Biceps Tendinopathy (ICL 2)

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2.1 Variations of the Intra-articular Portion of the Biceps Tendon: A Classification of Embryologically Explained Variations

The long head of the biceps is the common entry landmark when starting a shoulder arthroscopy. Sometimes it may be tricky to differentiate between normal biceps, an innocent congenital variant and a pathological tendon.

Out of two populations of 1,500 arthroscopies each, we collected, in a prospective and retrospective way, all possible variations of the proximal portion of the LHB. The embryology and the evolution of this tendon were reviewed.

We correlated the findings of these 3,000 arthroscopies to this embryology and included 57 cases, or 1.91 % of this population, to define a classification of 12 different form variants.

Their incidences and associated pathologies are investigated.

By offering this new classification; and a physiopathological hypothesis, we hope to help the surgeon in differentiating and addressing some of these variants that can acquire a pathological significance:

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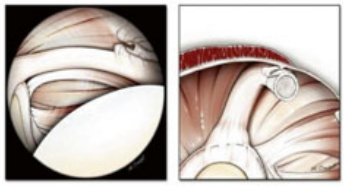
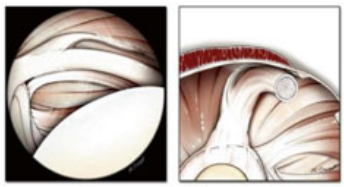
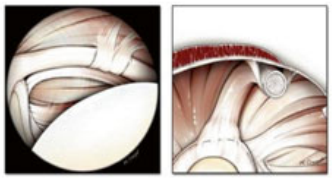
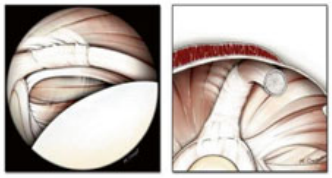
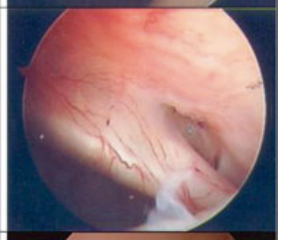
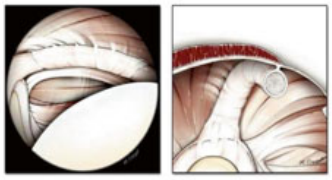
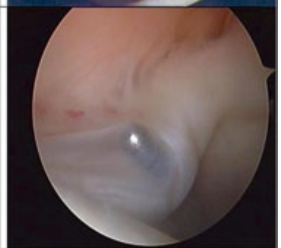
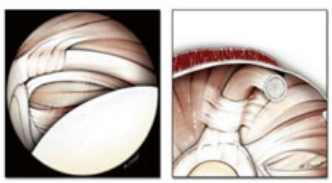
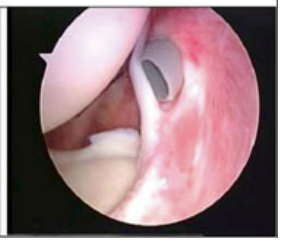
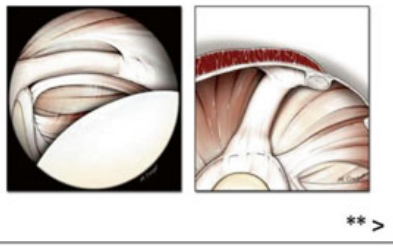
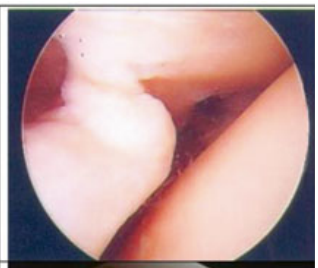
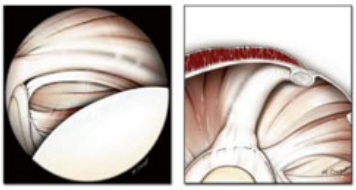
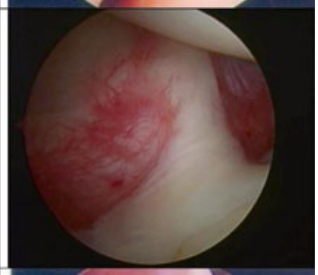
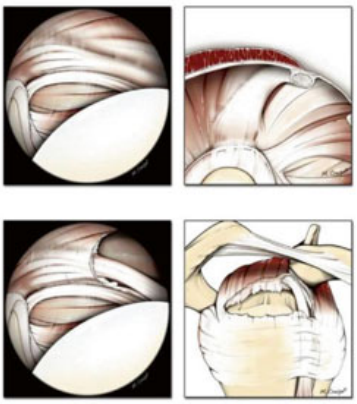
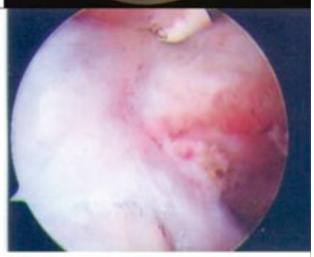
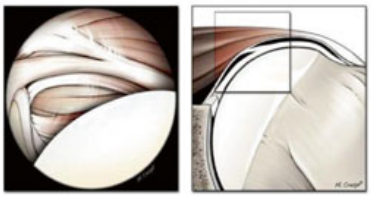
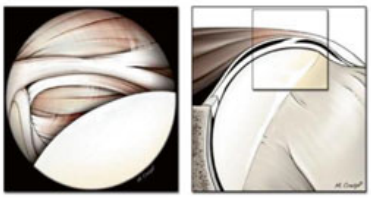
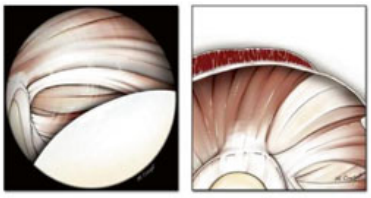
- The partial mesotenon can cause biceps-related complaints.
- The partial lateral adhesion can cause an hour-glass type of impingement, whereas the complete adherent or solid fusion of the LHB tendon to the inferior surface of the capsule (with extension to the upper labrum) can have an associated rotator cuff tear.
- The double-origin biceps and the strong medial adhesion of the biceps to the capsule, which may behave like a double origin, certainly can cause pathology.

Table: Classification: 12 Types Of Variations of the IA LHB, Dierickx & Castagna

	Type	% 57 pts	Illustrations by ©Crespi	Arthroscopic Examples
MESO	**Mesothenon**			
MESO-VI	**A. Vinculae**	7.0%		
MESO-SB	**B. Small Bands**	8.8%		
MESO-PU	**C. Pulley-like slings**	17.5%		
MESO-PA	**D. Partial Mesothenon-**	7.0 %		
MESO-CO	**E. Complete Mesothenon**	10.5 %		
ADH	**ADHERENT**			
ADH-PM	**A. Partially medially adherent to the SSP**	10.5 % *		

ADH-PL	**B. Partially laterally adherent to the SSP**	5.3 %	 ** >	
ADH-CL	**C. Complete adherent; attaching to the Labum**	8.8 % *		
ADH-CO	**D / Complete adherent to SSP; NOT attaching to the labrum**	1.7 %		
SPL	**SPLIT BICEPS**			
SPL-DO	**A. Split biceps Double – origin**	15.8 %		
SPL-RE	**B. Split biceps Reversed type**	3.5 % *		
ABS	**complete Absence of LHB**	3.5 % *		

2.2 Clinical Examination in Biceps Tendinopathy

Disorders of the long head of biceps tendon (LHB) are common in adult population with a overall incidence of between 29 % and 66 % [1–3]; they are associated with rotator cuff tears in up to 90 % of cases [4, 5], but in 4 % of patients, an isolated LHB lesion is reported [6].

The clinical diagnosis of LHB pathologies, however, is difficult and poorly reliable because most of the traditional clinical tests show a relatively high sensitivity but a poor specificity and a low level of positive predictive value [1, 7, 8].

The physical examination includes biceps palpation, Speed's test, O'Brien test, the upper cut test and BRF test.

The examiner with the biceps palpation researches the eliciting point of tenderness of the LHB. It consists in palpation of biceps tendon in the biceps groove 3–6 cm below the anterior acromion with the arm in 10° of internal rotation. If the patient complains pain during deep pressure in the bicipital groove, the test is positive [9].

Speed's test is performed with the patient standing with the shoulder elevated to 90° in maximal supination and the elbow extended; the patient is asked to resist the downward force applied to his/her palm by the examiner. The test is considered positive when patient reports pain in the bicipital groove area [7].

O'Brien test is performed with the examiner behind the patient. The patient is asked to resist a downward pressure with the arm at 90° of flexion and 10° of adduction in full pronation (thumb down). The manoeuvre is repeated with the limb in full supination (thumb up). The test is positive if the pain triggered in the first position decreases or disappears with the second manoeuvre [8].

Two new tests are recently described for the lesion of LHB: the upper cut test and the BRF test.

The upper cut test is performed with the shoulder in neutral position, the elbow flexed at 90° and the hand supinated making a fist. The patient is asked to bring the hand up and towards the chin in a boxing-style punch while the examiner places his hand over the patient's fist and contrasts the motion. The test is positive if the patient has pain [10].

In the BRF test, the patient is seated with the arm at the side and the elbow flexed at 90°. The patient is asked to maintain maximal resistance for 5 s, and the BRF strength is recorded with a digital dynamometer linked to the ground [11].

Tenderness on palpation of the biceps tendon is not considered a reliable test for biceps tendon injury. In fact, Gill et al. reported a sensitivity of 53 % and a specificity of 54 % [12]. Their results are consistent with the observations of Nove-Josserand and Walch [13].

The Speed's test shows slightly better results with a sensitivity of 90–67 % and a specificity of 13.8–50 % [7, 12].

The O'Brien test is also limited, showing 38–68 % of sensitivity and 46–61 % specificity [10, 12].

The new tests, upper cut and BRF, show more reliability with sensitivity and specificity values of 77 % and 80 %, respectively, for the upper cut test versus 60 % and 88 % for the BRF [10, 11].

BRF test presents a high specificity probably because it is performed with the arm at the patient's side reducing pain due to concomitant rotator cuff tears. Moreover, since the BRF test is objectively measured by a digital dynamometer, there is less risk of subjective interpretation between observers.

2.3 SLAP Lesions

2.3.1 Pathology

SLAP lesions are combined lesions from the superior (from anterior to posterior) labrum and the proximal insertion of the long head of biceps. The Snyder classification is most commonly used:

Type 1: Degenerative lesion with fraying of the free edge of the labrum but the insertion to the glenoid is unaffected.

Type 2: Labrum and LHB are torn off the glenoid edge. There is no cartilage under the avulsion area and the labral-bicipital complex is highly mobile.
Type 3: Bucket handle tear of the labrum, no interference of the LHB.
Type 4: Type 2 extending into the LHB, often associated with a labral tear.
Types 5–10 are combinations of SLAP lesions with different anterior and posterior labral lesions.

SLAP lesions are considered instability lesions but can also have a degenerative origin.

Traumatic causes as compression injuries (fall on outstretched hand) or traction injuries (hyperextension trauma), repetitive throwing or other overhead motions are typically associated with type 2 and type 4 lesions.

Type 1 lesions are degenerative and often associated with degenerative rotator cuff disease (74 % of patients with rotator cuff tears have biceps lesions often SLAP, and in 40 % of SLAP lesions, there is also a full-thickness RCT). Type 2 lesions differ according to age: in patients over 40 years old, it concerns often a degenerative lesion, whereas under 40 often associated with instability. Type 3 lesions are seldom and can be traumatic or degenerative.

2.3.2 Symptoms

Any pathology of the proximal biceps can present with pain. The pain pattern produced by SLAP lesions is unspecific, and many coexisting lesions exist. Sometimes SLAP lesions elicit a clicking sensation inside the joint. The extent of pathology and inflammation of the biceps distally might influence your decision for treatment. Pain in the bicipital groove radiating to the anterolateral upper arm is suspicious for biceps pathology. On palpation of the groove, the pain can move externally with the rotation and can extend under the level of the insertion of the pectoralis major. Pain can be elicited by internally and externally rotating the arm both in adduction and abduction, and the Gerber test is often painful.

2.3.3 Diagnosis

Many tests are described; some of them have a reasonable specificity but low sensitivity, and because of the overlap with other pathology, careful interpretation is necessary. An accurate method of diagnosing biceps pathology remains undefined. MR arthrogram or CT arthrogram offers on average around 70 % accuracy for SLAP tears but can show associated pathology as cuff tears or labral tears. The definitive diagnosis of a SLAP lesion is often only made at the time of surgery.

2.3.4 Treatment

Options are debridement, SLAP repair or biceps tenodesis or tenotomy. The success rate of the arthroscopic anchor suture repair varies, and on average patient satisfaction is 83 %, with return to sports of 73 %. Residual postoperative pain and stiffness are major concerns, in particular in patients over 40 years of age. The different tissue quality and capacity for tissue repair are possible causes of the failure of healing in this older age group. Tenodesis of the biceps can offer a higher satisfaction rate and return to sports level. Different techniques for tenodesis are described with different results in load to failure. Interference screws seem to have a higher load to failure compared to keyhole, bone tunnels and suture anchors. Interference screws have several advantages: maintaining the proper length to tension relationship of the biceps, the secure fixation allows early rehabilitation and the possibility of resection of a large part of inflamed tendon, and the procedure can be done all arthroscopic. Complications however are persistent pain in the groove, possibly related to small stress fractures, or failure of fixation due to degeneration of the biceps tendon and can be deleterious as in complete humeral shaft fractures. Other techniques as anchor of soft tissue tenodesis, or transfer of the LHB to the conjoined tendon, can be performed arthroscopically with satisfying results.

2.3.5 Conclusion

Our preferred treatment:

SLAP 1: Debridement
SLAP 2: Indications for SLAP repair: highly active (throwers)
- Age under 40
- Isolated lesion or in combination with labral tears
- No distal biceps pathology

CAVE: Stiffness has been a major complication; therefore, inform patient about possible failure and secondary tenodesis
Indications for LHB tenodesis (or tenotomy):
- Age over 40
- Advanced tears in biceps tendon
- Pulley lesions in associated cuff tears

SLAP 3: Debridement
SLAP 4: Repair or tenodesis

2.4 Proximal Biceps Tendinopathy in Elite Athletes, Associated Pathology and Treatment Protocol

Anterior shoulder pain is one of the most frequent causes of disability in overhead sports [16] and often forces athletes and workers to stop their activities.

The underlying pathology can be multifactorial in nature, and understanding the various contributing factors is important if the patient is to be properly treated and rehabilitated. An additional goal should be the prevention of further pathology or symptoms.

The overhead sports most commonly involved are throwing sports such as baseball, tennis and volleyball [27, 29, 30]. However, non-throwing sports including swimming and windsurf have also been shown to produce pathological conditions of the shoulder [15, 20, 21, 25, 37].

Technical deficiencies along with overuse and overload are the most important related factors. As a consequence, the athletes tend to suffer adaptive and pathologic changes that should be taken into account such as biceps tendonitis-tenosynovitis, GIRD and scapular dyskinesis [15, 33, 43].

In our sport-specific orthopaedic practice, the athlete is typically referred because of pain about the shoulder. Usually the diagnosis of the referral is sub-acromial impingement. A common occurrence in these patients is that evaluation of the axial skeleton's dynamics is overlooked. We have observed a recurring combination of signs and symptoms that are linked to shoulder pain in athletes. These observations will be discussed in this article.

Bearing in mind the possibilities of biceps tendinopathy (Fig. 2.1), scapular dyskinesis (Fig. 2.2a–c) and glenohumeral internal rotation deficit (GIRD) (Fig. 2.3) among the spectrum of shoulder pathologies throughout the evaluation of the disabled athlete may be of great help in planning both the protocol of treatment and prevention of recurrence.

It is important to emphasize that neither biceps pathology, GIRD nor scapular dyskinesis is rarely the cause of referral and is usually encountered only through physical evaluation [42, 44].

The use of the ultrasound machine by the orthopaedic surgeon to help and confirm biceps tenosynovitis (Fig. 2.4) or tendinosis is of paramount importance. It allows an immediate diagnosis and, if needed, injection under ultrasound guidance intra-seath but not in the tendon.

Conservative treatment of dyskinesis and GIRD by means of physiotherapy has shown to be effective in terms of return to sports and workplace activities [26, 27, 28, 29, 33, 35].

Unfortunately, in some cases the patient presents to the clinic too late for conservative treatment, and surgery may be needed to treat the underlying pathology [31, 38, 39]. Favourable results may still be obtained if the pathophysiology is fully evaluated and understood [15, 22, 23, 24, 34, 36, 40].

A holistic/comprehensive approach to the athlete's shoulder is advisable to correctly diagnose, treat and prevent these conditions.

In this article these concepts are reviewed along with the related pathology and our observations.

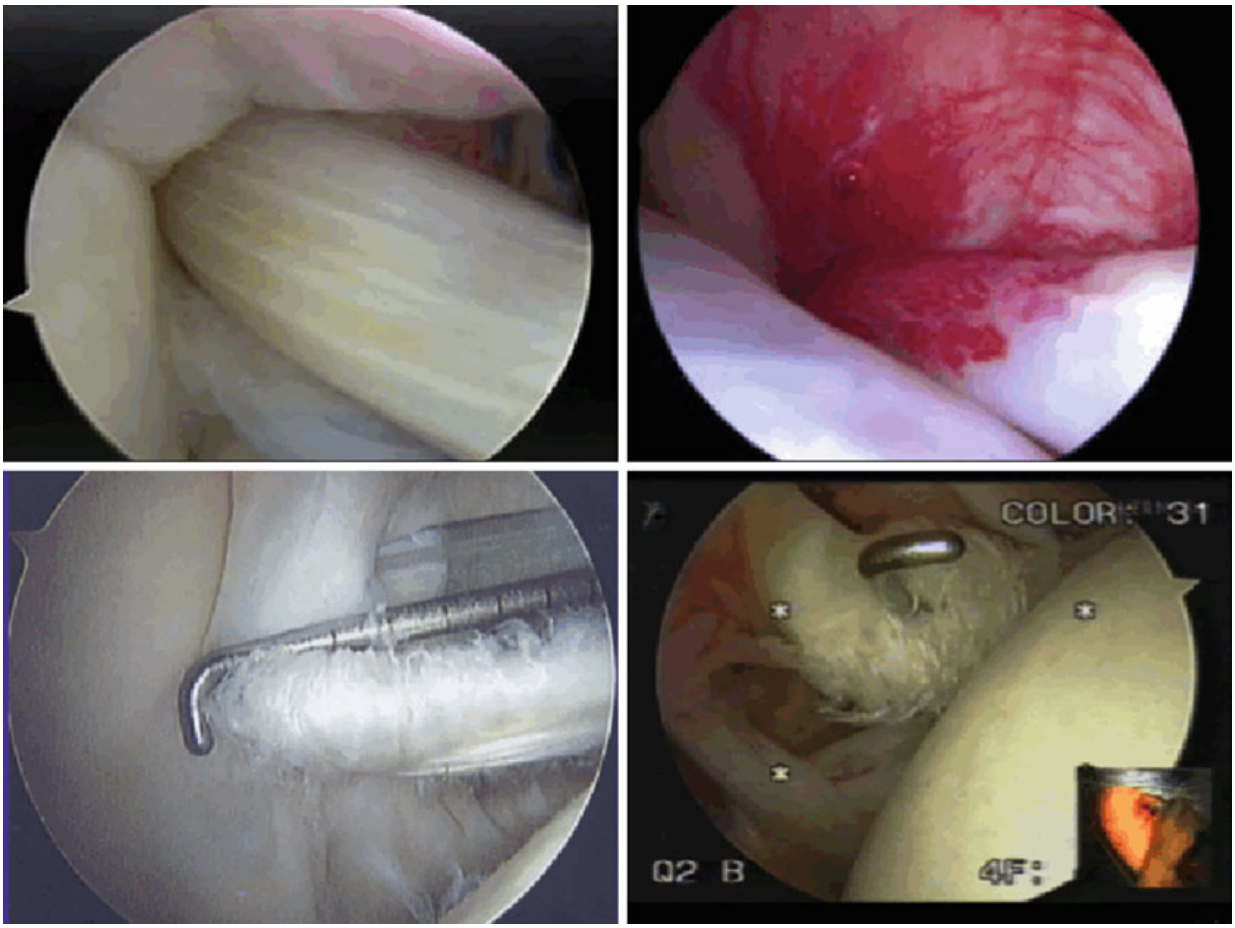


Fig. 2.1 Normal biceps tendnon (*upper row left*), Biceps tendinitis (*upper row right*), Biceps instability and degenerative partial tear of the tendon (*lower row*)

2.4.1 Tennis Shoulder: Biceps Tenderness + Dyskinesis + GIRD

2.4.1.1 Conservative Treatment

The sport of tennis enjoys worldwide popularity among participants of extremely diverse age and skill range.

The most common injuries in recreational players afflict the lower extremity such as ankle sprains, but in those athletes who have reached the elite level, the most frequent pathology involves the shoulder [14].

In our experience, elite players with symptomatic shoulders typically localize the pain anteriorly [33]. It is not uncommon for these athletes to be referred with the diagnosis of sub-acromial impingement [40]. Although it has been published that tennis players suffer a decrease in their sub-acromial space compared to matched controls by ultrasound [41], in our practice we have observed that this pain mainly emanates from the long head of the biceps, both with simple palpation and during ultrasound evaluation [33].

Additionally, a symptomatic long head of biceps is very commonly associated with dyskinesis and glenohumeral internal rotation deficit (GIRD) [33].

We studied 105 elite tennis players in 3 international professional championship tournaments. The study consisted of 210 shoulders in 76 males and 29 females. The mean age was 21.7 ± 4.9 years, mean height 178 ± 8 cm, mean weight 72.2 ± 9 kg and mean tennis hours played per week 19.4 ± 4.9 h. Ranking range was ATP 56–1.600 and WTA 102–1.100. Physical

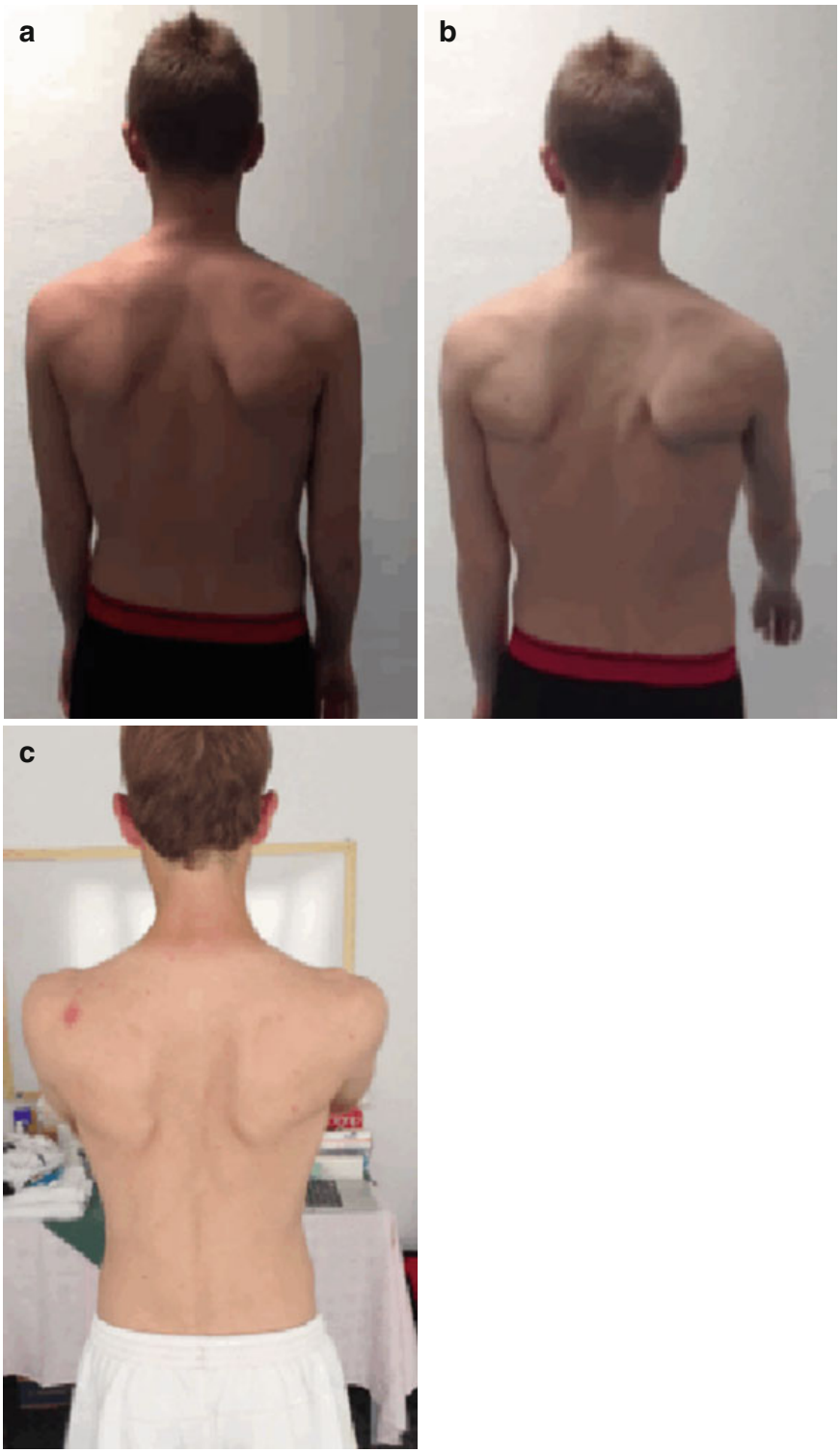


Fig. 2.2 (**a**–**c**) Assessment of the scapula kinesia during shoulder motion. One should look for symmetry or asymmetry of the shoulder blades during motion

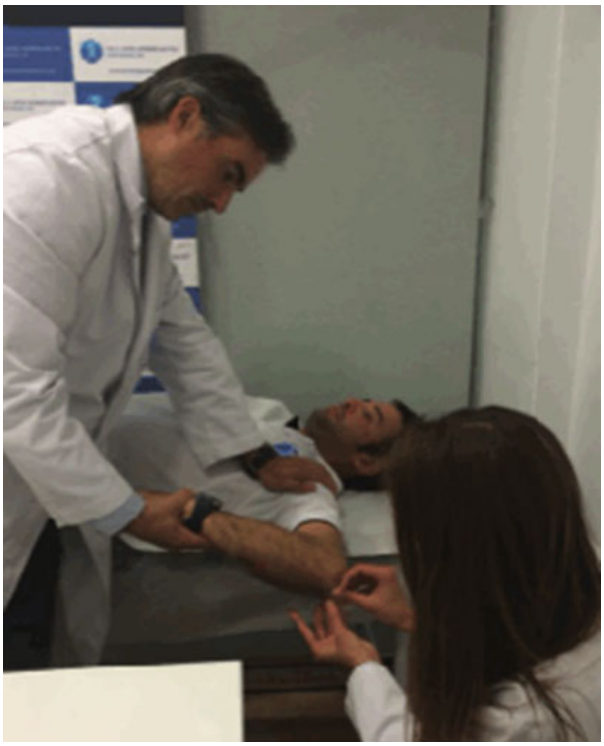


Fig. 2.3 Glenohumeral internal rotation deficit (GIRD). The patient is unable to bring the arm into the horizontal position

Fig. 2.4 Ultrasound of the shoulder. The probe is positioned perpendicular to the orientaion of the biceps sulcus. A black circle around the biceps tendon, called "Halo-phenomenon" typical for biceps tendinitis

evaluation with a goniometer (Fig. 2.3) and ultrasound measurements were taken.

We found that 34 % of these players exhibited tenderness in the LHB of their dominant arm (Fig. 2.5). Also, 91.3 % had scapular dyskinesis in the dominant arm as well as 90.3 % in the non-dominant arm (Fig. 2.6). The prevalence of GIRD in the dominant arm was 83.5 %.

Fig. 2.5 Examination of the biceps tendon. Point of tenderness is exactly over the biceps sulcus during pronation and suppination of the forearm

Fig. 2.6 Bilateral scapula alata is caused by muscle dysfunction in case of paralysis of the serratus anterior muscle, rhomboideus muscle or trapezius muscle

Finally, the association of GIRD and dyskinesis in the dominant arm was 75.7 %, while the association of GIRD + dyskinesis + tenderness on LHB was 24.3 %.

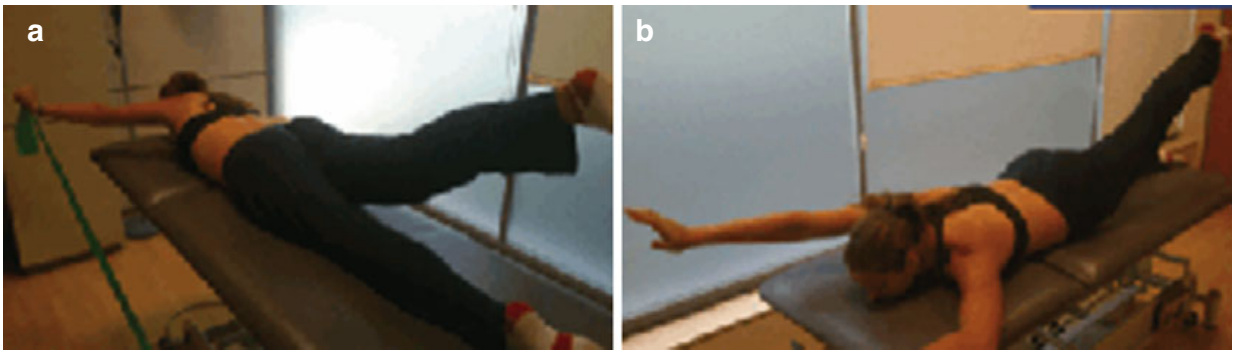


Fig. 2.7 (**a**, **b**) Cross Chain kinetic exercises according to Anne Cool [19]

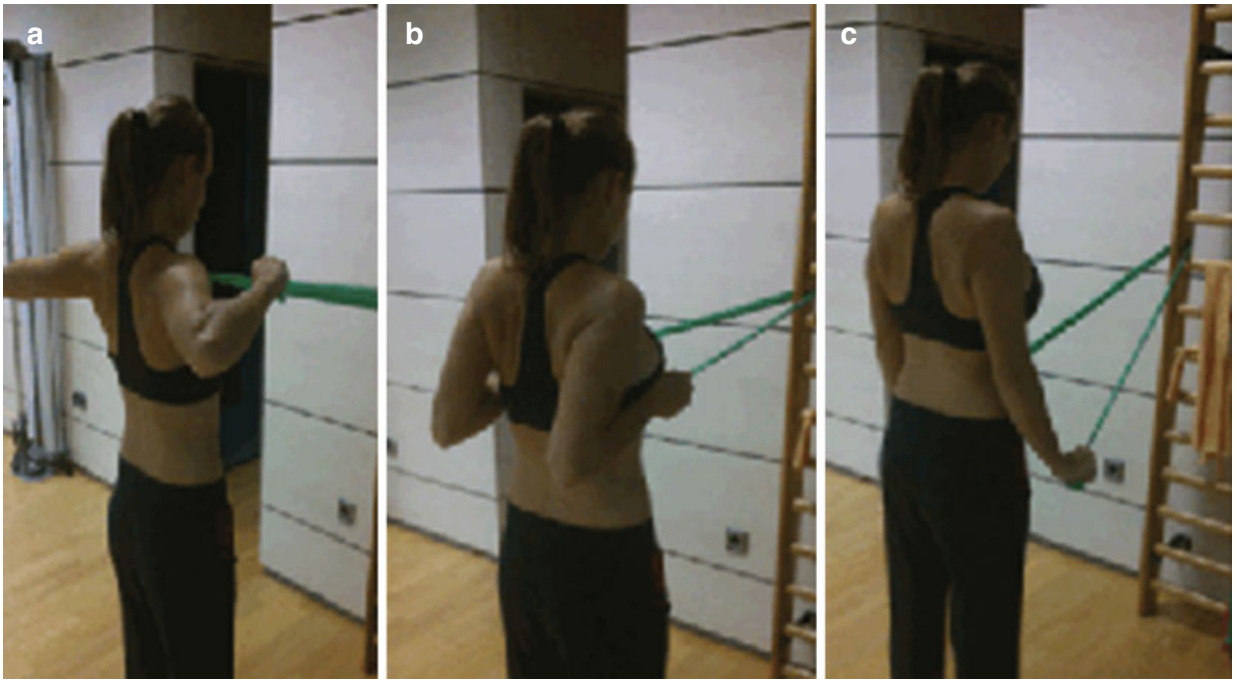


Fig. 2.8 (**a–c**) Periscapula muscle strengthening exercise using the TERA® ribbon

A higher frequency of dyskinesis has been reported in throwing athletes [29] and tennis players [41].

Altered dynamics of scapular motion in tennis players is a commonly occurring phenomenon. In our study we found that around 90 % of elite tennis players experienced the problem in one or both shoulders. Such a prevalent condition in these training intensive athletes is likely to be due to overload or fatigue. Errors in technique may also be involved. This same alteration in motion could also lead to further pathology, although at present it has not been reported.

It has been published that amateur tennis players suffer from GIRD more frequently on the dominant side compared to the non-dominant shoulder [43].

In our study we observed that this internal rotation deficit occurs in both shoulders although it is more severe in the dominant arm. This could be explained by the use of both arms for the backhand [33].

Whether these two conditions, dyskinesis and GIRD, are pathologic or adaptive is not known. But in our experience, when overhead athletes are treated by means of directed physiotherapy, the anterior shoulder pain is oftentimes completely alleviated [32, 33].

Our physiotherapeutic approach to the tennis player's shoulder is based on these findings.

Fig. 2.9 Stretching of the posterior capsule in order to treat the internal rotation deficit

Fig. 2.10 The patients lies in the lateral position on the affected shoulder as also shown in Fig. 2.9. The healthy contralateral arm presses the affected forarm onto the stretcher.

In terms of dyskinesis, we follow Anne Cools' approach [19], based on cross-chain kinetic exercises (Fig. 2.7), parascapular muscle strengthening (Fig. 2.8) and stiff structures stretching.

If GIRD is associated, which most often is the case, we use the baseball sleeper's stretch in the lateral decubitus position (Fig. 2.9), but we ask our patients to perform the exercise at least five times a day for at least 5 min. It is crucial to emphasize the importance of stretching the posterior capsule by leaning on the shoulder correctly (Fig. 2.10). At least once a day they visit the physiotherapist to work in a personalized manner [32].

Normally, the incapacitating pathology in the tennis player is pain from the long head of the biceps (LHB), which prevents them from serving, as well as creating difficulty with the volley and forehand. It is therefore important to emphasize to the player the need to treat the underlying condition. Our treatment protocol consists in injecting, under ultrasound guidance, 3 ml of a solution of 10 % diluted corticoid (1 ml = 40 mg triamcinolone acetate) mixed with 9 ml of local anaesthetic (4.5 ml lidocaine 2 % + 4.5 ml bupivacaine 0.5 %) in the biceps sheath. The use of the ultrasound is of critical importance because it allows for accurate injection within the sheath while avoiding injection in the biceps tendon itself (Fig. 2.11).

Fig. 2.11 Ultrasound guided injection into the sulcus of the biceps tendon

Although not obligatory, this injection is useful as a diagnostic tool and also allows the tennis player to begin the physiotherapy protocol sooner.

Therapy consists of manual transverse massage on the LHB, eccentric exercises, radial shock wave therapy and galvanic current injection with acupuncture needles (EPI) in the tendon when needed.

By treating our athletes with this protocol, we have shown in a pilot study that they may be pain-free and back to competition in about a month [32, 33].

In summary, the most important observation we have made when a tennis player comes referred for or complaining about anterior shoul-

der pain, the shoulder rotation and the dynamics of both scapulae should be assessed.

If there is an alteration in any of these factors, a holistic approach with directed physiotherapy is effective in treating the pain and pathology.

Based on Anne Cools' studies [19] and on our practice, we have developed a physiotherapeutic protocol.

It is divided into three phases:

Conscious muscle control
Muscle control and strength necessary for daily activities
Advance control during sports movements

2.4.2 Phase 1: Conscious Muscle Control

During this first phase, the objective is to gain conscious muscle control.

The most physiologic way to it is with the exercises that involve closed-chain activities (scapular clock), which are elevation, depression and retraction/protaction exercises with the hand on a wall. Each exercise should be repeated on 3 series of 15 repetitions each.

2.4.3 Phase 2: Muscle Control and Strength Necessary for Daily Activities

Once muscle balance is restored, the patient should start general scapular strengthening exercises.

Elastic bands are recommended to perform these exercises that consist on:

Closed-chain exercises and eccentric exercises for biceps.

For posterior capsule stretching: sleeper stretch and cross-body stretch exercises (Figs. 2.9 and 2.10).

For the scapular dyskinesis, cross-kinetic chain exercises are instructed with elastic bands in the prone position elevating one arm and the contralateral leg at the same time (Figs. 2.7 and 2.8).

Closed-chain exercises are believed to improve dynamic glenohumeral stability through stimulation of the intra-articular and periarticular proprioceptors and enhance co-contraction of the rotator cuff, thus being beneficial in case of shoulder instability [18].

2.4.4 Phase 3: Advance Control During Sports Movements

During this last stage of muscle control and strength, special attention should be paid to integrate kinetic chain into the exercise programme and implement sport-specific demands by performing plyometric and eccentric exercises, such as back push-ups or push-ups in parallel bars and on the floor.

Throwing athletes should perform eccentric exercises for external rotators with weight balls and elastic resistance tubing.

Swimmers on the other hand should focus on core stability exercises doing exercises such as W-V exercises, in which the patient is prone on a Swiss ball and perform movements, forming a W and a V with his arms [17].

In our experience, the described protocol was very effective in a pilot study [32] of patients, and they were able to return to their former occupation and sportive activities in a month and almost without any pain.

2.5 Arthroscopic Knotless Suprapectoral Tenodesis of the Long Head of Biceps: Clinical and Structural Results

2.5.1 Purpose

The purpose of this study was to evaluate the clinical, cosmetic and structural results of arthroscopic suprapectoral knotless epiosseous tenodesis of the long head of biceps.

2.5.2 Methods

Forty-nine patients (16 women, 33 men; mean age 58; mean follow-up 36.4 months (range

24–57 months)), in whom a tenodesis of the long biceps tendon (LHB) has been performed, were included into this study. The clinical evaluation included the constant score as well as the LHB score. In addition elbow flexion and supination strength were assessed. The integrity of the tenodesis construct was evaluated indirectly by sonographic detection of the LHB in the bicipital groove.

2.5.3 Results

The overall constant score did not reveal any significant differences comparing both sides (mean, 86 ± 19 points vs. 89 ± 16 points (n.s.). The mean LHB score reached 88.3 points (range, 54–100 points). Thirty-four patients (69.4 %) presented an examiner-dependent upper arm deformity although only 3 patients (6.1 %) confirmed a subjective cosmetic deformity.

Both flexion and supination strengths were significantly decreased compared to the non-operated side ($p < 0.05$). In five patients (10.2 %), it was not possible to verify the LHB sonographically in the bicipital groove. Therefore, the biceps tenodesis was classified as a failure.

2.5.4 Conclusion

The arthroscopic suprapectoral epiosseous knotless tenodesis of the LHB provides good functional results. The high rate of examiner-dependent upper arm deformities can be explained by a non-physiological situation of the primary length-tension relationship or an elongation of the tendon after fixation.

Take-Home Massage

- When a patient is referred with anterior shoulder pain, the physician should rule out biceps tendinosis or tenosynovitis as the main diagnosis. Also, the dynamics of the scapular movement and the range of motion of the glenohumeral joint should be evaluated and treated if altered.
- Tennis players usually present with LHB tenderness in combination with dyskinesis and GIRD.
- Conservative comprehensive physiotherapy treating all the pathologic entities is effective.
- In terms of biceps tenosynovitis, our protocol with injection under ultrasound guidance, manual transverse massage on the LHB, eccentric exercises, radial shock wave therapy and galvanic current injection with acupuncture needles (EPI) in the tendon when needed is useful.
- In terms of scapular dyskinesis, most of the time, conservative treatment based on conscious parascapular muscle control, strengthening and advance performance during daily life and sport-specific tasks is useful
- For GIRD, physiotherapy based on stretching the posterior capsule by means of physiotherapist and home exercises is advised.
- There is still no consensus on the ideal treatment of LHB pathology as recent studies show equal subjective results for tenotomy and tenodesis, whereas postoperative biomechanical results are in favour of tenodesis.

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