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Clinical assessment of the scapula: a review of the literature

Filip Struyf,[1,2] Jo Nijs,[1,2] Sarah Mottram,[3] Nathalie A Roussel,[1,2] Ann M J Cools,[4] Romain Meeusen[2]

[1]Department of Healthcare, Division of Musculoskeletal Physiotherapy, Artesis University College Antwerp, Merksem, Antwerp, Belgium
[2]Department of Human Physiology, Vrije Universiteit Brussel, Brussels, Belgium
[3]KC International, London, UK
[4]Department of Rehabilitation Sciences and Physiotherapy, University Ghent, Gent, Belgium

Correspondence to
Dr Filip Struyf, Division of Musculoskeletal Physiotherapy, Department of Healthcare, Artesis University College Antwerp, Van Aertselaerstraat 31, Merksem, Antwerp 2170, Belgium; filip.struyf@vub.ac.be

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ABSTRACT

Scientific evidence supporting a role for faulty scapular positioning in patients with various shoulder disorders is cumulating. Clinicians who manage patients with shoulder pain and athletes at risk of developing shoulder pain need to have the skills to assess static and dynamic scapular positioning and dynamic control. Several methods for the assessment of scapular positioning are described in scientific literature. However, the majority uses expensive and specialised equipment (laboratory methods), making their use in clinical practice nearly impossible. On the basis of biometric and kinematic studies, guidelines for interpreting the observation of static and dynamic scapular positioning pattern in patients with shoulder pain are provided. At this point, clinicians can use reliable clinical tests for the assessment of both static and dynamic scapular positioning in patients with shoulder pain. However, this review also provides clinicians several possible pitfalls when performing clinical scapular evaluation. On the basis of its clinical relevance, its proven reliability, its relation to body length and its applicability in a clinical setting, this review recommends to assess the scapula both static (visual observation and acromial distance or Baylor/double square method for shoulder protraction) and semidynamic (visual observation and inclinometry for scapular upward rotation). In addition, when the patient demonstrates with shoulder impingement symptoms, the scapular repositioning test and scapular assistant test are recommended for relating the patients' symptoms to the position or movement of the scapula.

INTRODUCTION

Shoulder pain is a very prevalent musculoskeletal disorder, with a lifetime prevalence of up to 66.7%.[1] One of the key factors contributing to shoulder pain is physical load on the shoulder complex.[2] Overhead athletes, such as throwers, swimmers, tennis and volleyball players, are highly exposed to such physical loads. In order to meet the musculoskeletal demands for repetitive overhead and loaded activities, athletes need effective shoulder mobility and stability mechanisms.[3] If these mechanisms are ineffective, the athlete may be exposed to possible shoulder injuries.[3] But how does an athlete combine optimal mobility and sufficient stability of the scapulothoracic joint? It is widely recognised that people should be able to position the scapula at rest and to control the scapula during arm movements for optimal upper-limb function.[4] There is sufficient evidence suggesting that scapular positioning and scapular motor control are altered in patients with musculoskeletal disorders, for example, shoulder impingement syndrome,[5 6] non-traumatic shoulder instability,[7] multidirectional shoulder joint instability,[8] insidious onset neck pain and whiplash-associated disorders,[9] rotatorcuff tendinopathy and rotatorcuff tears,[10] adhesive capsulitis[10] and shoulder pain after neck dissection in cancer patients.[11 12] In this view, it is necessary to evaluate potential biomechanical alterations that may contribute to this altered scapular positioning, such as soft tissue tightness, muscle activity or strength imbalance.[10]

In addition, scapular dyskinesis (alteration of optimal scapular kinematics)[13] was recently described as a non-specific response to a painful condition in the shoulder.[14] For example, a recent study concluded that tennis players with scapular dyskinesis present with a smaller subacromial space than control participants.[15] Apart from the evidence from case–control studies, physiotherapy targeting the scapulothoracic muscles was also found effective in patients with shoulder impingement syndrome,[16] and conservative treatments consisting of stretching and strengthening exercises targeting scapulothoracic muscles were able to improve scapular positioning in asymptomatic subjects.[17 18] For all these reasons, it seems essential that clinicians are able to assess scapular positioning, scapular muscle strength and scapular motor control in a reliable and valid way in patients with shoulder pain as well as in subjects at risk for developing shoulder pain, such as overhead athletes.[19] This literature overview provides guidelines, which should enable clinicians to identify faulty scapular positioning, scapular muscle strength and scapular motor control.

NORMAL SCAPULAR POSITIONING AND MOVEMENT

During shoulder movements, the scapula demonstrates posterior (backward) or anterior (forward) tilting, upward or downward rotation, internal (winging) or external rotation, anterior or posterior translation and superior or inferior translation.[3 20] The combined motions of anterior translation and internal rotation are frequently referred to as scapular protraction. Likewise, the combined motions of posterior translation and external rotation are referred to as scapular retraction.

OBSERVATION OF STATIC AND DYNAMIC SCAPULAR POSITIONING

Observation of resting scapular position

Observation of resting scapular position can be performed in the frontal and sagittal view with the patient positioning both arms relaxed beside his body. A recent literature review suggests an approximately horizontal scapular spine within +5° and −5° of scapular upward/downward rotation,[20] with the glenoid facing relatively downward in younger subjects and more upward in older subjects.[21] The scapula should be internally rotated about 40° in respect to the frontal plane and anteriorly tilted about 10°.[20] In addition, the medial border of the scapula should be positioned parallel to the thoracic midline,[22] the scapula of the dominant side lower and further away from the spine in comparison to the non-dominant side,[22] with the superior angle level with the spinous processes of T3 or T4, and the inferior angle level with T7, T8, T9 or even T10.[4] Observation of scapular positioning should be performed at rest, with both hands on ipsilateral hips and at 90° of shoulder abduction (figure 1).[23]

Abnormalities in scapular rest position can be defined as tilting or winging (eg, figure 1: winging of the right scapula with both arms relaxed beside the body). Tilting appears to be related to hand dominance, with the dominant side presenting with significantly more tilting than the non-dominant side.[20] The observation of tilting and winging at rest can be reliably used in clinical practice (table 1).[23] A common alteration in scapular resting posture is the so-called SICK scapula syndrome, which is described as scapular malposition, *i*nferior medial border prominence, *c*oracoid pain and malposition and dys*k*inesis of scapular movement.[24] This syndrome is characterised by an asymmetric position of the scapula in the dominant throwing shoulder.[24] Owing to a protracted (tilted) position of the scapula, this alteration is usually seen as a dropped scapula.[24] Although the validity of these evaluation systems are yet to be established, Tate *et al*[25] concluded that those identified as having scapular dyskinesis possess alterations in scapular kinematics similar to throwing athletes described as having the SICK scapula syndrome.

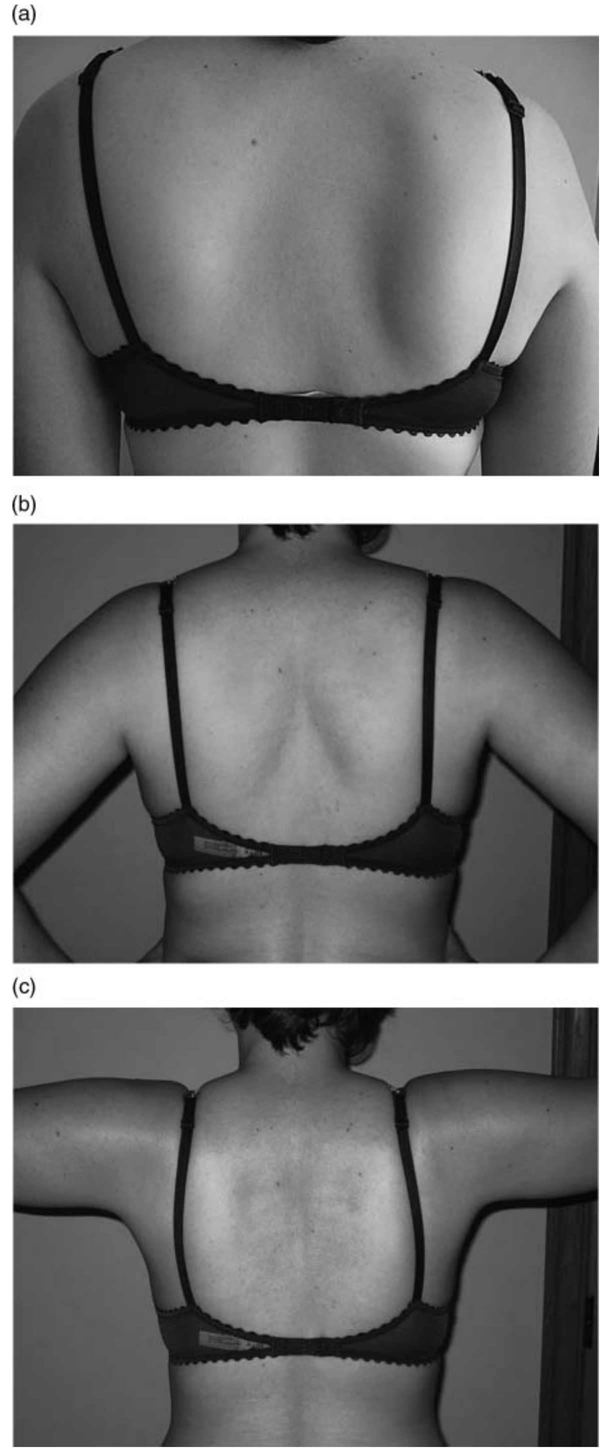

Figure 1 Observation of static scapular positioning at three positions.

Observation of scapular motion

Observation of scapular positioning during shoulder movement enables clinicians to assess scapular dyskinesis. It is suggested that scapular dyskinesis should be characterised as absent or present and can be further described as winging or dysrhystmia.[13] In scapular dysrhythmia, the scapula demonstrates premature or excessive elevation or protraction, non-smooth or stuttering motion during arm elevation or lowering, or rapid downward rotation during arm lowering.[13 26] The kinematic rhythm between glenohumeral abduction and scapular upward rotation does not appear to vary from one testing session to another, but left–right differences are considered normal.[27] In addition, clinicians should try to make sure that their patients perform shoulder abductions at the same velocity when observing dynamic scapular motion. For example, shoulder patients with capsular restrictions of joint mobility typically present with the scapula contributing massively to the range of motion in the first part of shoulder abduction.[28]

Several methods for the evaluation of scapular dyskinesis have been reported in the literature. First, two studies[14 23] concluded that the observation of tilting and winging during movement is a clinically applicable tool for assessing patterns of scapular motion (table 1). Second, McClure *et al*[29] suggest not to rate the scapula with a selected deviation (winging and tilting), but instead to classify scapular positioning as normal, subtle dyskinesis or obvious dyskinesis.[29] McClure *et al*[29] described subtle dyskinesis as a mild or questionable evidence of abnormality which was not consistently present. In addition, obvious dyskinesis was defined as striking, clearly apparent abnormality, evident on at least 3/5 trials (dysrhythmias or winging of one in (2.54 cm) or greater isplacement of scapula from thorax). This rating system of McClure *et al*[29] achieves satisfactory reliability for clinical use. In addition, shoulders visually judged as having dyskinesis showed distinct alterations in three-dimensional motion, which supports the validity of this observation system.[25]

Third, Uhl *et al*[30] concluded that a yes/no rating system provided a reliable evaluation system, which achieved high sensitivity (76%) and high predictive value (74%). They compared this rating system to Kibler's four-type rating system, which required a single-forced choice among four categories, including three subtypes of dyskinesis: types I (inferior angle

Table 1 Overview of the reliability data of clinical observation of scapular positioning

Test	Kibler *et al* (2002)[22a]	Struyf *et al*[23]	McClure *et al*[29]	Uhl *et al*[30]
Type I, II, III or IV	0.40 (videotaped)			0.44 (direct observation)
Tilting (at rest versus during movement)		0.48–0.52		
Winging (at rest versus during movement)		0.42–0.78		
Yes (type I, II, III)/no (type IV) method				0.41
Dyskinesis (winging and/or dysrhythmia)			0.48–0.61	

prominence), II (medial border prominence), III (excessive superior border elevation) and IV (symmetric and normal scapular motion). A shoulder was scored 'yes', when one or more of the first three types of Kibler's rating system were observed. The clinician scored 'no' is type IV was seen. However, asymmetry appears to be common in both the symptomatic and asymptomatic population.[30] Finally, the addition of weights during shoulder movements can reveal faulty scapular positioning patterns.[26 31] More specifically, weighted flexion was the motion that most commonly resulted in dyskinesis and a 3-kg load significantly reduced scapulothoracic motion through the range of 35°–45° of glenohumeral motion.[26 31]

MEASUREMENT OF STATIC SCAPULAR POSITIONING

In contrast to visual observation, for all measurements of static and dynamic scapular positioning, the orientation of the scapula depends on the therapists' palpating accuracy. However, previous research has been shown surface palpation of scapular position to be a valid method for determining the actual location of the scapula.[32]

Measurement of the distance between the posterior border of the acromion and the table/wall

The measurement of the distance between the posterior border of the acromion and the table (AT-distance) was described by Host.[33] Researchers have suggested that forward shoulder posture contributes to head, shoulder and neck pain.[34 35] This theory is based on the observation of similar scapular kinematics in patients with shoulder impingement syndrome as individuals with short pectoralis minor muscle length.[5 36–38] Subsequently, they found that shortening of the pectoralis minor muscle could result in a lack of posterior tilting, and therefore, could reduce subacromial space, which potentially results in shoulder pain.[36]

For the measurement of the AT-distance, the patient is supine, and instructed to relax (figure 2). The assessor measures the distance between the posterior border of the acromion and the table bilaterally (measured vertically with a sliding caliper). The assessor can repeat this procedure with the patient actively retracting both shoulders. The data collected during this measurement are adjusted by dividing by the body length, which results in the so-called AT index. The measurement of the AT-distance displayed excellent intraobserver and interobserver reliability in patients with shoulder pain (table 2).[39 40] When comparing the mean values between the symptomatic (72.7 mm relaxed; 48.3 mm retracted) and the asymptomatic side (71.9 mm relaxed; 49.2 mm retracted), no significant difference was found.[39] In an overhead athlete population with shoulder pain more forward shoulder posture was seen: mean AT-distance of 83.6 mm at rest and 53.8 mm during bilateral retraction.[39]

By placing the patient in upright position, a more clinical relevant and realistic view on scapular positioning may be provided. Supine position will reduce scapular protraction and less muscular activity is needed for scapular stability. The measurement of the distance between the posterior border of the acromion and a wall can be performed in standing posture (figure 3). In this position, the assessor measures the distance between the posterior border of the acromion and the wall bilaterally (measured horizontally with a sliding caliper). Struyf *et al*[23] concluded that this measurement (although clinically relevant) did not provide sufficient reliability for clinical use (table 2).

Baylor square and double-square technique

Forward shoulder posture can also be measured using the *Baylor square or double square technique*, described by Peterson *et al*[34] The square consists of a simple carpenter's square having a 24-inch long arm and a 16-inch short arm. During the Baylor square technique, the tester uses this tool to measure (in a sagittal plane) the distance from the anterior tip of the acromion process to the line, perpendicular to the C7 spinous

Figure 2 The measurement of the distance between the posterior border of the acromion and the examining table.

Table 2 Overview of the reliability data of clinical tests for the measurement of scapular positioning

Test	Peterson *et al*[35]	DiVeta *et al*[43]	Gibson *et al*[28]	Nijs *et al*[40]	Odom *et al*[45]	McKenna *et al*[58]	Watson *et al*[46]	Johnson *et al*[47]	Struyf *et al*[25]
Posterior acromion-table (relaxed)				0.88–0.94					
Posterior acromion-table (retracted)				0.92–0.91					
Posterior acromion-wall (relaxed)									0.72
Posterior acromion-wall (retracted)									0.75
Baylor square technique	0.91*								
Double Baylor square technique	0.89*								
Medial scapular border-T4 (relaxed)				0.50–0.79					
Medial scapular border-T4 (retracted)				0.70–0.80					
Medial scapular border-T3	0.91*								
LSST (arms relaxed)				0.82–0.96	0.79	0.65–0.74			
LSST (arms 45° abducted)				0.85–0.95	0.45	0.79–0.82			
LSST (arms 90° abducted)				0.70–0.85	0.57	0.20–0.57			
LSST (arms 90°, 1 kg load)									0.63
LSST (arms end-range abducted)									0.58
Scapular distance		0.94*	0.91–0.92						
Analogue inclinometry							0.81–0.94*		
Digital inclinometry								0.89–0.96*	

*Intraclass correlation coefficients are provided to indicate the interobserver reliability.
LSST, lateral scapular slide test.

process. During the double square, a 12-inch combination square with a second square is used in an inverted position. This device is used to measure the distance from the wall to the anterior tip of the subject's acromion.[34] Reliability data are presented in table 2. Besides excellent reliability, they found a strong correlation between the Baylor square (r=0.77) and a moderate correlation between the double-square method (r=0.65) and radiographic measurements.[34]

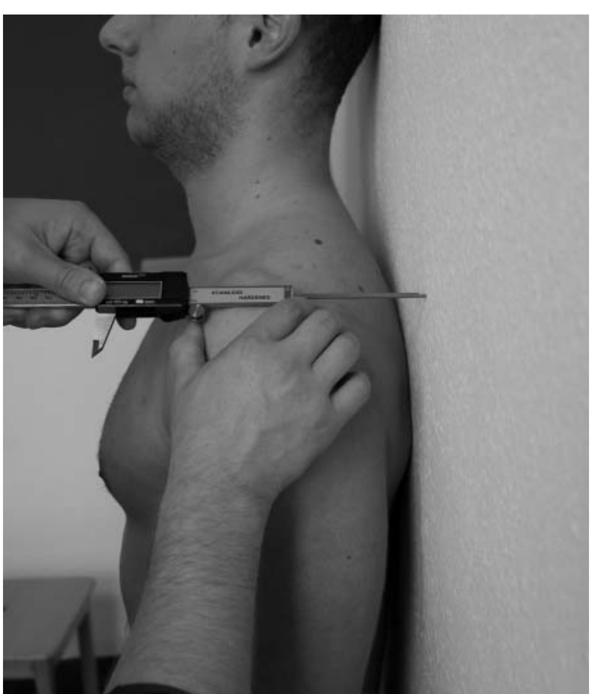

Figure 3 The measurement of the distance between the posterior border of the acromion and the wall in standing.

Although Peterson *et al*[34] could not support the validity of the double square method, this test could be of clinical value if it is 'accurate in detecting changes in a patients' shoulder posture'. In addition, Kluemper *et al*[40] demonstrated that by using the double square method, differences in forward shoulder posture can be detected in young competitive swimmers.

Measurement of the pectoralis minor muscle length

A potential contributing mechanism for forward shoulder posture includes muscle tightness.[10] Another method for measuring forward shoulder posture is the *measurement of the pectoralis minor muscle length*, which is validated by Borstad and Ludewig[36] using human cadavers. Because of height and muscle length variability among subjects, this measurement is best normalised creating a pectoralis minor index (PMI). The PMI is calculated by dividing the resting muscle length measurement by the subject height and multiplying by 100.[36] The resting muscle length is measured between the caudal edge of the 4th rib to the inferomedial aspect of the coracoid process with a measuring tape or sliding caliper (figure 4). PMI is suggested to reflect a shortened pectoralis minor when 7.65 or lower.[36]

Distance from the medial scapular border to the 4th thoracic spinous process

The measurement *of the distance from the medial scapular border to the fourth thoracic spinous processes* was also first described by Host.[33] The test is performed while standing. Both the fourth thoracic spinous process (T4) and the medial scapular border are identified through palpation. Palpation of T4 was performed by counting down from the 7th cervical spinous process (C7). Palpation of the C7 has demonstrated acceptable inter-rater reliability.[41] The distance between both anatomical landmarks is measured in the horizontal plane using a tape measure. Again, this procedure is repeated with the patient actively retracting both shoulders. Together with the initial description of the test, Host[33] provided a guideline for the interpretation of

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Figure 4 Measurement of the pectoralis minor muscle length.

the tests' outcome: in normal subjects, the distance from the medial scapular border to T4 should be 5.08 cm. However, the guideline was based on clinical observations rather than on experimental data. Nijs *et al*[39] found mean values of 6.15±2.07 (symptomatic side) and 6.00±1.62 cm (asymptomatic side). The interobserver reliability for the test was to low (the ICCs varied between 0.50 and 0.79) when performed with the patient relaxed (table 2). A fair interobserver reliability was found (ICCs between 0.70 and 0.80) for the evaluation of the distance from the medial scapular border to T4 with active bilateral shoulder retraction. Others measured the distance from the medial scapular border to the third (and not the fourth) thoracic spinous processes: evidence supportive of the intraobserver reliability (ICC=0.91) and criterion validity (the clinical tests' outcome correlated with the measurement performed on a radiography: r=0.57) has been provided (table 2).[34]

Scapular distance measurement

Finally, *the scapular distance* (distance between the acromial angle and third thoracic spinous process) is another test for the assessment of resting scapular positioning. The distance is normalised by dividing it by the scapular length (ie, the distance between the scapular spine, localised at the medial margin and the acromial angle).[42] The measurement of both the scapular distance and the scapular length have been shown to have good to excellent intraobserver and interobserver reliability in asymptomatic subjects (table 2).[42]

MEASUREMENT OF SCAPULAR POSITIONING AT DIFFERENT DEGREES OF SHOULDER ELEVATION

Lateral scapular slide test

The lateral scapular slide test (LSST) was designed by Kibler[43] to assess scapular asymmetry under varying loads. In order to maintain a consistent posture during the various test positions, subjects are instructed to fix their eyes on an object in the examination area.[44] For the first test position of the LSST, the patient is instructed to keep the arms relaxed by their sides. The distance between the inferior-most aspect of the inferior angle of the scapula and the closest spinous process in the same horizontal plane are measured bilaterally with a tape measure. This procedure is repeated for test position 2 (the patient is instructed to actively place both hands on the ipsilateral hips, and consequently the humerus is positioned in medial rotation at ±45° of abduction in the coronal plane) and test position 3 (the patient is instructed to actively extend both elbows, elevate and maximally internally rotate – thumbs down – both arms at or below 90° in the coronal plane). Between test positions 2 and 3, the patient is instructed to reposition the upper extremities from the test position to neutral. For interpreting the LSST, a side-to-side difference of 1.5 cm was originally suggested for the diagnosis of shoulder dysfunction.[43] Experimental data, however, indicated that a side-to-side difference of 1.5 cm is frequently observed in asymptomatic subjects, and that the threshold value of 1.5 cm has a low specificity in diagnosing shoulder dysfunctions.[44] In addition, the outcome of the LSST was unable to differentiate between the symptomatic and asymptomatic side.[39] Although the mean values for all three test positions were larger in the symptomatic side compared to the asymptomatic side, no statistically significant differences were observed. For all three tests positions we observed an acceptable to good interobserver reliability (ICCs>0.70). Table 2 shows the reliability data for all positions of the LSST.

In line with the notion that the muscular system is the major contributor of scapular mobility and stability, adding extra load could influence functional muscular activity and thus scapular positioning. Therefore, a modified LSST was designed, measuring two positions: 90° abduction in the frontal plane with 1 kg load, and 180° humeral abduction in the frontal plane. However, Struyf *et al*[23] concluded that these positions cannot be reliably used in clinical practice (table 2).

Measurement of scapular upward rotation

The *measurement of scapular upward rotation* (figure 5) can be performed by using two Plurimeter-V gravity references inclinometers.[45] The relative contribution of the glenohumeral joint and the scapula to total shoulder abduction within the coronal plane is assessed. One inclinometer is velcro taped perpendicular to the humeral shaft, just above the humeral epicondyle. The resting position of the humerus is recorded. Next, the

Figure 5 Measurement of scapular upward rotation by means of two inclinometers.

patient is instructed to perform shoulder abduction with full elbow extension, neutral wrist flexion/extension and with the thumb leading to ensure vertical alignment of the inclinometer. The patient is asked to stop at 45°, 90°, 135° and at their maximum achievable range. At each of the abduction positions, the scapular upward rotation is measured with a second inclinometer, manually aligned along the scapular spine. The overall intrarater reliability is very good (ICC=0.88), and ranges from 0.81 to 0.94 across different testing positions (table 2).[45]

A similar test by the use of a Pro 3600 digital protractor inclinometer, modified using two wooden locator rods, has been described previously for the clinical assessment of scapula upward rotation in patients with shoulder pain.[46] The two-dimensional measurements of scapula upward rotation demonstrated good to excellent intrarater reliability (ICCs varied from 0.89 to 0.96) and good validity in comparison with a magnetic tracking device (r varied from 0.59 to 0.92) (table 2).[46]

MEASUREMENT OF SCAPULAR MUSCLE STRENGTH

A hand-held dynamometer (HHD) has been suggested for clinical and research use because of its acceptable reliability and validity in the assessment of upper extremity muscle strength.[47–49] The middle and lower Trapezius muscle fibres can be tested by placing the patient in prone position. The patients are then asked to perform a horizontal abduction with external rotation. For differentiation between the middle and lower fibres, the patients' shoulder is abducted to 90° or 145°, respectively. Pressure is applied at the wrist of the subject, at the lateral aspect of the radius.[50] The upper Trapezius muscle fibres can be tested as described by Hislop *et al*.[51] The HHD is placed over the acromion. While the patient has to perform scapular elevation, the assessor applies a force directly downward in the direction of scapular depression. Finally, Kendall *et al*[52] recommended to test the Serratus anterior muscle strength by placing the patient supine, with the arm in 90° of forward flexion. While the patient has to perform a protraction movement (with the elbow extended), the assessor pushes the HHD through the palm of the hand towards the examining table.

In a recent study in adolescent tennis players, muscle balance ratios in the scapular muscles were calculated.[53] To our knowledge, this is the first study to add balance ratios to the data on isometric measurements within one player.[53]

MEASUREMENT OF SCAPULAR DYNAMIC CONTROL

Scapular clinical assessment not only addresses the position of the scapula or muscle strength but also addresses the control of the scapula during humeral movement. The medial rotation test (MRT—figure 6) has been described as an assessment tool for scapular dynamic control during medial (internal) glenohumeral rotation.[54] The participant is supine and with the humerus abducted to 90°, elbow flexed to 90° (with hand to the ceiling) and the humerus in the plane of the scapula. The scapula and glenohumeral joint are positioned in the neutral position. The participant is asked to perform 60° of internal rotation at the glenohumeral joint while keeping the scapula and glenohumeral joint in its neutral position. This test is scored positive when scapular forward tilt, downward rotation or elevation is observed. In non-painful shoulders, it is suggested that during active glenohumeral internal rotation to 60°, the scapula does not translate more than 16 mm.[55] Manual landmark identification can be tracked accurately by palpation.[55] This study supports the palpation strategy used during the MRT. Reliability and validity data on the MRT are currently lacking.

Figure 6 Evaluation of scapular motor control (medial rotation test).

SCAPULAR POSITIONING AND ITS RELATION TO SYMPTOMS

Scapular retraction/repositioning test

The scapular retraction/repositioning test (SRT, figure 7) has been described by Tate *et al*[56] If a positive impingement test is identified, it can then be repeated with the scapula manually repositioned using the SRT. The SRT is performed by grasping the scapula with the fingers contacting the acromioclavicular joint anteriorly and the palm and thenar eminence contacting the spine of the scapula posteriorly, with the forearm obliquely angled towards the inferior angle of the scapula for additional support on the medial border. In this manner, the examiner's hand and forearm applies a moderate force to the scapula to encourage scapular retraction (scapular retraction test) or posterior tilting and external rotation (scapular repositioning test),

Figure 7 The scapular repositioning test during the empty can position.

and to approximate the scapula to a mid-position on the thorax. The scapular repositioning test has demonstrated reliability and while performing this test, it has been shown that subjects are capable of demonstrating increased rotator cuff strength and report less pain by providing a stable base.[56 57]

(Modified) Scapular Assistant Test

During the modified scapular assistant test (m-SAT—figure 8), the examiner manually assists correct scapular movement during active elevation of the arm. Reduction of pain during this movement compared with non-assistance confirms scapular involvement in the shoulder complaints (=positive test). The m-SAT possesses acceptable inter-rater reliability for clinical use (k=0.53–0.62).[58]

DISCUSSION

In contrast to highly standardised and controlled laboratory settings, the use of clinical techniques are subject to the weakness of its user. For example, HHD is dependent on the assessors' strength to maintain a certain test position. In addition, several clinical methods assume that the thorax is a rigid segment, while motion of the ribs relative to the sternum may create small errors. Still, clinicians can use visual observation of scapular dyskinesis in a reliable and valid manner. In addition, for the measurement of static and dynamic scapular positioning, the measurement of the distance between the posterior border of the acromion and the table, the Baylor square technique, the measurement of the distance from the medial scapular border to T4 or T3, the LSST, analogue and digital inclinometry and the assessment of the 'scapular distance' have been identified as reliable tests. Some clinical tests lack sufficient reliability, such as the measurement of the distance between the posterior border of the acromion and the wall, the modified LSST, and the double-square technique. The measurement of the pectoralis minor muscle length has proven sufficient reliability in human cadavers, but in vivo measurements are still lacking here. In addition, both validity and reliability of the MRT still needs to be addressed.

The SAT and SRT are a unique possibility to register a direct connection between the patients' symptoms and his/her scapular static or dynamic properties. Therapists can reliably use these tests to support the Trapezius-Serratus Anterior force couple during retraining. Reliability of the SRT was suggested to be sufficient.[56] However, validity of the SRT still need to be reported before any conclusions can be made. These tests are important when addressing a symptomatic population. Asymmetry appeared to be common in both the symptomatic and asymptomatic population,[30] which raises the question whether altered scapular motion needs to be treated. However, Uhl *et al*[30] suggested that due to the yes/no method's sensitivity, a 'no' score regarding asymmetry is helpful in ruling out dyskinesis as a contributing factor to shoulder pain. A 'yes' score in a symptomatic shoulder would assist in selection treatment strategies.

There are studies supporting the validity of visual observation of scapular dyskinesis,[25 30] the assessment of the distance from the medial scapular border to the third thoracic spinous processes,[34] the measurement of the pectoralis minor muscle length,[36] and digital inclinometry.[46] It should be noted that assessment of scapular positioning should be used in conjunction with objective measurements of scapular muscle performance and body structure. This implicates that altered activity of scapular muscles prohibits normal scapular positioning.[5 47] The measurement of the scapular distance, pectoralis minor index and acromial distance index emphasises on relating anthropometric data to the clinical tests. The patients' body structure is clearly an influencing factor on normative data, which makes comparisons among studies with different patient populations difficult. Further studying of the clinimetric properties of the tests is warranted, especially for establishing normative data, for examining the validity, responsiveness to change and clinical importance. Still, clinicians can use the tests to monitor treatment progress.

Figure 8 The scapular assistant test.

CONCLUSION

On the basis of its clinical relevance, its proven reliability, its relation to body length and its applicability in a clinical setting, this review recommends to assess the scapula both static (visual observation and acromial distance or Baylor/double-square method for shoulder protraction) and semidynamic (visual observation and inclinometry for scapular upward rotation). In addition, when the patient demonstrates with shoulder impingement symptoms, the scapular repositioning test and scapular assistant test are recommended for relating the patients' symptoms to the position or movement of the scapula.

What is already known on this topic

- Several methods for the assessment of scapular positioning are described in the scientific literature. However, the majority uses expensive and specialised equipment (laboratory methods), making their use in clinical practice nearly impossible.

What this study adds

- This literature overview offers clinicians and therapists recommendations for a reliably and valid clinical evaluation of the scapulothoracic joint, and provides tests for scapular muscle strength assessment and tests for relating the patients' symptoms to scapular movement.

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Competing interests We certify that no party having a direct interest in the results of the research supporting this article has or will confer a benefit on us or on any organisation with which we are associated.

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