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Research Article

Interrater Reliability of the Clinical Examination of Muscular Scapular Stabilisation

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Abstract

The objective of this study was the assessment of the interrater reliability of four tests of the resting scapula and five tests of muscular stabilisation of the scapula with a total of 65 subjects without using any quantitative measuring devices.

A visual and palpatory examination of the resting scapula was made with regard to observation features such as acromion level in relation to the angulus superior, scapular winging, the shape of the margo medialis and the scapular tilt. The trapezius as a whole, the trapezius ascendens and serratus anterior muscles were tested with manual resistance for their scapular stabilisation capacity. The trapezius descendens was tested for active sufficiency.

Introduction

Optimal functioning of the scapula is considered a key factor for good performance of the arm in sport and everyday life. Altered scapular kinematics and scapular rest positions are frequently detected in diagnoses such as shoulder impingements, tendinopathies or ruptures of the rotator cuff, shoulder instabilities, superior labral tears and frozen shoulders [1-5]. However, a connection between scapular dyskinesis and shoulder pathologies currently remains unclear. Scapular dyskinesis can be both the reason for but also the result of, or a contributing factor to shoulder pathology [6]. It becomes apparent, however, that an exercise programme focused on the scapula improves its function and reduces symptoms for people with a subacromial impingement [7-12]. This also appears to apply to athletes who suffer from shoulder pain with various underlying pathologies [13]. An increasing number of scientific papers shows a connection between neck pain and scapular dyskinesis as well as neck pain and a changed activity of the scapular muscles [14-20].

The clinical examination of the scapula generally includes three main elements

- The visual and palpatory examination of the scapula at rest and in motion.
- The influence of a manual correction of the scapular dysfunction on the symptoms based on tests as for example the Scapular Reposition Test [21,22] or the Scapular Assistance Test [23,24].
- The examination of surrounding anatomical structures that could be responsible for scapular dyskinesis (e.g., muscular performance or muscle length tests, examinations of neurology or the scapulothoracic joint).

Causes of scapular dyskinesis are multifactorial and manifold [6]. Muscular weakness or a lack of inter- and intramuscular coordination of the scapular muscles, however, is regarded as one of the most important factors that have an influence on scapular dyskinesis [25-30]. Reversely, it is also assumed that an altered scapular position has a negative effect on the muscle functions, which again favours injuries [3,27,31-34]. The serratus anterior muscle and the trapezius as primary upward rotators of the scapula have a special role in the shoulder elevation process. A weakness or changed timing of these muscles was detected in cases of shoulder and neck pain [17,25,27,34-36].

The examination of the scapula is a great challenge in clinical practice. The three-dimensional motion patterns of the scapula, the surrounding soft tissue and the small levers complicate an observation and measuring of the bony points of contact. However, to recognize scapular dyskinesis and to specifically train a changed muscle function, physiotherapists need tests that can identify a dysfunction. Even though the reliability of muscle function examinations of the shoulder using a dynamometer (a quantitative measurement of pressure or traction) produces better results [37], manual muscular performance tests are used widely in clinical practice. They can be quickly and easily performed and do not require any technical equipment. The intratester reliability of strength tests of the scapular muscles with a handheld dynamometer was repeatedly assessed and delivered good to excellent data [26,38,39]. However, there are hardly any interrater reliability studies on manual muscular performance tests of the scapular muscles without quantitative measuring devices. To date, there is no reliable series of tests that allows an examination of the resting scapula and muscular stabilisation of the scapula without technical devices.

The purpose of this study was an assessment of the interrater reliability of visual and palpatory examinations of the resting scapula and muscular stabilisation of the scapula of patients with shoulder symptoms, patients with neck pain and subjects with neither shoulder nor neck pain.

Method

Study design

An interrater reliability study was carried out. Two experienced physiotherapists successively assessed the interrater reliability of four scapula position and five scapular stabilisation tests with 65 subjects. The study was ethically justified by the Cantonal Ethics Committee Zurich.

Test protocol

Recruitment was carried out at Medbase Sports Medical Center Zurich, a sports medicine competence centre in Zurich, Switzerland. Among the 65 subjects were 18 with shoulder pain, 18 who suffered from neck pain and 29 without any complaints of the upper extremities. At the time of recruitment, the participants were either in physiotherapeutic treatment at the centre or had been summoned by the examiners. Examinations were carried out on seven test days between September and November 2013. On the test days, treating physiotherapists referred those patients to the examiners who seemed qualified according to an assessment of inclusion and exclusion criteria. Inclusion criteria were shoulder mobility of at least 140° elevation and the ability to stay in a prone position. Exclusion criteria were shoulder mobility of less than 140°, instability of the shoulder complex caused by fractures, torn ligaments or torn tendons as well as acute cervical radiculopathies, severe osteoporosis, central nervous system disorders and generalised pain syndromes. The procedure is graphically displayed in figure 1.

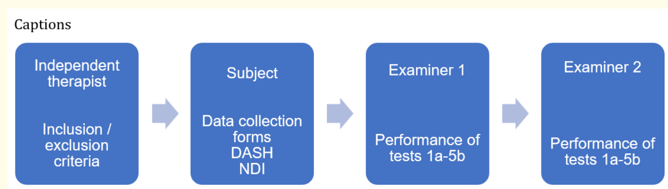

Figure 1: Procedure.

The study was explained verbally and in writing to the participants and each signed a written declaration of consent. Participation was voluntary and the subjects were allowed to quit at any time. Each subject drew an anonymous participation number from a sealed envelope and was assigned to his/her first examiner by rolling a die. Randomisation of the sequence of the scapula tests was guaranteed by drawing a random schedule. The examiner was neither aware of the subject's diagnosis and actual symptoms nor of the other examiner's test results. The tests were carried out one by one by the examiners without interruption between the test runs. An examination of the nine tests lasted about ten minutes per examiner. The examiners were two certified physiotherapists. Both had more than ten years of professional experience and were manual therapy specialists. Three practise and coordination meetings were held prior to the implementation and assessment of the tests. Following the examination, each subject completed a data collection form and the Neck Disability Index (NDI) and Disabilities of the Arm, Shoulder and Hand (DASH) questionnaires.

Examination

The examination consisted of nine different tests: four scapular position tests and five tests of scapular stabilisation. The criteria for the scapular rest position assessed in this study were features that are often described in literature. Downward rotation of the scapula is considered as one of the most common scapular malpositions. A correct position of the scapula requires the acromion to be positioned less cranially in relation to the angulus superior [40]. Winging (protrusion of the margo medialis, outward and backward from the thorax) is often associated with a weakness of the serratus anterior muscle [41]. A flat thoracic spine, kyphosis or scoliosis could be further reasons. The margo medialis is almost parallel to the spine and located 8-9 cm from the spinous processes of the thoracic spine [42]. Tilting (anteriorly tilted position, protruding of the angulus inferior) is often the result of a tight pectoralis minor or a biceps brachi caput breve [40].

The muscles tested in this study were the trapezius and serratus anterior muscles. Test positions were chosen based on earlier examinations. [43] assessed different variations of test positions for the trapezius ascendens and recommended the prone position with arms in extension and outward rotation. This position produced the highest EMG amplitude and at the same time excluded data of the trapezius descendens. To do justice to the function of the trapezius as a stabiliser and upward rotator of the scapula as one unit, [38] developed a new muscular performance test at 110° abduction. In their study, the test showed high intratester reliability and validity. A method was selected for the serratus anterior that not only gives resistance against arm elevation but also resistance against the protraction of the scapula. The Shoulder Shrug Test examined the difference of the extent of the shoulder girdle movement when arms are in a neutral position compared to the extent when arms are elevated. It is therefore not an actual muscular performance test but a test for active sufficiency and motion control of the trapezius descendens.

All tests were rated according to three categories: negative, moderate or positive. The statistics are listed in the appendix. The following tests were rated

- **Test 1a:** Acromion Level in Relation to the Angulus Superior
- **Test 1b:** Scapular Winging
- **Test 1c:** The Shape of the Margo Medialis in Relation to the Spine
- **Test 1d:** Scapular Tilt
- **Test 2:** Scapular Stabilisation Test at 130° Flexion Against Resistance
- **Test 3:** Scapular Stabilisation Test at 110° Abduction Against Resistance
- **Test 4:** Scapular Stabilisation Test in Glenohumeral Extension and Lateral Rotation Against Resistance
- **Test 5a:** Shoulder Shrug Test in a Neutral Position
- **Test 5b:** Shoulder Shrug Test with an Elevation of 140°

Test 1a: Scapular rest position

The subject stood upright, the examiner stood behind the subject and made a visual and palpatory examination of both scapular positions regarding the level of the acromial angle in relation to the angulus superior.

Test 1b: Scapular winging

The subject stood upright, the examiner stood behind the subject and made a visual and palpatory examination of both scapula positions regarding scapular winging.

Test 1c: The shape of the Margo medialis in relation to the spine

The subject stood upright, the examiner stood behind the subject and made a visual and palpatory examination of both scapula positions regarding the shape of the margo medialis in relation to the spinous processes.

Test 1d: Scapular tilt

The subject stood upright, the examiner stood behind the subject and made a visual and palpatory examination of the scapular tilt.

Test 2: Scapular stabilisation test at 130° flexion against resistance; dominant serratus anterior (Figure 2)

Figure 2: Test 2: Scapular Stabilisation Test at 130° Flexion Against Resistance (Dominant Serratus Anterior).

The subject sat upright, the upper arm at 130° flexion, the lower arm in a neutral position. The examiner stood next to the subject. The closer hand was placed laterally at the angulus inferior to register any scapular movements. The other hand provided resistance at the subject's fist in axial direction of the arm and at the same time towards the ground. The subject had to hold this position for 10 seconds against maximum resistance.

Test 3: Scapular stabilisation test at 110° abduction against resistance; dominant trapezius (Figure 3)

Figure 3: Test 3: Scapular Stabilisation Test at 110° Abduction Against Resistance (Dominant Trapezius).

The subject sat upright, the arm was at 110° abduction, palm facing down. The examiner stood next to the subject and placed the closer hand laterally at the angulus inferior to register any scapular movements. The other hand was placed on the forearm. The examiner provided resistance at the scapula towards the downward rotation and at the forearm towards the ground. The subject had to hold this position for 10 seconds against maximum resistance.

Test 4: Scapular stabilisation test in glenohumeral extension and lateral rotation against resistance; dominant trapezius ascendens (Figure 4)

Figure 4: Test 4: Scapular Stabilisation Test in Glenohumeral Extension and Lateral Rotation Against Resistance (Dominant Trapezius Ascendens).

The subject was in a prone position, both arms positioned alongside the body, fingers pointing to the toes. The examiner stood next to the treatment table at the level of the subject's pelvis. Both hands were positioned laterally and caudally at the angulus inferior. The examiner moved the subject's scapula into the required position (retraction, adduction, slight upwards rotation). The subject lifted his/her arms in extension and outward rotation off the treatment table. The examiner provided resistance at both anguli inferiores in direction of the downward rotation and cranialisation. The subject had to hold this position for 10 seconds against maximum resistance.

Test 5a: Motion control shoulder shrug test in a neutral position; dominant trapezius descendens (Figures 5 and 6)

The subject stood upright with his/her arms in a neutral position. The examiner stood behind the subject, who had to lift both scapulae to a maximum (towards the ears). The examiner then estimated the height of the shoulder girdle elevation.

Figure 5: Test 5a: Initial Position - Motion Control Shoulder Shrug Test in Neutral Position (Dominant Trapezius Descendens).

Figure 6: Test 5a: Final Position - Motion Control Shoulder Shrug Test in Neutral Position (Dominant Trapezius Descendens).

Figure 7: Test 5b: Initial Position - Motion Control Shoulder Shrug Test, Arm Elevation (Dominant Trapezius Descendens).

Figure 8: Test 5b: Final Position - Motion Control Shoulder Shrug Test, Arm Elevation (Dominant Trapezius Descendens).

Test 5b: Motion control shoulder shrug test with arm elevation; dominant trapezius descendens (Figures 7 and 8)

The subject stood upright; his/her arms were at 140° flexion. The examiner stood behind the subject, who had to lift both scapulae to a maximum (towards the ears). The examiner then estimated the height of the shoulder girdle elevation.

Statistical analysis

All statistical analyses were carried out using the R program (R version 3.0.2; The R Foundation for Statistical Computing). Average and standard deviation were calculated for all demographic data and maximal and minimal figures were specified. The interrater reliability of the scapular position tests and the scapular stabilisation tests were measured using the weighted Kappa statistic [44]. The reliability of all tests for all groups was calculated (wKappa overall), as well as the wKappa per test of the shoulder group, the neck group and the control group. Additionally, the 95% confidence interval and the respective percentage agreement were calculated. The weighted Kappa is a statistical measure for interrater reliability. Reliability specifies the measurement error in relation to the heterogeneity of the random sample. It has therefore two aspects: the precision of the measurement and the differentiability of the subjects. The formula for the weighted Kappa is as follows

Po is the relative observed agreement of the two examiners and *Pe* is the hypothetical probability of chance agreement. If the examiners' results coincide, = 1. If = 0, the agreement is in accordance with what would be expected by chance. A negative value implies that the agreement is worse than random. The reliability values listed below were proposed by Landis and Koch [45]: < 0 = *Poor*, 0 - 0.20 = *Slight*, 0.21 - 0.40 = *Fair*, 0.41 - 0.60 = *Moderate*, 0.61 - 0.80 = *Substantial*, 0.81 - 1.00 = *Almost Perfect*.

Results

All demographic data of the subjects are listed in table 1. The Scapular Tilt (Test 1d) was the most reliable among the scapular rest position tests for the shoulder group and showed a wKappa coefficient of 0.65 (left) and 0.64 (right). The Shoulder Shrug Test (Test 5b) was the most reliable test for the right-hand side among the scapular stabilisation tests with an almost perfect wKappa coefficient of 1. The same test, however, showed a wKappa coefficient of 0.49 on the left, which put the conclusion of this test into perspective. All other tests showed *poor* to *fair* agreement. The results of the interrater reliability of all tests for all subjects are presented in table 2. Interrater reliability of the single groups is listed in table 3.

	Shoulder patients	Neck patients	Control group	Total
Number	18	18	29	65
Gender: female/male	8/10	12/6	18/11	38/27
Age (years): mean[a] +/-SD[b] (min[c]-max[d])	39.72 +/-13.80 (17-73)	39.39 +/-12.42 (22-70)	36.17 +/-15.08 (16-71)	38.05 +/-13.93 (16-73)
Height (cm): mean[a] +/-SD[b] (min[c]-max[d])	174.1 +/-9.18 (157-192)	166.8 +/-8.91 (158-180)	172.3 +/-8.03 (158-187)	171.31 +/-8.95 (157-192)
Weight (kg): mean[a] +/-SD[b] (min[c]-max[d])	73.67 +/-12.60 (52-100)	62.33 +/-12.41 (42-92)	66.21 +/-11.33 (48-87)	67.2 +/-12.58 (42-100)
Dominant hand: right/left	15/3	16/2	26/3	57/8
Tested shoulder side: right/left	7/11	18/18	29/29	54/58
Shoulder pain: none/right/left/both	0/7/11/0	5/5/4/4	28/1/0/0	33/13/15/4
Duration of shoulder pain (weeks): mean[a] +/-SD[b] (min[c]-max[d])	245.3 +/-282.54 (2-1040)	204.6 +/-254.67 (0-728)	0 +/-0 (0-0)	124.6 +/-226.64 (0-1040)
Neck pain: yes/no	5/13	18/0	1/28	23/42
Duration of neck pain (weeks): mean[a] +/-SD[b] (min[c]-max[d])	139.3 +/-314.24 (0-1040)	255.7 +/-282.93 (1-1040)	0 +/-0 (0-0)	109.4 +/-243.29 (0-1040)
NDI[e] in per cent: mean[a] +/-SD[b] (min[c]-max[d])	8.556 +/-5.81 (0-20)	16.44 +/-10.79 (4-38)	3.655 +/-4.41 (0-14)	8.55 +/-8.76 (0-38)
DASH[f] in per cent: mean[a] +/-SD[b] (min[c]-max[d])	14.61 +/-15.59 (0-54)	7.222 +/-9.85 (0-33)	2 +/-2.92 (0-10)	6.94 +/-10.97 (0-54)

Table 1: Demographic Data of Subjects.

Note: a) mean: Arithmetical Mean Value, b) SD: Standard Deviation, c) min: Minimum, d) max: Maximum, e) NDI: Neck Disability Index, f) DASH: Disabilities of Arm, Shoulder and Hand

Test		w[a] of all subjects	CI 95%[b]	Match %
1a Right:	Level Angulus Superior vs. Level Acromion	0.29	0.13 - 0.45	24
1a Left:	Level Angulus Superior vs. Level Acromion	0.20	0.03 - 0.37	24
1b Right:	Scapular Winging	0.27	-0.01 - 0.56	64
1b Left:	Scapular Winging	0.45	0.22 - 0.68	65
1c Right:	Shape of Margo Medialis	0.33	0.10 - 0.56	46
1c Left:	Shape of Margo Medialis	0.28	0.07 - 0.50	41
1d Right:	Scapular Tilt	0.53	0.32 - 0.73	55
1d Left:	Scapular Tilt	0.47	0.24 - 0.69	56
2 Right:	Scapular Stabilisation Test Serratus Anterior	0.11	-0.15 - 0.37	50
2 Left:	Scapular Stabilisation Test Serratus Anterior	0.07	-0.17 - 0.30	44
3 Right:	Scapular Stabilisation Test Trapezius	0.29	0.02 - 0.55	55
3 Left:	Scapular Stabilisation Test Trapezius	0.27	0.08 - 0.45	41
4 Right:	Scapular Stabilisation Test Trapezius Ascendens	0.27	0.05 - 0.48	50
4 Left:	Scapular Stabilisation Test Trapezius Ascendens	0.28	0.06 - 0.50	62
5a Right:	Shoulder Shrug Test, Arms Hanging	0.39	0.16 - 0.62	64
5a Left:	Shoulder Shrug Test, Arms Hanging	0.11	-0.14 - 0.36	53
5b Right:	Shoulder Shrug Test, Maximum Elevation of Arms	0.36	0.15 - 0.57	61
5b Left:	Shoulder Shrug Test, Maximum Elevation of Arms	0.35	0.14 - 0.55	60

Table 2: Interrater Reliability of all Subjects.

Note: a) wk: Weighted Kappa; b) CI 95% = 95% Confidence Interval.

	Shoulder group		Neck group			Control group			
Test	w[a]	CI 95%[b]	Match %[c]	w[a]	CI 95%[b]	Match %[c]	w[a]	CI 95%[b]	Match %[c]
1a r[d]	0.37	0.15-0.58	27	-9.1	0	0	0.33	0.08-0.59	27
1a l[d]	0.20	0.03-0.37	17	-0.18	-0.61-0.26	27	0.44	0.81-0.71	33
1b r[e]	0.34	0.03-0.66	62	0	0	85	0.23	-0.36-0.81	61
1b l[e]	0.54	0.32-0.75	68	0.49	0.04-0.94	72	0.34	-0.1-0.77	55
1c r[f]	0.22	-0.09-0.53	41	0.46	-0.27-1.2	71	0.45	0.10-0.80	44
1c l[f]	0.28	0.01-0.54	34	-0.02	-0.59-0.54	36	0.49	0.15-0.84	55
1d r[g]	0.64	0.40-0.87	62	0	-0.66-0.66	28	0.57	0.25-0.90	55
1d l[g]	0.65	0.41-0.89	65	0.12	-0.43-0.67	63	0.09	-0.31-0.50	38
2 r[h]	-0.07	-0.43-0.29	51	0.44	0.14-0.74	42	0.05	-0.34-0.44	50
2 l[h]	0.16	-0.12-0.44	51	0.14	-0.29-0.58	27	-0.18	-0.58-0.22	44
3 r[i]	0.30	-0.07-0.67	62	0.36	-0.08-0.81	42	0.25	-0.18-0.68	50
3 l[i]	0.34	0.09-0.59	44	0.57	0.29-0.85	54	-0.03	-0.38-0.32	27
4 r[k]	0.20	-0.14-0.54	55	0.15	0.25-0.54	71	0.30	0.06-0.55	33
4 l[k]	0.35	0.04-0.66	65	-0.04	-0.61-0.53	54	0.29	-0.04-0.61	61
5a r[l]	0.30	-0.04-0.64	62	0.43	0.02-0.84	57	0.54	0.22-0.86	72
5a l[l]	0.04	-0.29-0.36	51	-0.42	-0.94-0.11	27	0.54	0.22-0.86	72
5b r[m]	0.39	0.09-0.69	65	1.00	1.00	100	0.20	-0.15-0.54	38
5b l[m]	0.33	0.02-0.64	62	0.49	0.06-0.92	72	0.26	-0.08-0.60	50

Table 3: Interrater Reliability of Shoulder, Neck and Control Group.

Note: a) wκ: weighted Kappa, b) CI 95% = 95% confidence interval, c) match % = match in per cent, d) 1a right and left: Level Angulus Superior vs. Level Acromion, e) 1b right and left: Scapular Winging, f) 1c right and left: Shape Margo Medialis, g) 1d right and left: Scapular Tilt, h) 2 right and left: Scapular Stabilisation Test for Serratus Anterior, i) 3 right and left: Scapular Stabilisation Test of Trapezius, k) 4 right and left: Scapular Stabilisation Test of Trapezius Ascendens, l) 5a right and left: Shoulder Shrug Test, Arms Hanging, m) 5b right and left: Shoulder Shrug Test, Maximum Elevation of Arms.

Discussion

The objective of this study was the assessment of the interrater reliability for four tests of the scapular rest position and five tests of muscular stabilisation of the scapula with 65 subjects without any quantitative measuring devices.

The scapular tilt (Test 1d) was the most reliable observation feature among the scapular rest position tests with a wKappa coefficient of 0.65 (left) and 0.64 (right) for the shoulder group. The criteria acromion level in relation to the angulus superior (Test 1a), scapular winging (Test 1b) and the shape of the margo medialis in relation to the spine (Test 1c) showed slight to moderate reliability results. The most reliable test among the scapular stabilisation tests was the Shoulder Shrug Test (Right) With Arm Elevation (Test 5b) for the neck group, which indicated an excellent wKappa coefficient of 1.0. However, the same test delivered a wKappa coefficient of 0.49 (left), which nevertheless put the information from this test into perspective. All other assessed tests presented even poorer reliability. No test proved sufficient reliability that would justify its use in clinical practice.

Poor reliability can have two sources of error: On the one hand, it could be that the examiners did not test reliably enough (measurement error), on the other hand, it could be that the random samples are highly homogeneous.

To optimise the reliability of the examiners, assessment criteria were defined in detail and the implementation and assessment of the tests were standardized during three meetings with volunteers. Additionally, the examiners were two physiotherapists with many years of professional experience. Nevertheless, it is possible that the examiners did not practice administering the tests enough or that the implementation of the tests was not coordinated carefully enough. Heterogeneity of the subjects was probably guaranteed by the range of symptoms and a large variety in age, profession and leisure activities.

The bony reference points of the scapula are difficult to palpate and hard to see due to a lot of surrounding soft tissue, which might have been a reason for the unreliable evaluation of the visual and palpatory examination of the scapular rest position. As the authors do not know of another study that has similarly assessed the reliability of the scapular rest position, the results could not be compared. Warner, J.J., *et al*. [46] discovered that anomalies of the scapula are better recognizable in dynamic movements compared to a static examination. [47] proposed that mild scapular dysfunctions may be better recognized in eccentric compared to concentric movements. Assessments of the interrater reliability of scapular dyskinesis patterns in flexion, scaption or abduction only showed slight to moderate reliability values [48-52]. Various studies indicate a large individual variability of the scapula position at rest and in motion and even healthy people often show side differences [52,53]. At the same time, the percentage of people with a changed scapular rest position or a changed scapular motion pattern seems to be about the same for people with or without shoulder pain [11,52]. Furthermore, Tate, A.R., *et al*. [21] discovered that a changed scapular motion pattern does not significantly correlate with shoulder pain. [6] thus claimed that scapular dyskinesis should only be treated if it can be linked to an injury or pain in the shoulder complex. Due to these results, the examination of the scapular rest position must be critically evaluated.

Reasons for the poor weighted Kappa values of the three shoulder stabilisation tests and the shoulder shrug tests seemed to be, in particular, the fact that it was nearly impossible for the examiners to put manual resistance and feel the movement of the scapula and the humerus at the same time. A simplification of the assessment categories into only two categories (positive-negative) instead of three categories (positive-moderate-negative) as used by the authors might have led to better results. [54] however, assessed the interrater reliability of manual scapular muscle tests based on only two categories and did not produce any better data other than that of the serratus anterior on the left (w 0.77). In contrast to our results, functional tests of the scapular muscles with a handheld dynamometer registered much better interrater reliability data [26].

Due to the results of the study on hand, the clinical examination of the scapula must be critically reassessed. However, without any clinically practicable and reliable tests for the determination of a scapular dyskinesis, we face a dilemma. On the one hand, the great benefit of training focused on the scapula for patients with shoulder pain is well-known [7-10,12,13,55] and, on the other hand, there are no reliable manual, and thus inexpensive tests available that could identify any scapular control dysfunctions. The use of technical devices, such as the handheld dynamometer for muscular performance tests, for example, seems to be necessary to obtain reliable results.

Future research should focus on the search for reliable and valid tests for muscular scapular stabilisation to close the knowledge gap between examination and treatment of scapular dysfunction.

Conclusion

Except for the Shoulder Shrug Test on the left with a wKappa of 1.0 and the Scapular Tilt Test with a wKappa of 0.65 (right) and 0.64 (left), the assessed tests of the scapular rest position and for muscular scapular stabilisation have provided poor to fair reliability. These results support the findings of previously published studies.

An examination of the scapular rest position and scapular stabilisation should continue to be critically evaluated in further studies.

Bibliography

1. Burkhart SS., *et al*. "The Disabled Throwing Shoulder: Spectrum of Pathology Part III: The SICK Scapula, Scapular Dyskinesis, the Kinetic Chain, and Rehabilitation". *Arthroscopy* 19.6 (2003): 641-661.
2. Mell AG., *et al*. "Effect of Rotator Cuff Pathology on Shoulder Rhythm". *Journal of Shoulder and Elbow Surgery* 14.1 (2005): 58s-64s.
3. Ludewig PM and JF Reynolds. "The Association of Scapular Kinematics and Glenohumeral Joint Pathologies". *Journal of Orthopaedic and Sports Physical Therapy* 39.2 (2009): 90-104.
4. Ogston JB and PM Ludewig. "Differences in 3-Dimensional Shoulder Kinematics Between Persons with Multidirectional Instability and Asymptomatic Controls". *The American Journal of Sports Medicine* 35.8 (2007): 1361-1370.
5. Timmons MK., *et al*. "Scapular Kinematics and Subacromial-Impingement Syndrome: a Meta-Analysis". *Journal of Sport Rehabilitation* 21.4 (2021): 354-370.
6. Kibler WB., *et al*. "Clinical Implications of Scapular Dyskinesis in Shoulder Injury: the 2013 Consensus Statement From the 'Scapular Summit". *British Journal of Sports Medicine* 47.14 (2013): 877-885.
7. McClure PW., *et al*. "Shoulder Function and 3-Dimensional Kinematics in People with Shoulder Impingement Syndrome Before and After a 6-Week Exercise Program". *Physical Therapy* 84.9 (2004): 832-848.
8. Roy JS., *et al*. "Effect of Motor Control and Strengthening Exercises on Shoulder Function in Persons with Impingement Syndrome: a Single-Subject Study Design". *Manual Therapy* 14.2 (2008): 180-188.
9. De Mey K., *et al*. "Scapular Muscle Rehabilitation Exercises in Overhead Athletes with Impingement Symptoms: Effect of a 6-Week Training Program on Muscle Recruitment and Functional Outcome". *The American Journal of Sports Medicine* 40.8 (2012): 1906-1915.
10. Huang HY., *et al*. "EMG Biofeedback Effectiveness to Alter Muscle Activity Pattern and Scapular Kinematics in Subjects with and Without Shoulder Impingement". *Journal of Electromyography and Kinesiology* 23.1 (2013): 267-274.
11. Struyf F., *et al*. "Scapular Positioning and Movement in Unimpaired Shoulders, Shoulder Impingement Syndrome, and Glenohumeral Instability". *Scandinavian Journal of Medicine and Science in Sports* 21.3 (2011): 352-358.
12. Worsley P., *et al*. "Motor Control Retraining Exercises for Shoulder Impingement: Effects on Function, Muscle Activation, and Biomechanics in Young Adults". *Journal of Shoulder and Elbow Surgery* 22.4 (2013): e11-19.
13. Merolla G., *et al*. "Supraspinatus and Infraspinatus Weakness in Overhead Athletes with Scapular Dyskinesis: Strength Assessment Before and After Restoration of Scapular Musculature Balance". *Musculoskeletal Surgery* 94.3 (2010): 119-125.
14. Thigpen CA., *et al*. "Head and Shoulder Posture Affect Scapular Mechanics and Muscle Activity in Overhead Tasks". *Journal of Electromyography and Kinesiology* 20.4 (2010): 701-709.
15. Wegner S., *et al*. "The Effect of a Scapular Postural Correction Strategy on Trapezius Activity in Patients with Neck Pain". *Manual Therapy* 15.6 (2010): 562-566.
16. Helgadottir H., *et al*. "Altered Scapular Orientation During Arm Elevation in Patients With Insidious Onset Neck Pain and Whiplash-Associated Disorder". *Journal of Orthopaedic and Sports Physical Therapy* 40.12 (2010): 784-791.
17. Helgadottir H., *et al*. "Altered Activity of the Serratus Anterior During Unilateral Arm Elevation in Patients with Cervical Disorders". *Journal of Electromyography and Kinesiology* 21.6 (2011): 947-953.

18. Petersen SM and SN Wyatt. "Lower Trapezius Muscle Strength in Individuals with Unilateral Neck Pain". *Journal of Orthopaedic and Sports Physical Therapy* 41 (4 (2011): 260-265.

19. Sheard B., *et al*. "Evaluating Serratus Anterior Muscle Function in Neck Pain Using Muscle Functional Magnetic Resonance Imaging". *Journal of Manipulative and Physiological Therapeutics* 35.8 (2012): 629-635.

20. Zakharova-Luneva E., *et al*. "Altered Trapezius Muscle Behavior in Individuals With Neck Pain and Clinical Signs of Scapular Dysfunction". *Journal of Manipulative and Physiological Therapeutics* 35.5 (2012): 346-353.

21. Tate AR., *et al*. "A Clinical Method for Identifying Scapular Dyskinesis, Part 2: Validity". *Journal of Athletic Training* 44.2 (2009): 165-173.

22. Tate AR., *et al*. "Effect of the Scapula Reposition Test on Shoulder Impingement Symptoms and Elevation Strength in Overhead Athletes". *Journal of Orthopaedic and Sports Physical Therapy* 38.1 (2008): 4-11.

23. Rabin A., *et al*. "The Interrater Reliability of the Scapular Assistance Test". *Journal of Orthopaedic and Sports Physical Therapy* 36.9 (2006): 653-660.

24. Seitz AL., *et al*. "Effects of Scapular Dyskinesis and Scapular Assistance Test on Subacromial Space During Static Arm Elevation". *Journal of Shoulder and Elbow Surgery* 21.5 (2012): 631-640.

25. Ludewig PMand TM Cook. "Alterations in Shoulder Kinematics and Associated Muscle Activity in People with Symptoms of Shoulder Impingement". *Physical Therapy* 80.3 (2000): 276-291.

26. Michener LA., *et al*. "Scapular Muscle Tests in Subjects with Shoulder Pain and Functional Loss: Reliability and Construct Validity". *Physical Therapy* 85.11 (2005): 1128-1138.

27. Cools AM., *et al*. "Scapular Muscle Recruitment Patterns: Trapezius Muscle Latency with and Without Impingement Symptoms". *The American Journal of Sports Medicine* 31.4 (2003): 542-549.

28. Cools AM., *et al*. "Trapezius Activity and Intramuscular Balance During Isokinetic Exercise in Overhead Athletes with Impingement Symptoms". *Scandinavian Journal of Medicine and Science in Sports* 17.1 (2007): 25-33.

29. Cools AM., *et al*. "Isokinetic Scapular Muscle Performance in Young Elite Gymnasts". *Journal of Athletic Training* 42.4 (2007): 458-463.

30. Kibler WB and A Sciascia. "Current Concepts: Scapular Dyskinesis". *British Journal of Sports Medicine* 44.5 (2010): 300-305.

31. Laudner KG., *et al*. "Scapular Dysfunction in Throwers with Pathologic Internal Impingement". *Journal of Orthopaedic and Sports Physical Therapy* 36.7 (2006): 485-494.

32. Kibler WB. "The Scapula in Rotator Cuff Disease". *Medicine and Sport Science* 57 (2012): 27-40.

33. Kibler WB and J McMullen. "Scapular Dyskinesis and its Relation to Shoulder Pain". *Journal of the American Academy of Orthopaedic Surgeons* 11.2 (2003): 142-151.

34. Ebaugh DD., *et al*. "Effects of Shoulder Muscle Fatigue Caused by Repetitive Overhead Activities on Scapulothoracic and Glenohumeral Kinematics". *Journal of Electromyography and Kinesiology* 16.3 (2006): 224-235.

35. Ebaugh DD., *et al*. "Scapulothoracic and Glenohumeral Kinematics Following an External Rotation Fatigue Protocol". *Journal of Orthopaedic and Sports Physical Therapy* 36.8 (2006): 557-571.

36. Cools AM., *et al*. "Scapular Muscle Recruitment Pattern: Electromyographic Response of the Trapezius Muscle to Sudden Shoulder Movement Before and After a Fatiguing Exercise". *Journal of Orthopaedic and Sports Physical Therapy* 3.5 (2002): 221-229.

37. Hayes K., *et al*. "Reliability of 3 Methods for Assessing Shoulder Strength". *Journal of Shoulder and Elbow Surgery* 11.1 (2002): 33-39.

38. Cibulka MT., *et al*. "A New Manual Muscle Test for Assessing the Entire Trapezius Muscle". *Physiotherapy: Theory and Practice* 29.3 (2013): 242-248.

39. DiVeta J., *et al*. "Relationship Between Performance of Selected Scapular Muscles and Scapular Abduction in Standing Subjects". *Physical Therapy* 70.8 (1990): 470-476.

40. Sahrmann SA. "Diagnosis and Treatment of Movement Impairment Syndromes". edition. K. White. 2002, St. Louis, Missouri 63146: Mosby (2002).

41. Kibler WB., *et al*. "Scapular Dyskinesis and its Relation to Shoulder Injury". *Journal of the American Academy of Orthopaedic Surgeons* 20.6 (2012): 364-372.

42. Sobush DC., *et al*. "The Lennie Test for Measuring Scapular Position in Healthy Young Adult Females: a Reliability and Validity Study". *Journal of Orthopaedic and Sports Physical Therapy* 23.1 (1996): 39-50.

43. Arlotta M., *et al*. "Selective Recruitment of the Lower Fibers of the Trapezius Muscle". *Journal of Electromyography and Kinesiology* 21.3 (2011): 403-410.

44. Sim J and CC Wright. "The Kappa Statistic in Reliability Studies: Use, Interpretation, and Sample Size Requirements". *Physical Therapy* 85.3 (2005): 257-268.

45. Landis JR and GG Koch. "The Measurement of Observer Agreement for Categorical Data". *Biometrics* 33.1 (1977): 159-174.

46. Warner JJ., *et al*. "Scapulothoracic Motion in Normal Shoulders and Shoulders with Glenohumeral Instability and Impingement Syndrome. A Study Using More Topographic Analysis". *Clinical Orthopaedics and Related Research* 285 (1992): 191-199.

47. Kibler WB. "The Role of the Scapula in Athletic Shoulder Function". *The American Journal of Sports Medicine* 26.2 (1998): 325-337.

48. Ellenbecker TS., *et al*. "Reliability of Scapular Classification in Examination of Professional Baseball Players". *Clinical Orthopaedics and Related Research* 470.6 (2012): 1540-1544.

49. Hickey BW., *et al*. "Accuracy and Reliability of Observational Motion Analysis in Identifying Shoulder Symptoms". *Manual Therapy* 12.3 (2007): 263-270.

50. Kibler WB., *et al*. "Qualitative Clinical Evaluation of Scapular Dysfunction: A Reliability Study". *Journal of Shoulder and Elbow Surgery* 11.6 (2002): 550-556.

51. McClure P., *et al*. "A Clinical Method for Identifying Scapular Dyskinesis, Part 1: Reliability". *Journal of Athletic Training* 44.2 (2009): 160-164.

52. Uhl TL., *et al*. "Evaluation of Clinical Assessment Methods for Scapular Dyskinesis". *Arthroscopy* 25.11 (2009): 1240-1248.

53. Morais NV and AG Pascoal. "Scapular Positioning Assessment: is Side-to-Side Comparison Clinically Acceptable?" *Manual Therapy* 18.1 (2013): 46-53.

54. Cleland JA., *et al*. "Interrater Reliability of the History and Physical Examination in Patients with Mechanical Neck Pain". *Archives of Physical Medicine and Rehabilitation* 87.10 (2006): 1388-1395.

55. Struyf F., *et al*. "Scapular-Focused Treatment in Patients with Shoulder Impingement Syndrome: A Randomized Clinical Trial". *Clinical Rheumatology* 32.1 (2013): 73-85.