
<td>Water polo</td>
<td>High risk</td>
<td>C</td>
<td>Yes</td>
</tr>
<tr>
<td>Instability 7</td>
<td>20</td>
<td>D</td>
<td>Traumatic fall during competition</td>
<td>Judo</td>
<td>With contact</td>
<td>C</td>
<td>Yes</td>
</tr>
<tr>
<td>Instability 8</td>
<td>20</td>
<td>D</td>
<td>Traumatic fall during playing</td>
<td>Rugby</td>
<td>With contact</td>
<td>C</td>
<td>Yes</td>
</tr>
<tr>
<td>Instability 9</td>
<td>28</td>
<td>D</td>
<td>Traumatic fall during soccer game</td>
<td>Martial arts</td>
<td>With contact</td>
<td>R</td>
<td>No</td>
</tr>
<tr>
<td>Instability 10</td>
<td>27</td>
<td>D</td>
<td>Traumatic fall during soccer game</td>
<td>Weight training</td>
<td>With cocking</td>
<td>R</td>
<td>Yes</td>
</tr>
<tr>
<td>SLAP 1</td>
<td>28</td>
<td>D</td>
<td>Traumatic type II, eccentric bench press</td>
<td>Jiujitsu</td>
<td>With contact</td>
<td>P</td>
<td>No</td>
</tr>
<tr>
<td>SLAP 2</td>
<td>31</td>
<td>ND</td>
<td>Traumatic type II, fall on outstretched hand</td>
<td>Jiujitsu</td>
<td>With contact</td>
<td>C</td>
<td>No</td>
</tr>
<tr>
<td>SLAP 3</td>
<td>27</td>
<td>D</td>
<td>Atraumatic type II, repetitive overhead motion</td>
<td>Handball</td>
<td>High risk</td>
<td>C</td>
<td>Yes</td>
</tr>
<tr>
<td>SLAP 4</td>
<td>36</td>
<td>D</td>
<td>Traumatic type III, fall with locked arm</td>
<td>Jiujitsu</td>
<td>With contact</td>
<td>C</td>
<td>No</td>
</tr>
<tr>
<td>SLAP 5</td>
<td>27</td>
<td>D</td>
<td>Atraumatic type II, repetitive overhead motion</td>
<td>Baseball</td>
<td>With cocking</td>
<td>C</td>
<td>No</td>
</tr>
<tr>
<td>SLAP 6</td>
<td>21</td>
<td>D</td>
<td>Atraumatic type II, repetitive overhead motion</td>
<td>Baseball</td>
<td>With cocking</td>
<td>C</td>
<td>No</td>
</tr>
<tr>
<td>SLAP 7</td>
<td>19</td>
<td>D</td>
<td>Atraumatic type II, repetitive overhead motion</td>
<td>Swimming</td>
<td>With cocking</td>
<td>C</td>
<td>No</td>
</tr>
<tr>
<td>SLAP 8</td>
<td>26</td>
<td>D</td>
<td>Traumatic type II, overstretch with adduction</td>
<td>Circus</td>
<td>With cocking</td>
<td>P</td>
<td>No</td>
</tr>
<tr>
<td>SLAP 9</td>
<td>29</td>
<td>D</td>
<td>Traumatic type IV, motorcycle crash</td>
<td>Soccer</td>
<td>With contact</td>
<td>R</td>
<td>No</td>
</tr>
<tr>
<td>SLAP 10</td>
<td>25</td>
<td>D</td>
<td>Atraumatic type II, repetitive overhead motion</td>
<td>Baseball</td>
<td>With cocking</td>
<td>C</td>
<td>No</td>
</tr>
</tbody>
</table>

P, professional; C, competitive; R, recreational; D, dominant; ND, non-dominant.
Despite the fact that athletes with anterior shoulder instability presented deficits in maximal isokinetic strength, no alterations were found in their torque steadiness pattern. Some studies evaluating passive joint repositioning and kinesthesia have reported that patients with anterior shoulder instability present proprioceptive deficits.21,22 Recently, Hung and Darling23 found that individuals with anterior shoulder dislocation did not exhibit joint position sense deficits in active repositioning but had greater errors during passive repositioning. The authors suggested that individuals with unstable shoulders may be able to exert proper shoulder muscle activation to stabilize the glenohumeral joint when moving into vulnerable positions such as the one used in our study (abduction and external rotation). Since the torque steadiness test is considered an integrated sensory-motor control evaluation,13 it is possible that our volunteers presented deficits in proprioception, but active stabilizers compensated for them during the test. Complementary proprioceptive evaluation for kinesthesia and joint position sense could have contributed to the sensory-motor control test results in our study.

Regarding the SLAP lesion, studies evaluating muscle strength and control are scarce, we were able to find only two retrospective studies. Pillai et al.15 evaluated external rotation strength after surgical repair in patients with isolated SLAP lesions compared to a group with SLAP and spino-acioid cyst. Ellenbecker et al.7 compared shoulder strength between injured and uninjured sides after arthroscopic superior labrum repair and found a small (10% or less) strength deficit in internal and external rotators. If we consider that the SLAP lesion is a fairly recent diagnosis that is mainly treated by surgery,6,8 planning intervention strategies relies on determining SLAP lesion deficiencies compared to healthy controls. Our study found that the SLAP group did not present maximal strength alterations compared with a matched healthy control group. We can speculate that, although SLAP lesions lead to sports limitations and complaints, they do not decrease strength in the way that instability does.

However, in submaximal strength control test, the athletes with SLAP lesions showed decreased internal rotator steadiness. This increase in torque fluctuation could influence their capacity to achieve the desired force or produce the intended limb trajectory since it could reduce their ability to apply precise force.24 Previous studies have also found neuromuscular alterations in internal rotator muscles among asymptomatic overhead athletes14 and athletes with shoulder pain.25 Internal rotator muscles are fundamental for dynamic shoulder stability and joint protection mechanisms, improving the passive barrier to anterior translation25 and assisting with centering in humeral head motion.15 Our results reinforce the importance of internal rotator muscles for shoulder joint support as well as their impairment in shoulder injuries.

This is the first study to evaluate torque steadiness in athletes with a SLAP lesion. A previous study found that healthy athletes present higher fluctuation in internal rotation torque than non-athletes, which was considered an adaptation to sports activity that could have helped prevent shoulder injuries.19 Although higher variability can be considered a positive factor in overuse prevention, excessive variability can be considered pathological.20 Since injured athletes were compared with matched controls who can be considered to represent the normal pattern for their respective sports, we believe that an increase in torque fluctuation in this case can be considered harmful.

Despite impairment of internal rotator muscle control, most of the SLAP athletes maintained a regular training regimen, unlike the athletes with anterior instability. Considering that the stability of the labrum is increased by muscle activity and capsuloligamentous integrity,27 their continued shoulder rotator strength allowed the athletes with SLAP to continue training. In athletes with anterior shoulder instability, it is possible that the inherent loss of capsuloligamentous stability limited their participation in sports. However, whether the shoulder rotator weakness observed in these athletes is a cause or a consequence of such instability13 or even resultant from decreased sports participation remains unclear. Our findings demonstrate that these injury types may cause different impairments in sports activity.

There were no differences in the ER/IR strength ratio between the injured and control groups. The ER/IR ratio has been widely reported in shoulder strength profiles and is considered a predictor of shoulder injuries.10,11,28 The proportion of athletes with ER/IR ratio imbalance was also similar between the injured and control group. Therefore, despite the high intra-group variability, our study

### Table 2

<table>
<thead>
<tr>
<th></th>
<th>Instability group (n = 10)</th>
<th>Instability control group (n = 10)</th>
<th>p value</th>
<th>SLAP group (n = 10)</th>
<th>SLAP control group (n = 10)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Isometric peak torque (Nm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External rotation</td>
<td>23.5 (19–47)</td>
<td>29.5 (23–43)</td>
<td>0.353</td>
<td>28.5 (14–39)</td>
<td>26 (16–35)</td>
<td>0.436</td>
</tr>
<tr>
<td>Internal rotation</td>
<td>41.5 (26–78)</td>
<td>41.5 (30–70)</td>
<td>0.579</td>
<td>35 (24–70)</td>
<td>37 (19–63)</td>
<td>0.684</td>
</tr>
<tr>
<td><strong>Standard deviation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External rotation</td>
<td>0.36 (0.16–0.68)</td>
<td>0.39 (0.22–0.59)</td>
<td>0.739</td>
<td>0.43 (0.2–1.05)</td>
<td>0.36 (0.23–0.43)</td>
<td>0.190</td>
</tr>
<tr>
<td>Internal rotation</td>
<td>0.51 (0.24–0.95)</td>
<td>0.59 (0.38–1.71)</td>
<td>0.393</td>
<td>0.54 (0.35–1.18)</td>
<td>0.48 (0.28–1.17)</td>
<td>0.113</td>
</tr>
<tr>
<td><strong>Coefficient of variation (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External rotation</td>
<td>4.07 (2.28–7.56)</td>
<td>3.89 (2.26–5.77)</td>
<td>0.631</td>
<td>4.62 (3.36–8.55)</td>
<td>4.22 (2.16–5.73)</td>
<td>0.393</td>
</tr>
<tr>
<td>Internal rotation</td>
<td>3.55 (2.06–5.05)</td>
<td>4.48 (3.0–7.05)</td>
<td>0.529</td>
<td>4.61 (2.94–8.43)</td>
<td>3.72 (2.33–6.45)</td>
<td>0.003</td>
</tr>
</tbody>
</table>

6 Considering the adequate ratio between 66% and 75%.20
reinforces that this variable alone should not represent shoulder injury risk. We suggest that it can be altered by other factors besides injury. This is also supported by a recent study that demonstrated the necessity of more than one isokinetic parameter to indicate an increase in injury risk.

Previous studies have compared the injured shoulder with the contralateral one, despite the use of a control group. Side-to-side differences may be present independent of shoulder injury, as has been shown in healthy athletes between the dominant and nondominant arm. Since the present study included athletes from different types of sports, each one with a different overload on the nondominant side, the contralateral was not used for comparisons.

There are some limitations to this study that should be noted. We should be careful in generalizing the results for all severities of shoulder instability, considering that only athletes able to control the shoulder in abduction and external rotation without pain or apprehension were included in this study. Since most subluxations and dislocations occur in this position, we had to exclude athletes with more severe instability (more than 10 episodes) and limited external rotation motion. Even though it limited the number of subjects in our injured groups, we chose this position since it challenges the dynamic stabilization of shoulder muscles and, in this position, subscapularis, infraspinatus and the long head of the biceps tendon contract to stabilize the glenohumeral joint.

Additionally, these results are limited to athletes with instability or SLAP lesion that present symptoms and, finally, the small sample size should be emphasized as a limitation. Further studies are necessary to investigate these patterns in asymptomatic injured athletes. Additionally, although we used validated clinical examination tests and imaging studies for diagnosing SLAP lesions, arthroscopy remains the definitive means of diagnosis and characterization.

Finally, this study has some clinical implications for the conservative treatment of the shoulders of athletes. Our results show that anterior shoulder instability and SLAP lesion are related to different alterations in shoulder rotator strength and control. Considering that shoulder rotator weakness was more apparent in athletes with anterior instability, external and internal rotator strengthening exercises should be prominent in their treatment. For athletes with a SLAP lesion, rehabilitation should focus on functional exercises that require internal rotation force control. These results demonstrate that specific shoulder muscle adaptations are related to each injury type and should be considered in the rehabilitation of athletes.

5. Conclusion

In conclusion, athletes with anterior shoulder instability and SLAP lesions presented different impairments regarding strength and sensory motor control compared to matched healthy athletes. While athletes with anterior shoulder instability demonstrated deficits in shoulder rotation strength, athletes with SLAP presented altered shoulder internal rotation force control.

Practical implications

- Although current practice for treating anterior instability and SLAP lesions is similar regarding improvement in the dynamic stability of the rotator cuff, these lesions present different muscle strength and force control patterns.
- Anterior shoulder instability involves an overall deficit in rotator cuff strength without alterations in submaximal force control. This finding reinforces the need for internal and external rotator resistance strength training as a principal component of conservative treatment.
- SLAP lesion results included internal rotation force control alterations without strength deficits compared to matched controls. This indicates a reduced ability to apply precise force and compromises sports performance. Physical therapy for such athletes should focus on functional exercises involving strength control.

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References


