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Accuracy of lateral scapular slide test and modified lateral scapular slide test in smartphone users with scapular dyskinesia: A cross-sectional study

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ABSTRACT

Background: Lateral Scapular Slide test (LSST) and Modified Lateral Scapular Slide test (MLSST) are used to evaluate scapular dyskinesia. *Aims:* To find out the accuracy of the LSST and MLSST in Smartphone users with Scapular Dyskinesia. *Method:* 75 individuals aged 18-35 years were screened with Smartphone use of more than 4 hours daily. LSST was performed with arm at the side, 45° abduction and at 90° abduction with medial rotation. The first two positions in MLSST were performed similarly as in LSST, while the third position was performed with 90° scaption and 1kg load. A difference of bilateral measurement between the inferior scapular angle and the T7 vertebral spinous process was obtained. *Result:* MLSST was found to be more accurate test (70%) than LSST (60%) to assess scapular dyskinesia. *Conclusion:* Applying loads in scaption position in the MLSST improved the accuracy of the test to diagnose scapular dyskinesia and may substitute the third position in the conventional LSST.

Keywords: Modified Lateral Scapular Slide test, Lateral Scapular Slide test, Reliability, Validity, Scapular Dyskinesia, Smartphone

1. INTRODUCTION

Scapular dyskinesis is described as an obvious change in scapular static posture and movement pattern that results in a change in how the scapular stabilizer muscles are activated (Longo et al., 2020). Excessive smartphone screen time is one of the factors that can lead to scapular dyskinetic patterns. Operating a smartphone continuously for more than 4 hours every day impairs the role of scapular stabilizing muscles and produces scapular dyskinesia (Mohamed et al., 2020).

Several methods have been proposed to assess scapular function (Paraskevopoulos et al., 2020). Kibler proposed 3 test positions to assess the scapular function; arms at the side (P1), arms at 45° abduction (P2) and arms at 90° abduction with medial rotation (P3) (Odom et al., 2001). Kibler assessed the activity of scapular stabilizing muscles along with the scapular position (Odom et

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al., 2001). Kibler stated that placing the arm in abduction and medial rotation placed stress on the trapezius and serratus anterior (Robertson, 1984).

Although LSST is accepted as an objective tool by many previous studies, the reliability of LSST changes with age group, gender, dominant and non-dominant hand and condition of the individual (Park, 2017). Shadmehr et al., (2016) performed a Modified lateral scapular slide test (MLSST) to reinforce the stress on stabilizing muscles and evaluate whether the alteration further points up the bilateral scapular measurements. Along with loading, Shadmehr et al., (2014) stated that the MLSST should be performed in scaption as this position reflects the neural and muscular control of the scapula and is considered the functional position (Shadmehr et al., 2014). The test is performed in three positions with one kg of weight in the hands: Pa- arms at side 0^{o} abduction, Pb- arms at 45^{o} abduction and Pc- arms at 90^{o} scaption.

Shadmehr et al., (2014) stated good to high reliability of MLSST in their study and stated that the low measurement errors and good reliability were possibly due to the addition of 1kg load in 900 scaption. These two quantitative tests (Lateral scapular slide test and modified lateral scapular slide test) are simple and quick tests to assess scapular dyskinesis and are reliable. However, it is important to know about the accuracy of both the test for clinical implications.

2. METHODS

Study Design

This was a cross-sectional observational and prospective study, where convenient sampling was taken into consideration. The study investigated the diagnostic accuracy of the Lateral Scapular Slide test and Modified Lateral Scapular Slide test. The study was conducted from November 2022 to April 2023.

Participants

The study consisted of 75 (n=75) participants. Before participating, a well-informed consent form was signed and the subjects were acquainted with the aim and methodology of the research. The subjects aged 18-35 years of age, using smartphones for more than 4 hours daily were included in the study. Subjects could not participate if they had any of the following issues: Scapular dyskinesia secondary to shoulder dysfunction, recent trauma affecting the neck and shoulder, congenital abnormalities/musculoskeletal abnormalities in the cervical spine or scapular region or thoracic region, previous history of severe surgical procedures related to cervical/thoracic spine and neuromuscular dysfunctions. The Institutional Ethics Committee gave their approval to this project with IEC number (VSPMSCOP/UG-2022SUMMER13).

Procedure

Participants were interrogated and the screenshots of the screen time of the week, from their smartphones were obtained. Participants with more than four hours per day usage on a smartphone were taken into consideration by calculating the weekly average screen time.

Subjects were assessed twice. A Lateral Scapular Slide test was performed where the participant was appropriately exposed and instructed to stand in an anatomical position, with the head erect. The landmarks (T7 vertebrae's spinous process and inferior scapular angle) were assessed and marked by adhesive tape. The distance was measured from the T7 vertebrae's spinous process to the scapular inferior angle on both sides, using a measuring tape. The patient was assessed in three different arm positions (Figure 1, 2).

P1 - arms at the side (0^{0} abduction)

P2 - 45^{0}abduction

P3 - 90^{0} abduction with medial rotation

Davies and Dickoff- Hoffman and Kibler stated that in each position, the distance measured should not vary more than 1cm-1.5cm from the original measure. A distance of more than 1.5cm suggests the presence of scapular dyskinesia.

A Modified Lateral Scapular Slide test was performed on the next day to avoid performance bias. The first two positions of MLSST were performed similarly as performed in LSST. The third position of LSST i.e., 90° frontal plane abduction was replaced with 90° scaption with 1kg weight. Scapular measurements were recorded bilaterally (Figure 3).

Figure 1 LSST with arms at the side

Figure 2 LSST tape measurement at 90-degree abduction

Figure 3 MLSST in scaption position with 1kg load

Statistical analysis

Statistical analysis was done using the Statistical software STATA version 14.0. Mean and standard deviation was used to report continuous variables. Frequency and percentages were used to express categorical variables. Categorical variables were compared between the 2 groups by performing the chi2 test. The mean difference was calculated between the 2 methods by performing an independent t-test. Diagnostic evaluation was performed by calculating the Sensitivity, specificity, PPV, NPV and overall accuracy of the technique. The area under the curve (ROC) was determined. P<0.05 was considered as statistical significance.

3. RESULTS

Subjects' characteristics

75 subjects were screened whose smartphone screen time was more than 4 hours a day. 50 out of 75 subjects had scapular dyskinesia. 35 subjects having scapular dyskinesia were females and 15 were males.

Other characteristics

A comparison of the mean difference between LSST and MLSST at different arm positions showed no significant difference at 0° and 45° arm elevations. However, the mean difference was highly significant in 90° arm elevation in subjects with scapular dyskinesia, (p= 0.0001) with more mean difference in MLSST (1.85) than in LSST (1.65) (Table 1).

Table 1 Comparison of mean differences at different positions between LSST and MLSST

Position	Technique	Cases		p-value	Control		p-value
		Mean	SD		Mean	SD	
0° Position	LSST	0.99	0.63	-	0.48	0.39	-
	MLSST	0.99	0.63		0.48	0.39	
45° Position	LSST	1.11	0.60	-	0.49	0.39	-
	MLSST	1.11	0.60		0.49	0.39	
90° Position	LSST	1.65	0.30	0.0001 HS	0.54	0.32	0.0341,S
	MLSST	1.85	0.43		0.79	0.59	

SD- Standard Deviation, HS- Highly Significant, S- significant

Diagnostic Accuracy

MLSST had higher sensitivity (68%), negative predictive value (58.97%) and accuracy (70%) compared to LSST. The area under the curve (AUC) for MLSST was also higher (0.98) than that for LSST (0.95), indicating better diagnostic accuracy. The specificity and positive predictive value of LSST were found to be 100% (Table 2).

Table 2 Diagnostic Evaluation of LSST and MLSST

	Lateral Scapular slide test	Modified lateral Scapular slide test
Sensitivity	40 %	68 %
Specificity	100 %	92 %
Positive Predictive Value	100 %	94.44 %
Negative Predictive Value	45.45 %	58.97 %
Accuracy %	60 %	70 %
Area under Curve	0.95	0.98

4. DISCUSSION

The accuracy of MLSST was found to be more (70%) than LSST (60%). This might attribute to the fact that the third arm position in MLSST incorporated a loaded scaption position rather than unloaded frontal plane abduction. During glenohumeral elevation, scapular stabilizing muscles are progressively recruited to maintain a normal scapulohumeral rhythm (Phadke et al., 2009). Mohamed et al., (2020) in their stated that smartphone use for more than 4 hours daily causes scapular muscle imbalance, leading to weakness and fatigue.

Excessive smartphone use affects upper back posture and produces protracted shoulders (Cochrane et al., 2019). Therefore, weakness of scapular muscles due to excessive smartphone use produces scapular dyskinesia. Thus, in MLSST, the addition of load during scaption created an improper length-tension relationship and produced asynchronous firing in already weakened muscles. As a result, scapular dyskinesia was assessed way more easily in MLSST than in LSST. Struyf et al., (2009) in their study, similarly incorporated 1kg loading but in 90° coronal plane abduction and determined poor interrater reliability (ICC=0.63). As opposed to that, Da-Costa et al., (2010) found fair interrater reliability (ICC=0.74) for the 90° scaption position.

Scaption is the physiological and functional movement of shoulder elevation (Kapandji, 1971). Movement of the humerus is less constrained in scaption in contrast to frontal plane abduction, as the glenohumeral capsule is less twisted in scaption. As a result, in the present study, adding load in the scaption position increased the ability of MLSST to provide better results than LSST. The mean difference of side-to-side measurements was found to be more in the loaded scaption position in MLSST (1.85) than in the frontal plane 90°abduction position in LSST (1.65). The area under the curve (AUC) for MLSST was also higher (0.98) than (0.95), indicating better diagnostic accuracy.

The diagnostic evaluation showed that the sensitivity of MLSST was more (70%) than LSST (60%). The precise palpation of the bony landmarks to assess scapular dyskinesia might contribute to the increased sensitivity of the test. Due to the scapular posterior tilt during frontal plane abduction, the inferior scapular angle shifts closer to the thorax and is therefore difficult to palpate (Chu et al., 2012). On the other hand, posterior tilt is reduced in scapular plane abduction, making it relatively more prominent and easy for palpation (Chu et al., 2012). Previous studies conducted, to find the reliability of MLSST had similar results.

Shadmehr et al., (2014) discovered good to high interrater and intrarater reliability of MLSST in both symptomatic and asymptomatic groups. It appears that the LSST's poor diagnostic performance in this investigation could be explained by the fact that scapular asymmetry between side-to-side measurements may be present normally without kinetic alterations (Uhl et al., 2009). The present study focused on how excessive smartphone use causes kinematic alterations in the scapula further aggravating the scapular asymmetry. This indicates that MLSST will be able to correctly identify individuals with scapular dyskinesia.

The Negative Predictive Value (NPP) was also more in MLSST (58.97%) than in LSST (45.45%). With greater sensitivity of MLSST, individuals with negative test will less likely have the disease and thus have greater negative predictive value. In, conclusion, the MLSST technique demonstrated better diagnostic accuracy compared to LSST for detecting scapular dyskinesis. The study's findings may have clinical implications for the diagnosis of scapular dyskinesia.

Clinical implications

The findings show that the measurements taken with MLSST increase the chances of accurately diagnosing scapular dyskinesia instead of LSST. Furthermore, MLSST is as easy as LSST to be incorporated in clinical diagnosis with respect to the time required for the test and a similar procedure with only a few replacements in MLSST. Also, the loaded scaption position in MLSST assesses functional movement and the effect of scapular muscle recruitment during shoulder elevation.

5. CONCLUSION

According to this study, applying loads in the scaption position in the Modified Lateral Scapular Slide test improved the accuracy of the test to diagnose scapular dyskinesia and may substitute the third position in the conventional Lateral Scapular Slide test.

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Author's contributions

Concept and design of study or acquisition of data or analysis and interpretation of data was done by author Dr Apoorva Andhare and author Dr Neha Gotmare.

Drafting the article or revising it critically for important intellectual content was done by author Dr Apoorva Andhare.

Final approval of the version to be published was given by author Dr Neha Gotmare.

Informed consent

Informed consent was obtained from the patient.

Ethical approval

Not applicable.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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Data and materials availability

All data associated with this study are present in the paper.

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