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Effective rehabilitation in patients with scapular dyskinesis

Introduction

The scapula with the glenoid is the anchor for the humeral head and forms the origin of the rotator cuff as a basis for motions of the upper limb. Insufficient scapulohumeral motion implies a deficit of this anchorage. Physiologically, the scapula performs a complex three–dimensional movement during arm elevation including upward rotation, posterior tilting and varying internal/external rotation depending on the plane and angle of elevation [11, 27]. This is possible because of predominant muscular stabilization, besides the bony fixation of the clavicula, on the thorax with the upper and lower fibres of the trapezius, serratus anterior ("force couple") and the posterior rhomboid muscle (**Fig. 1**). However, scapular dyskinesis (SD) is a divergence of the regular position and movement of the scapula [16, 18, 19].

Divergence during scapular dyskinesis

During arm elevation the lower trapezius (LT) with its attachment to the medial border allows the centring of the scapula rotation centre and supports the external rotation of the scapula [1]. Additionally, owing to its attachment on the margo inferior the muscle allows for a stabilization to the thorax during arm lowering. The other partner of the force couple is the serratus anterior muscle: It is a major stabilizer of the scapula and facilitates an upward rotation, posterior tilting and external rotation [26]. The position in external rotation and posterior tilting is necessary to allow for an optimal activation of the shoulder muscles during overhead activities such as throwing, especially during the cocking phase [33]. In concert with the muscles of the knee and hip in extension, plus a stable trunk ("kinetic chain"), the retracted scapula is a stabile anchor for the rotator cuff and therewith the humeral head for arm elevation. Maximal rotator cuff strength is achieved with a stable and retracted scapula [40].

Thus, SD itself is not a specific pathology, rather a symptom of one or more different pathologies and functional impairment. To date it is unclear whether SD is the cause or rather a consequence of shoulder pathologies. A study by Clarsen et al. examining Norwegian elite handball players showed that SD predicts shoulder pain [4]. Another prospective study by Struyf et al. evaluating recreational overhead athletes showed that the presence of SD did not influence the occurrence of shoulder pain [39]. However, the presence of SD may negatively influence specific shoulder pathologies. If an SD is not treated sufficiently, it can impair the healing of the underlying disease. A selection of pathologies are listed in **Table 1**.

Clinical examination

Patients with SD are typically young with nonspecific shoulder pain and irregular scapula motion. Nevertheless, SD is found not only in symptomatic patients, but also in healthy overhead athletes as an individual adaptation [14, 38]. Overhead sport such as volleyball, tennis, handball and swimming with repetitive abduction and external rotation may cause muscle imbalances and dyskinesis of the scapula. Dysfunction of the "force couple" and the kinetic chain is assumed to cause secondary impingement, which is not to be confused with classic outlet impingement of the shoulder. Thus, the recognition of deficits at different levels of the kinetic chain during physical examination is important in guiding proper treatment. In addition, the focus of the examination should be on pathology such as superior labral anterior–posterior (SLAP) or pulley lesions, rotator cuff tears and glenohumeral internal rotation deficit (GIRD).

The clinical examination of SD includes visual evaluation of the scapula, which is done from the dorsal side with bilateral repetitive arm elevation. Adding handheld weights may help to identify subtle SD, especially in athletes [22]. Results from visual assessment of SD can be classified according to Kibler into four types (**Table 2**; [19]), although other classifications exist:

However, during visual examination itself it is not possible to determine wheth-

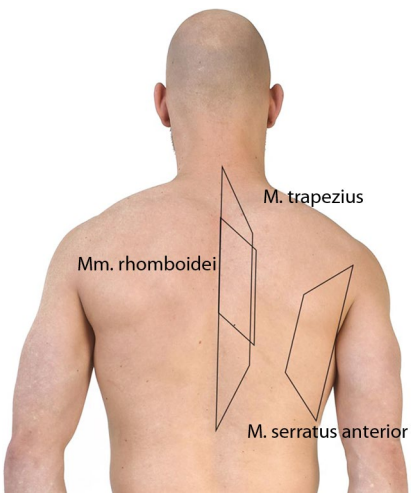

Fig. 1 ▲ Overview of periscapular muscles

Fig. 2 ▲ Sleeper stretch (**a** frontal, **b** axial). Starting position: lying on the side using a head pad, pathological shoulder lying on the mattress, elbows bent at 90°, healthy hand holds the wrist of the pathological arm, own weight pushes the pathological arm down with minimal force (approximately 0.5 kg). [**a** Courtesy of Kopkow C, Dexel J, Kasten P (2015) Skapuladyskinesie. Klinische Untersuchung und Therapiestrategie. Zeitschrift für Physiotherapeuten 67:10–16]

Fig. 3 ▲ Cross-body stretch (**a** frontal, **b** axial). Starting position: lying on the side using a head pad, pathological shoulder lying on the mattress, elbow flexed, arm is pulled across the body (up to pain level). [**a** Courtesy of Kopkow C, Dexel J, Kasten P (2015) Skapuladyskinesie. Klinische Untersuchung und Therapiestrategie. Zeitschrift für Physiotherapeuten 67:10–16]

Fig. 4 ◀ Star excursion balance exercise. Upright standing position, knees slightly bent, hands supported on hips, imagine a four-sided star on the floor, standing on one leg while trying to reach the end of the star sides as far as possible with the contralateral leg. Reach each of the eight points, five to eight repetitions

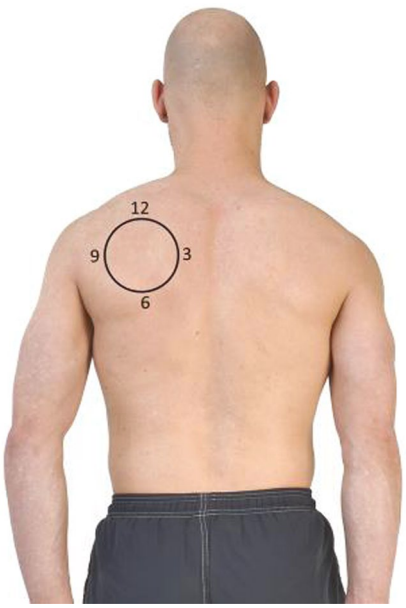

Fig. 5 ▲ Scapula clock exercise. Standing or in upright sitting position, a clock is used for visualization of scapula movement; the scapula is slowly moved into the different directions (3, 6, 9 and 12 o'clock). Each position should be reached once, 15 repetitions on each side. [Courtesy of Kopkow C, Dexel J, Kasten P (2015) Skapuladyskinesie. Klinische Untersuchung und Therapiestrategie. Zeitschrift für Physiotherapeuten 67:10–16]

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Effective rehabilitation in patients with scapular dyskinesis

Abstract

For a balanced scapulohumeral rhythm in arm elevation, it is necessary to have an optimal position, motion, stability and muscle performance of the scapula and scapular muscles. In the case of abnormal movements, so-called scapular dyskinesis, the tendons (e.g. biceps tendon, rotator cuff) can be irritated and may cause pain in overhead activity. There are various causes for scapular dyskinesis and, therefore, the treatment is a challenge for therapists. The aim of conservative treatment is to restore normal position and movement of the scapula and furthermore dynamic scapular stability during overhead activities. Rehabilitation based on effective exercises should be tailored individually and the complexity of the exercises should be increased slowly.

Keywords

Scapular dyskinesis · Rehabilitation program · Overhead athlete · Impingement · Throwing sports

Effektive Rehabilitation bei Patienten mit Skapuladyskinesie

Zusammenfassung

Für einen ausgeglichenen skapulohumeralen Rhythmus bei Armelevation ist eine optimale Position, Beweglichkeit, Stabilität und Muskelkraft der Skapula und der die Skapula umspannenden Muskulatur notwendig. Im Fall einer abnormen Bewegung der Skapula, Skapuladyskinesie genannt, können Sehnen (z. B. die Bizepssehne und Rotatorenmanschette) geschädigt werden, was zu Schmerzen bei Überkopfaktivität führen kann. Es gibt verschiedenste Ursachen für eine Skapuladyskinesie. Die Therapie ist daher eine Herausforderung für den Behandler. Das Ziel einer konservativen Therapie ist es, die normale Position und Bewegung der Skapula sowie darüber hinaus die dynamische Stabilität während Überkopfaktivität wiederherzustellen. Die Rehabilitation basiert auf einem effektiven Übungsprogramm und wird individuell angepasst, wobei die Komplexität der Übungen langsam gesteigert werden sollte.

Schlüsselwörter

Skapuladyskinesie · Rehabilitation · Überkopfsportler · Impingement · Wurfsport

Table 1 Pathologies of the shoulder, which can cause scapular dyskinesis

Bony pathology: thoracic kyphosis, fractures of the scapula or clavicle
Neurological pathology: cervical radiculopathy, peripheral nerve damage (accessory nerve or long thoracic nerve)
Joint pathology: AC joint dislocation or arthrosis, glenohumeral joint pathologies (micro or macro instabilities, GIRD)
Muscular pathology: muscle disbalance of periscapular muscle pathologies (force couple) and pectoralis major and minor

AC: acromioclavicular, *GIRD:* glenohumeral internal rotation deficit.

Table 2 Kibler classification of scapular dyskinesis

Type I: prominence of the inferomedial scapula border
Type II: lifting of the medial scapula border
Type III: lifting of the total scapula
Type IV: inconspicuous scapula

er the position and/or movement of the scapula contribute to shoulder symptoms. Therefore, symptom alteration tests such as the scapular assistance test (SAT) or the modified SAT (mSAT) and the scapular retraction test (SRT) should be used [15, 21, 24, 40]. The SAT is performed while the examiner manually assists the upward rotation of the scapula during active elevation of the upper limb by pushing the inferior medial border of the scapula on the thorax [23]. The SAT was modified (mSAT) by Rabin et al. with inclusion of manual assistance of both upward rotation and posterior tilt [35]. Kopkow et al. demonstrated in a recently published study that the mSAT is reliable for clinical use, also if performed with additional handheld weights [24]. Positive symptom alteration test results will help identify patients in need of specific scapula-focused treatment. It is assumed that in the case of a positive test result, a scapula-specific treatment is promising [5, 8, 16].

Treatment

In the case of manifest structural pathologies such as glenohumeral instability with labral lesions, full thickness rotator cuff tear or SLAP lesions, an operative treatment should be considered as the basis of the treatment of SD. However, evidence regarding the influence of SD on outcomes after surgery is lacking and further studies evaluating this issue are needed. In patients with positive symptom alteration test results (SAT, mSAT or SRT) a preoperative scapula-specific treatment might help to improve postoperative outcomes. Nevertheless, in the case of primary or secondary muscular deficits throughout the complete kinetic chain, e.g. weakness of the serratus anterior and the trapezius muscle (force couple), the core trunk or lower extremity muscles, a structured and step-by-step physiotherapeutic treatment is recommended.

In throwing athletes with acute shoulder pain, a break from any overhead sporting activities is often necessary for pain management. Furthermore, a generally accepted conservative treatment with, e.g. NSAIDs and physical applications such as iontophoresis, electrical stimulation and cryotherapy should be always followed to diminish pain and inflammation for symptom reduction in patients with SD [36].

However, the aim of conservative treatment in patients with SD is to restore optimal scapula position and movement characterized by posterior tilt, external rotation and upward rotation during elevation of the upper limb. Therefore, the two basic pillars of pathology should be addressed in the case of pathological findings: the deficit of soft-tissue flexibility and the lack of muscle performance [5]. In general, it is recommended that isometric before dynamic exercises and training of proprioception before strength should be performed. In cases of deficit of soft-tissue flexibility, manual therapy and stretching exercises are indicated and in cases of lack of muscle perfor-

Fig. 6 ◀ Inferior glides. Standing or in upright sitting position, arm abducted up to 90°, fist clenched, the patient applies pressure with his/her fist in the direction of adduction and retracts/inferiorly and depresses the scapula. Hold end position for about 5 s, ten repetitions, three cycles

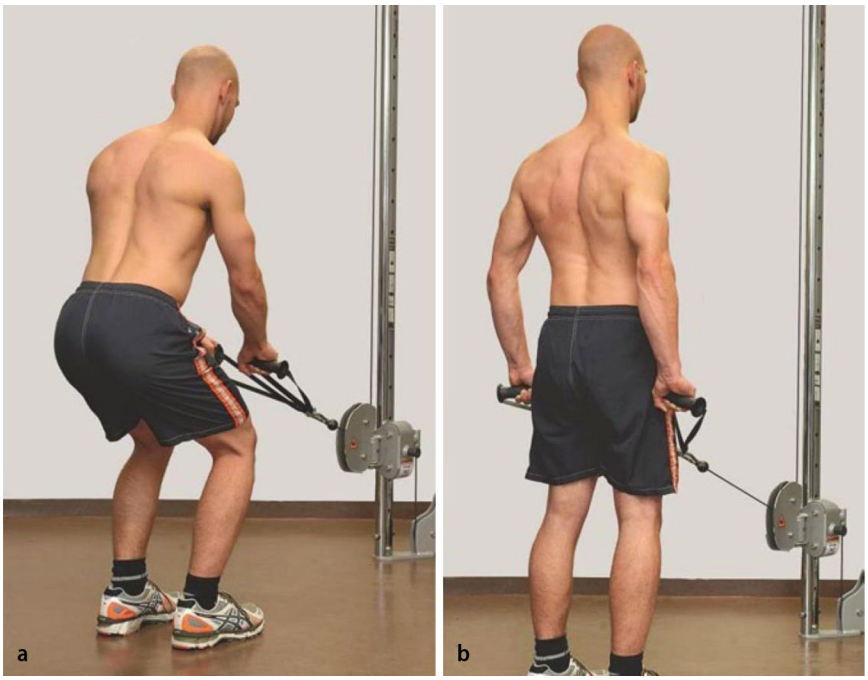

Fig. 7 ▲ Low-row exercise. **a** Starting position: standing position, knees and trunk slightly flexed. **b** End position: extension of trunk and lower extremity, scapular retraction combined with low rows (elbows straight by the side). Hold end position for about 5 s, ten repetitions, three cycles. [**b** Courtesy of Kopkow C, Dexel J, Kasten P (2015) Skapuladyskinesie. Klinische Untersuchung und Therapiestrategie. Zeitschrift für Physiotherapeuten 67:10–16]

mance, neuromuscular coordination and strength training. The exercises are gradual, beginning with training of the lower extremities and trunk stability ("core exercises") as a prerequisite for correct posture and sufficient strength transfer from the lower to the upper extremity [37].

Rehabilitation of flexibility deficits

In cases of SD an internal rotation deficit of the glenohumeral joint caused by tenderness and stiffness of the posterior–inferior capsule and the external rotator muscle is often seen [17]. This leads to an anterior tilting and downward rotation of the scapula [2], causing impingement during active elevation of the upper limb. The "sleeper stretch" (**Fig. 2**) and the "cross-body stretch" (**Fig. 3**) have shown positive effects in improving the range of motion (ROM) and increasing the acromiohumeral distance [28, 31, 32]. Nevertheless, increasing internal rotation should be done carefully in the elite athlete, since this will probably decrease external rotation, which is essential for overhead athletes. In addition, the total ROM should be measured and considered before focusing solely on internal rotation [30].

Besides the posterior–inferior capsule, in particular the pectoralis minor and the levator scapulae muscle may cause flexibility problems and stretching exercises to treat such deficiencies have been published [10, 34]. The "corner stretch" (90° abduction and external rotation) seems to be an exercise with a large increase in the length of the pectoralis major [3], but this position will cause pain in most patients. Therefore, it is recommended to perform the exercise supine with passive stabilization of the scapula in a neutral position and with the assistance of a therapist [10]. However, whether a real elongation of the muscle or a sensory adaptation to the pain is the main effect is still debated [41].

Rehabilitation of muscular deficits

Before strengthening exercises, it should be ensured that no sensomotoric deficits of the kinetic chain exist. In cases of relevant deficits, simple exercises such as "knee bends" or "star excursion balance" (**Fig. 4**) may be used for conscious muscle control and to improve sensomotoric deficits and flexibility of the lower limb [20]. Core stability is achieved through "lateral forearm push-ups" because of a high activation of the gluteus medius and obliquus abdominis externus [9].

Especially during the acute phase with persistent shoulder pain and before beginning with the strengthening of the periscapular muscles, sensomotoric and isometric exercises to stabilize the scapula can be done parallel to core stabilization, because the shoulder is not to be moved dynamically [19, 23]. During the acute phase, exercises such as "scapula clock" (**Fig. 5**) and "inferior glides" (**Fig. 6**) are recommended and can be used to address conscious muscle control of scapular muscles [17, 23]. Holtermann et al. evaluated electromyography feedback systems for the learning of selective activation of scapular muscles and found promising clinical applications for restoring scapular muscle balance [13]. Exercises such as "low rows" can be applied, primarily isometric, and can be increased with decreasing pain in "mid" or "high rows" (**Fig. 7**).

If no further sensomotoric deficits are present, the secondary focus should be in

Fig. 8 ▲ Wall slides exercises. **a** Upright standing position, homolateral leg extended, sliding on the wall with actively retracted scapula. **b** Start under 90° abduction, then progress if there is no pain and the scapula can be stabilized

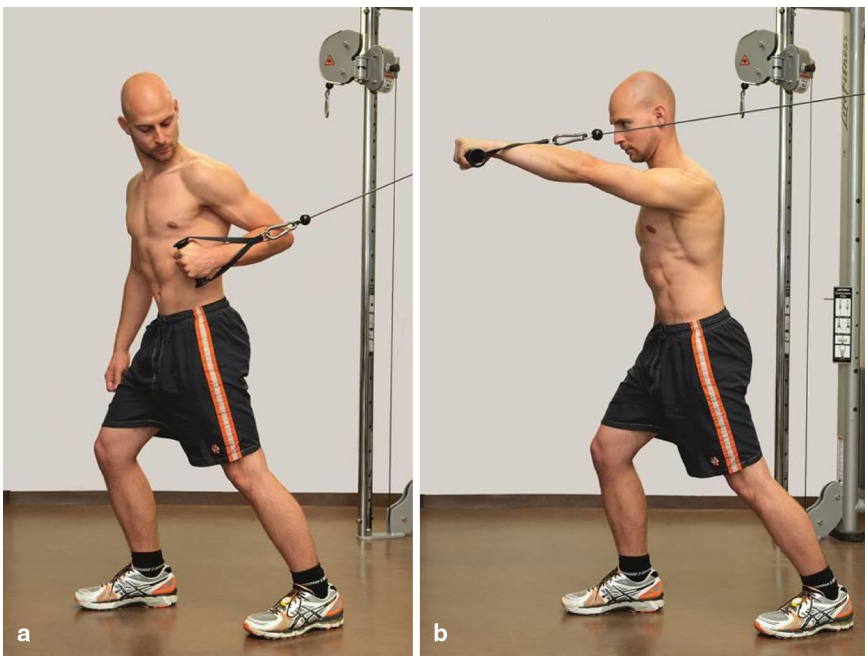

Fig. 9 ▲ Scapula punches. **a** Starting position: upright standing position, resistance using elastic tubes and trunk rotation. **b** End position: extension of shoulders and elbows up to 120° of elevation and full protraction. Hold end position for about 5 s, ten repetitions, three cycles

restoring muscle disbalances [6, 7, 25]. The upper trapezius (UT) muscle often shows hyperactivity in patients with SD, and thus exercises should be selected that activate the lower trapezius (LT) and the anterior serratus muscle (SA) [7]. Therefore, exercises with a low UT/LT and UT/SA ratio are of particular importance [23].

Through the high activation of the serratus anterior muscle "push-up plus" exercises appear to be very suitable in the closed chain. The therapy intensity could increase by combining the exercise with an ipsilateral extension of the leg through increasing activity of the SA muscle [29].

Training of muscular endurance and strengthening exercises

To change from the closed to the open kinetic chain exercises, "wall slides" exercises (**Fig. 8**) may be used, which activates the SA and also enables the patient to move the upper limb into overhead positions [12]. In the case of sufficient muscle stability of the scapula, "lateral pull", "scapula punches" (**Fig. 9**) and "three-point plank with shoulder extension" exercises (**Fig. 10**) can be used in combination with "core exercises" for increasing intensity. At the end of rehabilitation, patients should be able to stabilize the scapula during their individual activities such as overhead sport but also work. Therefore, this needs to be addressed individually in the final rehabilitation phase [5].

Return to play

Before athletes are able to return to play, sport-specific exercises should be performed to increase endurance and strength according to the individual sporting demands. Sufficient scapular stability and absence of pain during sport-specific exercises are needed before the athlete can return to sport. Cools et al. recommend (a) symmetrical scapular muscle strength in athletes not performing throwing sports and (b) 10 % increased strength on the dominant side in athletes performing unilateral overhead sporting activities [5]. Persistent pain and/or insufficient stability of the scapula will hamper return to sport. After returning to sport, athletes should be closely monitored for early detection of renewing problems and for adapting the sporting activities again to avoid long-term absence from sporting activities.

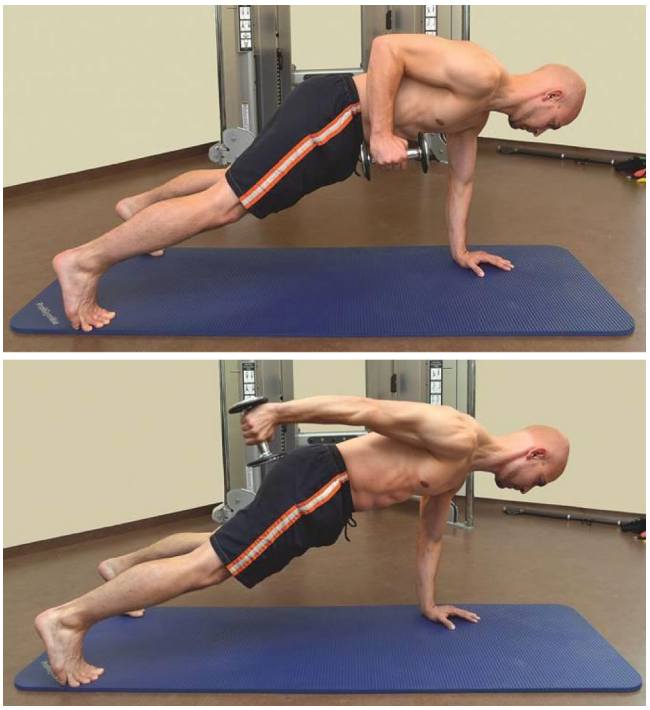

Fig. 10 ◀ Three-point plank with shoulder extension. **a** Three-point plank, elbow flexed 90° with light weight in the hand and followed by arm extension. **b** Hold end position for about 5 s, ten repetitions, three cycles

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Compliance with ethical guidelines

Conflict of interest. J. Nowotny, C. Kopkow, F. Mauch and P. Kasten state that there are no conflicts of interest.

The accompanying manuscript does not include studies on humans or animals.

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