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Asia-Pacific Journal of Sports Medicine, Arthroscopy, Rehabilitation and Technology 8 (2017) 13−17
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Original article

Anterior internal impingement of the shoulder in rugby players and other overhead athletes

Siddharth R. Shah, MBBS, MSc Sports Medicine (UK), MRCS-Ed , Orthopedic Registrar[a,*], Ian Horsley, PhD , Chartered Physiotherapist and Lead Physiotherapist for English Institute of Sport, Clinical director of Back In Action Rehabilitation[b,c], Christer G. Rolf, MD, PhD , Professor[d]

[a] *Leeds General Infirmary Hospital, Leeds, UK*
[b] *English Institute of Sport, Wakefield, UK*
[c] *Back In Action Rehabilitation, Wakefield, UK*
[d] *Department of Orthopaedics, CLINTEC, Karolinska University Hospital, Stockholm, Sweden*

Received 12 August 2016; revised 16 November 2016; accepted 17 November 2016
Available online 21 January 2017

Abstract

Background/Objective: Impingement syndromes are a common cause of shoulder pain in overhead athletes. Anterior internal impingement is a recently suggested mechanism for activity-related pain of the shoulder. Impingement syndromes were initially described to occur due to repetitive or excessive contact between the rotator cuff and other structures in the shoulder.
Methods: This is a retrospective, clinical case study reporting 54 consecutive cases of anterior internal impingement in overhead athletes, of which 28 (51.2%) cases were of rugby players. All had undergone physiotherapy without relief of the symptoms. Of 54, there were 45 male and 9 female patients with an average age of 27 years (range, 17−51). The mean duration from injury to surgery was 40.7 weeks (range, 5−364). Of the 54 patients, 29 (53.7%) were full-time professional and 25 (46.3%) were semiprofessional or recreational athletes. The players associated the onset of pain occurred following an injury in 29/54 cases (53.4%), whereas in the remaining 25 cases (46.2%), a gradual onset of symptoms was described. All 54 patients could demonstrate a "functional impingement sign" in positioning their arm and provoke pain.
Result: On examination, the examiner could reproduce the same pain in 38/54 (70.3%) patients only. Of the 54 patients, "SLAP tests" including O'Brien's test, Palm up test, and compression rotation test were positive in shoulders of 39 (72.2 %) patients, Jobe's test in 27 (50%), Gerber's lift off test in 6 (11%), and Hawkin's test in 6 (11%) patients. During arthroscopic assessment, impinging flap tears were found in 44 (81.4%) patients from the SLAP, whereas undersurface rotator cuff flap tears were found in 24 (44.4%), flap tears from the anterior or inferior labrum were found in 16 (29.6%), and distal subscapularis flap tears were found in 10 (18.5%) patients. Only in 12/54 patients (22.2%) was an isolated pathology found, in all cases SLAP tears. Treatment included vaporisation and excision of the impinging flaps. In 15/54 (27.7%) patients, repair of an unstable SLAP tear was undertaken using absorbable suture anchors and fibre wires. All athletes returned to their previous activity level within 17.2 weeks (range, 6−36) from surgery and were discharged when they claimed that they were symptom free.
Conclusion: This series of anterior internal impingement, which we believe is the largest in the literature to date, demonstrates the value of an to assess and successfully treat overhead athletes with anterior impingement syndrome.
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Keywords: anterior shoulder impingement; posterior shoulder impingement; rugby shoulder pain; shoulder arthroscopy; SLAP tear

* Corresponding author. 'The Sunrise', 318 Ecclesall Road South, Sheffield S11 9PU, UK.
E-mail address: dr.siddharthhshah@gmail.com (S.R. Shah).

http://dx.doi.org/10.1016/j.asmart.2016.11.001
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Introduction

Impingement syndromes are a common cause of shoulder pain[1–4] in overhead athletes. They were initially described to occur due to repetitive or excessive contact between the rotator cuff and other structures in the shoulder.[5] In 1972, Neer[6] introduced the external impingement syndrome. He reported that mechanical impingement of the rotator cuff tendon occurs beneath the anteroinferior portion of the acromion, especially when the shoulder is in a forward-flexed and internally rotated position. Consequently, this syndrome was labelled external or subacromial impingement.[7–9] First described in 1992 by Walch et al,[10] posterior internal impingement was defined as excessive contact between the undersurface of the supraspinatus and infraspinatus tendons with the posterior superior glenoid rim or labrum.[10–13] Although this contact between the undersurface rotator cuff and posterior superior glenoid is physiological,[7,10,12,14,15] it is supported in the literature that posterior internal impingement can be a mechanism of injury.[2,11,12,14–17] The biomechanics of an overhead throwing motion is believed to intensify the contact between the structures, resulting in a tissue injury.[10,12–16,18] Lesions on the articular posterior aspect of the supraspinatus tendon and/or portion of the infraspinatus tendon as well as Type I or II SLAP lesions have also been identified using arthroscopy in overhead athletes.[10,12,13] Paley et al[16] reported undersurface cuff fraying in 93% of overhead athletes with posterior internal impingement, and posterior-superior labral fraying was found in 88%.

More recently, a type of internal impingement separate to posterior internal impingement has been described.[3,4,19] Anterior internal impingement was first introduced to by Gerber and Sebesta[4] as a different form of intra-articular impingement responsible for pain of the shoulder. They showed that impingement of the undersurface of the pulley and the subscapularis tendon occurs against the anterosuperior glenoid rim in a position of flexion and internal rotation of the arm. This contact has also been shown in cadaveric studies.[20,21] It has been suggested that such contact is physiological.[3] However, in cases of partial rotator cuff tears and flaps, the contact may become pathological as the fragmented tissue is sheared and compressed between the superior humeral head and glenoid. One study found that when lesions of the pulley or the subscapularis tendon were present, they could be shown to contact corresponding lesions of the anterosuperior glenoid labrum in the flexed internal arm position.[4] Similar to posterior internal impingement, this may contribute to lesion formation.[4,19] Gerber and Sebesta[4] claimed that because of repetitive, forceful internal rotation manoeuvres above the horizontal plane, friction damage results from impingement between the pulley system and subscapularis on one hand and the anterior superior glenoid rim on the other, leading to the aforementioned pathological lesions. Such movement is typical in overhead sports, such as tennis, but also occurs as a repetitive movement during overhead work, such as brick laying.[4] Struhl[3] claimed that the presentation of patients with anterior internal impingement is often identical to that of patients with subacromial impingement, making preoperative identification impossible. However, the mean age of patients in their review was 37 years, well below the usual age for patients with subacromial impingement. Hence, although these patients had signs and symptoms similar to those with subacromial impingement, their relatively young age lowered the index of suspicion for that diagnosis. As a relatively new site of impingement, clinical reports on anterior internal impingement in the literature remain limited.[3,4,19]

This study reports 54 consecutive cases of anterior internal impingement in overhead athletes. The series, which we believe is the largest in the literature to date, describes the clinical presentation, introduces a concept of a "functional impingement sign" correlated to intra-operative pathology and consequential treatment, highlighting the importance of a sport-specific approach to the management.

Materials and methods

This is a retrospective, clinical case study. All players signed a written consent for treatment and surgery. All the surgeries and clinics occurred at Sheffield Centre of Sports Medicine, Sheffield, UK. It was at the time fully owned by the University of Sheffield, but it ceased to exist in 2009. The University Clinic received a general ethical approval from the University Ethical Committee to conduct audition and research of which the patients were informed and agreed to when entering the clinic, but no specific ethical approval was applied for this particular study of the records of anonymised patients. In total, 54 consecutive athletes were referred due to overhead activity-related pain and underwent clinical assessment and arthroscopic surgery by a senior orthopaedic surgeon at a Sports Medicine Centre. All had undergone physiotherapy without relief of the symptoms. These 54 cases accounted for 14.7 % of the 365 arthroscopic shoulder procedures performed in athletes at our centre over this time. All complained of activity-related pain on overhead activities as the main symptom, in some cases associated with stiffness or weakness. Cases treated for instability, fractures, external impingement, posterior impingement, complete rotator cuff tears, frozen shoulder, and post-traumatic stiffness were excluded. The clinical assessment incorporated documenting the patients' age, sex, activity level, sport, side of injury, mechanism of injury, duration of symptoms, and previous treatment interventions. All patients were examined by the same senior surgeon. Range of motion, Sulcus sign, Wilcoxon's criteria for general joint laxity, apprehension test, Hawkins impingement test, Neer's internal impingement test, O'Brien's test, Gerber's lift off test, across body test, compression and rotation test, Palm up test, and Jobe's test were undertaken comparing both sides. A "functional impingement test" was undertaken guided by the athlete's presentation. This functional test was performed by the examiner guided by the athlete's demonstration of pain provoking movement in order to try to reproduce the symptoms.

Based on the outcome of the history and objective assessment, the clinical working diagnosis suggested an impingement syndrome requiring arthroscopic assessment. All had undergone X-ray examination, which was normal. Magnetic resonance imaging was undertaken in 16 of 54 (29.3%) patients, and all were deemed normal. Arthroscopy was conducted in beach chair position. All were confirmed as having anterior internal impingement, and corresponding pathology was identified and treated during arthroscopic surgery.

Results

The study included 45 male and 9 female patients, with the mean age of 36 (range, 17–52) years. The commonest side for injury was the dominant right side (66%). The mean time from injury to surgery was 40.7 (range, 5–364) weeks. Of the 54 patients, 29 (53.7%) were professional and 25 (46.3%) were recreational athletes. The full-time professional athletes were 21 rugby players, 3 tennis players, 2 cricketers, 1 platform diver, 1 squash player, and 1 ballet dancer. The recreational athletes played semi-professional rugby ($n = 7$) or recreational tennis ($n = 7$), squash ($n = 3$), cricket ($n = 3$), martial arts ($n = 2$), climbing ($n = 1$), salsa dancing ($n = 1$), and racket ball ($n = 1$). A total of 52 (96.2%) patients reported sharp pain on certain overhead positions in their sport as the main symptom. In two patients, the main complaint included gradual deteriorating serving in tennis and bowling in cricket, leading to diffuse shoulder "problems" and "clicking". In 10 of 54 (18.5%) patients, the pain was described as nonsharp but rather as discomfort in certain positions, leading to subjective dysfunction. In 37/54 cases (68.5%), the player associated the onset of pain to a direct initial injury in 29/54 cases (53.4%), which was referred to as either an isolated tackle ($n = 10$), a tackle and fall on an outstretched arm ($n = 9$), and an isolated fall on outstretched arm ($n = 10$). In the remaining 25 cases (46.2%), a gradual onset of symptoms related to the sporting activities was described.

The clinical examination revealed that all 54 patients could demonstrate a "functional impingement position" of their arm and consequently provoke the impingement. This position was in all patients with the arm abducted over shoulder height and in various degrees of external rotation (Figure 1). The position did correlate to their active movements that they referred to as being painful in their sport. When examined passively, the examiner could reproduce the same pain in 38 of 54 (70.3%) patients only. This was interpreted so that there must be an element of active muscle contraction during the manoeuvre to elicit pain. All athletes had full or only slightly reduced active and passive range of motion as compared with the other shoulder. A subjective assessment of their active thoraco-scapular control revealed less good control in affected shoulder compared to contra lateral side. A jerky movement of scapulae was seen whilst the athlete's arm passed the painful position. Wilcoxon's general joint laxity test, Sulcus sign, apprehension test, and posterior drawer were negative in all cases. Of 54 patients, "SLAP tests" including O'Brien's test, Palm up test, and compression rotation test were positive in 39 shoulders (72.2 %), Jobe's test in 27 (50%), Gerber's lift-off test in 6 (11%), and Hawkin's test in 6 (11%) patients. 27, 28 in these articles we confirm the weak sensitivity and specificity with these clinical tests, but conclude that if three out of the tests are positive it warrants further investigation with arthroscopy.

Figure 1. Functional impingement test.

During arthroscopic assessment, impingement of injured flap tears was observed between the anterior or superior part of the glenoid and humeral head. Of the 54 patients, SLAP flap tears were found in 44 (81.4%), undersurface rotator cuff flap tears were found in 24 (44.4%), other impinging flap tears of the anterior or in some cases inferior labrum was found in 16 (29.6%), and distal subscapularis flap tears were found in 10 (18.5%). In three patients, the flaps originated from the lower anterior labrum, but the players denied any previous dislocation. Only in 12/54 (22.2%) patients, an isolated pathology was found in all cases SLAP tears (Table 1). Treatment included vaporisation and excision of the impinging flaps in all cases. In 15/54 (27.7%) patients, repair of an unstable SLAP tear was undertaken using absorbable suture anchors and fibre wires. There was no complication. After surgery all athletes underwent physiotherapy to restore thoraco-scapular control, muscle strength, and functional sport-specific training. All

Table 1.
Lesions found in study group.

Lesion	No. of patients ($N = 54$)	Percentage (%)
Mixed SLAP lesion	44	81.4
Undersurface rotator cuff flap tears	24	44.4
Flap tears from the anterior or inferior labrum	16	29.6
Distal subscapularis flap tears	10	18.5
Isolated pathology in SLAP	12	22.2

athletes returned to previous activity level within in an average of 17.2 (range, 6−36) weeks from surgery and were discharged when they claimed that they were symptom free. Return to play assessment was performed by one of the authors using a routine battery of rugby-specific functional tests.

Discussion

This study demonstrates a large series of anterior internal impingement in overhead athletes, in accordance with the findings of Struhl.[3] The cases in our study are of course selected from the local sports undertaken, majority of cases being those of professional rugby players. All the rugby teams have professional physiotherapists who, in these cases, have ruled out further potentials of improvements by conservative management. Rugby is classified as a collision sport, but the tackle position has previously been described as being conclusive to being classified as an overhead sport,[22] described an injury-specific tackle position as being in the abducted externally rotated position, the position of throwing which is indeed overhead.[23] Out of all shoulder arthroscopic surgeries performed over this period at our centre, these cases represented 14.7 %. Thus, this clinical entity can easily be missed by team medics as indicated by the long duration from symptoms to referral. The active "functional impingement test" performed and demonstrated by the injured athlete provides the most valuable clinical information. Let the athlete demonstrate! This suggestion is supported by the fact that the functional impingement test as replicated passively by the examiner was positive only in 70.3 % cases. However, in all cases there was at least one positive test, which would indicate the use of arthroscopy when physiotherapy has failed to relieve the symptoms. The corresponding intra-articular pathology observed (only 22.2 % an isolated injury) may suggest that this impingement syndrome may be caused by an initial injury (suggested by the injured athlete in 68.5% of the cases), leading to "micro instability" as suggested by the loss of thoraco-scapular control, provoking further injuries. On the other hand, 31.5% of the patients had a gradual onset of symptoms, confusing the picture. While posterior internal impingement is well described in the literature,[7,10,12−15] anterior internal impingement is a relatively new concept. Clinical reports on such patients are very limited, and our understanding of the exact mechanism is not sufficient. Contact between the rotator cuff and superior anterior labrum is physiological when the shoulder is rotated in a forward flexed position. However, if the rotator cuff is torn forming an undersurface flap, or there is a flap from the superior or anterior labrum or from the subscapularis as demonstrated in our cases, this contact becomes abnormal, with impingement of fragmented tissue between the humeral head and the glenoid.[3] This may well cause pain and dysfunction of the shoulder and could be described and treated similarly to a meniscal flap tear in the knee, with vaporisation, partial excision or, in some cases, by resuture. In most of the reported cases, the diagnosis could thus be described as "a flap tear in the shoulder". Lesions of the long head of the biceps and the pulley (insertion of superior gleno humeral and coraco humeral ligaments) have also been implemented as sources of impingement.[4] Habermyer et al[19] found that 75% of patients with a lesion of the pulley combined with a supra spinatus and a sub scapularis tear had anterior impingement. It is thought that repetitive, forceful rotational manoeuvres above the horizontal plane results in frictional damage from impingement between the pulley system and subscapularis tendon on one hand and the anterior superior glenoid rim on the other. This may lead to the aforementioned pathological lesions,[19,24,25] and explains its prevalence in overhead athletes. Gerber and Sebesta[4] also subscribe to this theory. The poor thoraco-scapular control, which was demonstrated preoperatively, indicates that this impingement syndrome is not only a "stone in the shoe" syndrome but also engages primarily or secondarily the functional stabilising structures around the shoulder. It is interesting to note that 11% patients had a positive "external impingement test"[1]; however, there was no other sign of sub acromial impingement. Therefore, subacromial decompression was not undertaken in any of these cases. It has been suggested that the clinical presentation of patients with anterior impingement is often identical to that of patients with subacromial impingement.[3,26−28] The data from this study suggests differently, in contrast to Struhl[3] who found this in all 10 of their patients. Our study patients displayed a number of different positive tests, thereby confusing the diagnosis. This does support the view that diagnosis of this phenomenon is difficult. McFarland et al[1] concluded that since the exact pathophysiology of pain in an athlete who throws overhead has not been established, the results of the examination of these patients must be interpreted with caution. Since SLAP lesions, partial rotator cuff tears, and internal impingement may result in variable findings on examination, they concluded that diagnostic arthroscopy may be the best way to diagnose these lesions in an overhead-throwing athlete.[1] We fully agree with this statement. An intra-operative assessment in beach chair position is an excellent way to reproduce the clinical findings from previous examination in relation to observed pathology. With this mini invasive approach and minimal surgery, the athlete can return soon to their sport after a few weeks of physiotherapy. We are currently undertaking a more detailed analysis as a clinical follow-up study including functional assessment of shoulder function to investigate whether performed treatment success were maintained over time.

In conclusion, an anterior internal impingement syndrome must be suspected when an overhead athlete complains of persistent and reproducible activity-related pain, which does not respond to physiotherapy. The athlete's own demonstration of the painful position, the "functional impingement test", is the most valuable clue to the diagnosis. Arthroscopy and intra-operative assessment is very valuable and should be considered early. Further studies evaluating etiological factors are needed.

Author contribution

Author Siddharth R Shah MRCSEd, MBBS Msc MRCS-Ed is an orthopedic registrar at Leeds General Infirmary Hospital,

UK and has helped in data analysis and literature search as well as working on the manuscript (1st Author). Ian Horsley PhD is a Chartered physiotherapist who works with professional rugby players and has contributed with compiling and analyzing of the data and working on the manuscript (2nd Author). Christer G Rolf MD PhD has examined and operated all included Patients- Department of Orthopaedics, CLINTEC, Karolinska University Hospital, Stockholm, Sweden (3rd Author).

Conflicts of interest

The authors declare that they have no conflicts of interest.

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