

Measurements of scapular position and rotation: a reliability study

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ABSTRACT- The purpose of this study was to examine the intratester and intertester reliability of two classic methods (Kibler and DiVeta) and additional tests (Kibler technique for the medial border, DiVeta in two positions 45° and 90° abduction + internal rotation, rotatory index and normal scapular abduction). A convenient sample of seventeen subjects (13 females, 4 males) without postural abnormalities, shoulder pathology or surgery participated in this study. For data analysis the SAS software package was used and the intraclass correlation coefficient (ICC) calculated. The classic Kibler method scored moderate to good for intratester and intertester reliability, where as the procedure of DiVeta, the additional measures, normal scapular abduction and rotatory index were reliable when they are performed by the same clinician but showed low values for intertester reliability. Further research is necessary to examine the sensitivity of these tests in pathological situations, to study the influences of age and sex on these parameters, and to examine the effect of strengthening programmes for the scapulothoracic muscles in the rehabilitation of shoulder injuries.

INTRODUCTION

Smooth motion of the scapula and humerus with respect to the thorax is essential for shoulder function and abnormalities may indicate clinical entities. Weakness of the scapular stabilisers, particularly trapezius and serratus anterior results in altered biomechanics and in abnormal stresses to the anterior capsular structures of the shoulder (Lippitt and Matsen, 1993), with an increased risk for impingement. Researchers have recently attempted to devise simple practical and reliable means of quantification of scapular position. Kibler (1991) described the lateral slide test. This procedure consisted of measures from T7 spinous process to the inferior angle of the scapula and was modified by Davies and Dickoff-Hoffmans (1993) by adding two more positions. DiVeta et al. (1990) proposed to use a piece of string to measure the linear distance between the spinous process of the third vertebrae and the inferior process of the acromion, with the arm at rest at the side. To investigate the validity of these procedures in pathological situation, and to follow up the effect of strengthening exercises on the scapulothoracic muscles in the rehabilitation programmes for the shoulder these protocols have to be examined on their reliability. Only a few authors reported data regarding the reliability of repeated measurements and measures between testers (DiVeta et al., 1990; Neier et Worrell, 1993; Gibson et al., 1995; Odom et al., 1995; Sobush et al., 1996). The aim of this study was to determine the intratester and intertester reliability of both the classic (Kibler and DiVeta) and additional measurements (Kibler

technique for medial border, DiVeta in two other positions, rotatory index and normal scapular abduction). If one of these procedures turns out to be reliable, reseachers can concentrate on the sensitivity of these tests in the pathological situation and in the documentation of the effects of rehabilitation programmes.

METHODS

A convenient sample of seventeen subjects (13 females, 4 males) without postural abnormalities, shoulder pathology or surgery participated in this

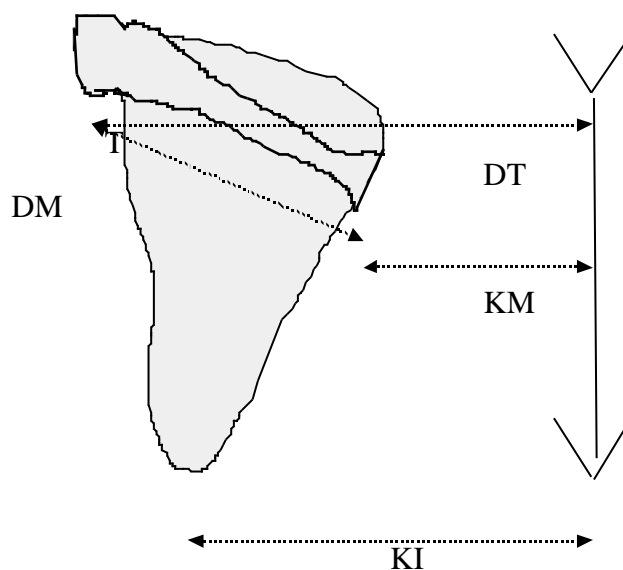


Figure 1- The measurements; K= Kibler, D=Diveta, T= Thoracic vertebrae; I= inferior angulus; M=medial border.

Table 1 - *Intratester reliability: Means, ICC and p-values for dominant (D) and non-dominant (ND) extremity; K= Kibler, D=DiVeta, m=medial border, i= inferior angle, t=distance to third thoracic vertebra in 0°(1), 45°(2) and 90°+IR abduction (3); p<0.05*; classic measures are in bold*

		ICC intra	SEM	pT1(1)- T1(2)	NORMAL SCAPULAR ABDUCTION		ICC Intra
Ki1	D	0.93	0.32	0.07	DT1/DM	D	0.87
	ND	0.83	0.18	0.44		ND	0.90
Ki2	D	0.90	0.40	0.65	DT2/DM	D	0.78
	ND	0.80	0.62	0.48		ND	0.90
Ki3	D	0.96	0.45	0.60	DT3/DM	D	0.55
	ND	0.93	0.60	0.08		ND	0.30
Km1	D	0.99	0.12	0.90	ROTATORY INDEX		
	ND	0.91	0.38	0.61			
Km2	D	0.89	0.41	0.11	KM1/KI1	D	0.88
	ND	0.96	0.25	0.40		ND	0.83
Km3	D	0.68	0.55	0.02*	KM2/KI2	D	0.94
	ND	0.57	0.54	0.03*		ND	0.78
Dt1	D	0.90	0.40	0.43	KM3/KI3	D	0.79
	ND	0.89	0.37	0.97		ND	0.94
Dt2	D	0.86	0.38	0.15			
	ND	0.92	0.35	0.97			
Dt3	D	0.64	0.68	0.73			
	ND	0.90	0.40	0.08			
Dm	D	0.88	0.35	0.27			
	ND	0.85	0.55	0.44			

study. They were all students (age range 21-23 year) not engaged in athletic or repetitive manual work favouring the dominant extremity. All were right handed. An informed consent was obtained from each subject. The subjects were asked to exposure their vertebrae and scapula for observation and palpation. An upright but relaxed position was requested as they were sitting on a tabouret. After 30 seconds each tester palpated the medial, inferior angle of the scapula and the inferior process of the acromion on both sides and the third spinous process. Then the thoracic midline was determined by drawing a straight line from the third spinous process to the midpoint between the superior iliac spines caudally. After all marking was completed, measurements were taken to the nearest millimetre using a tape measure. The measurements consisted of the following (Figure 1) : the linear distance from the thoracic midline to the medial border (KM) and to the inferior angle of the scapula (KI), the distance from the inferior process of the acromion to the third vertebra (DT) and to the medial border of the scapula (DM). The subjects were then asked to place their hands on their hips with the web space between the thumb and second finger on the lateral iliac crests, where after the marking and measuring was repeated (position 2 = 45° abduction). The last position (or position

3) consisted of 90 degrees abduction and internal rotation of the arms checked by standard goniometry. After completing these thirteen measurements, all marks were removed before the subjects left the room and the entire procedure was repeated by the second tester in the adjacent room. At the end of the session they returned to the first tester for a re-evaluation. We also calculated the normal scapular abduction (DT/DM) as proposed by DiVeta et al. (1990) and a rotatory index by dividing the KM by KI.

Statistics

For data analysis the SAS software package was used and the intraclass correlation coefficient (ICC) calculated. The following criteria were used to define the degree of reliability bases on our ICC values: 0.90 to 0.99 = high reliability, 0.80 to 0.89 = good reliability, 0.70 to 0.79 = moderate reliability and 0.69 and below = poor reliability. The standard error of measurement ($SEM = SD \sqrt{1-ICC}$) was used to determine the measurement error associated with repeated scapular measurements.

RESULTS

The Intraclass Correlation Coefficient (ICC) for intratester reliability (Table 1) ranged from 0.96 to 0.80 for both methods without significant differ-

Table 2 - Intertester reliability: Means, SD, ICC and p value for dominant (D) and non-dominant (ND) extremity by both testers; $p < 0.05^*$

		ICC inter	SEM	p T1(1)- T2	normal scapular abduction		ICC Inter
KI1	D	0.78	0.60	0.90	DT1/DM	D	0.27
	ND	0.72	0.57	0.10		ND	0.33
KI2	D	0.87	0.47	0.10	DT2/DM	D	0.53
	ND	0.78	0.65	0.00*		ND	0.65
KI3	D	0.89	0.71	0.21	DT3/DM	D	0.14
	ND	0.90	0.72	0.08		ND	0.13
KM1	D	0.79	0.57	0.73	rotatory index		
	ND	0.66	0.77	0.54			
KM2	D	0.87	0.45	0.30	KM1/KI1	D	0.80
	ND	0.80	0.56	0.66		ND	0.74
KM3	D	0.52	0.66	0.49	KM2/KI2	D	0.97
	ND	0.57	0.54	0.09		ND	0.54
DT1	D	0.45	0.93	0.32	KM3/KI3	D	0.44
	ND	0.72	0.60	0.40		ND	0.71
DT2	D	0.49	0.73	0.00*			
	ND	0.74	0.63	0.98			
DT3	D	0.63	0.69	0.01*			
	ND	0.57	0.83	0.74			
Dm	D	0.68	0.57	0.00*			
	ND	0.7	0.80	0.00*			

ences, whereas the ICC for intertester reliability ranged from 0.42 to 0.90 with higher values (moderate and good) for the Kibler technique.

In the additional tests also high values were obtained for ICC intratester, except for the measurements of the linear distance of the medial border of the scapula to the thoracic midline; the distance of the inferior process of the acromion to the third vertebra, both in 90° abduction and internal rotation and the scapular abduction in position 3.

The ICC for intertester reliability (Table 2) was only acceptable for the DiVeta measurement in 45° abduction. Significant differences were noted between both testers on the following measures: Kibler in 45° abduction, DiVeta in 45° abduction and 90° abduction and the scapular size measure.

DISCUSSION

Intratester reliability

Our values for the ICC (0.90-0.89) using the DiVeta Protocol are in agreement with the results obtained by DiVeta (1990) (0.94), Neirer and Worrell (1993) (0.80) and Gibson et al.(1995) (range 0.92-0.95). Only Gibson et al.(1995) (ICC=0.81-0.94 and SEM 0.44-0.79 cm) and Odom et al. (1995) (ICC=0.82-0.90 and SEM=0.51-0.88cm) reported values for the intratester reliability for the procedure used by Kibler. In contrast with their results (ICC high in position

1 and ranged from high to good for position 2 and 3), we found a high reliability in position 3 and the ICC ranged from good to high in position 1 and 2. We believe that the lower values for position 1 in our trial is due to the sitting posture, which allows more postural variation. We selected this position for general use to avoid time pressure in measuring older people in the standing position. No data regarding the intratester reliability for the measures of the distance from the medial border of the scapula and the additional DiVeta measures were reported. In our study these measures were reliable for position 1 and 2 but not for position 3. Although the third position (90° abduction) was checked by goniometer, the procedure between the two testers was difficult to standarize. Normalised scapular abduction is composed of two values; scapular distance (DT) and scapular size (DM). DiVeta et al. (1990) and Neier and Worrell (1993) reported lower reliability values (0.78 and 0.35) than in our study (ICC=0.90-0.87). Each component contains measurement errors; the normal scapular abduction was reliable in position 1 and 2. Our calculated index using Kibler and the additional measures ranged from good to high and offered the opportunity to determine scapular rotation without sophisticated equipment.

Intertester reliability

The intertester reliability was only good or moderate in the Kibler method and additional Kibler measure in position 2. All other measurements, NSA and Kibler index demonstrated moderate or even poor reliability. These results of the Kibler method are similar to the values obtained by Sobush et al. (1996) for position 1 (0.77-0.86); but significantly higher than those reported by Gibson et al. (1995) and Odom et al. (1995) in all positions. We believe that some familiarisation with the technique is necessary and can be the reason for this discrepancy. These results demonstrate that the inferior angle of the scapula, although it describes an arc rather than a point can be used as reference point in measurement. The SEM values never exceeded the value of 1 cm, indicating that bilateral differences of 1 cm can be indicative of weakness of the scapular stabilisers, as suggested by Kibler. We believe the results should however be correlated with other clinical findings before conclusions should be made. Gibson et al. (1995) concluded a high reliability for the measures of DiVeta, whereas we observed poor reliability. We believe that the longer distance is responsible for greater variation caused by different tension on the tape-measure in the DeVita procedure.

CONCLUSION

We believe that the Kibler technique is reliable but needs a lengthy familiarisation period, it holds promise for further studies and has the advantage of measuring in three positions. The additional measures, DiVeta, normal scapular abduction and rotation index, were reliable when they are performed by the same clinician. All these measures are fast and easy ways to examine patients before and after their rehabilitation programme in shoulder pathology and determine the scapular position and rotation without sophisticated equipment. Further research is necessary to examine the sensitivity of these tests in pathological situations, to study the influences of age and sex on this parameters, and to examine the effect of strengthening programmes for the scapulothoracic muscles in the rehabilitation of shoulder injuries.

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