

Reliability of modified-modified Schober's test for the assessment of lumbar range of motion

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Abstract

Objective: To determine the intra-rater reliability of modified-modified Schober's test for measuring lumbar flexion and extension in patients of lumbar radiculopathy.

Method: The case-control reliability study was conducted at the University of Lahore Teaching Hospital, Lahore, Pakistan, from March to September 2020, and comprised lumbar radiculopathy patients of either gender aged 35-60 years in group A and healthy controls in group B. Lumbar flexion and extension were measured by the same examiner on three different occasions. A non-stretching measuring tape was used in which the first two measurements were taken using the modified-modified Schober's test on the same day with a difference of 5 minutes, and the third measurement was taken three days later to assess reliability. To assess the test-retest reliability, intraclass correlation coefficient was calculated through two-way random analysis of variance. Standard error of measurement and minimal detectable change were also calculated. Data was analysed using SPSS 25.

Results: Of the 40 subjects, 20(50%) were in group A with a mean age of 45.00 ± 6.72 years, and 20(50%) were in group B with a mean age of 49.60 ± 6.65 years. Overall, there were 16(40%) male and 24(60%) female subjects. Within-day lumbar flexion and extension measurements were highly reliable in controls (intraclass correlation coefficient 0.93 for flexion and 0.96 for extension) as well as in patients (intraclass correlation coefficient 0.94 for flexion and 0.95 for extension). The high values of intraclass correlation coefficient 0.91 for flexion and 0.94 for extension in the controls and 0.83 for flexion and 0.92 for extension in the patients showed high reliability also for between-days measurements.

Conclusion: The modified-modified Schober's test appeared to be a highly reliable technique for the measurement of lumbar flexion and extension in patients of lumbar radiculopathy as well as in healthy controls.

Keywords: Modified-Modified Schober's test, Lumbar radiculopathy, Lumbar range of motion. (JPMA 72: 1755; 2022)

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Introduction

Spinal range of motion (ROM) with accurate assessment is the top recommendation for evaluating lumbar functions and to facilitate the lumbar assessment in which flexion and extension being the commonly assessed movement.^{1,2} The normal ROM for flexion is 60°, extension and lateral flexion on both sides ranges up to 25°.³ According to American Physical Therapy Association (APTA) guidelines, the measurement of joint integrity and mobility is a necessity for appropriate intervention.^{2,4} There are many methods to measure lumbar flexion and extension, including tape measurement,⁵ goniometry, electrogoniometre, dual inclinometre,⁶ Schober's method, radiological analysis,¹ spinal motion analyser,⁷ dynamic spinal visualisation, fingertip to floor method⁸ and vertebral motion analyser.⁹ Each of the above-mentioned techniques has its own pros and cons.

Reliability is the consistency or repeatability of measurements, meaning the degree to which

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measurements are error-free and the degree to which repeated measurements agree.¹⁰ The current study was planned to determine the intra-rater reliability of Modified-modified Schober's test (MMST)^{1,6,8,11-17} for measuring lumbar flexion and extension in patients of lumbar radiculopathy.

Patients and Methods

The case-control reliability study was conducted at the University of Lahore Teaching Hospital, Lahore, Pakistan, from March to September 2020. After approval from the institutional ethics review board, the sample size was calculated using the formula:

$$n = \frac{Z_{1-\alpha/2}^2 \sigma^2}{\epsilon^2 \mu^2}$$

with $1-\alpha = 95$, $\sigma = 1.08$, $\epsilon = 0.05$, $\mu = 6.12$, and $n=39$.¹¹

The sample was raised using convenience sampling technique. Those included were lumbar radiculopathy patients of either gender aged 35-60 years in group A and healthy controls in group B. The healthy controls had no

history of lower back pain (LBP), including mechanical or non-mechanical back pain. Lumbar flexion and extension measurements were taken using the MMST.¹⁵

The Schober's test (ST), involving tape measurement of spinal ROM, is also known as skin distraction method.^{6,12} This was one of the most accessible and easily interpretable methods for measuring spinal motion in LBP patients. In the original ST technique, the landmark used was lateral lumbar fossa. In this technique, the tape is held directly over the spine between points at lumbosacral junction and 10cm above the lumbosacral junction in the neutral standing position. When the patient goes into full flexion, the increase in the distance between two points is the spinal flexion range.⁸

The original ST was then modified by marking a point 5cm below and 10cm superior from the lumbosacral junction. Lumbar extension can also be measured by using modified ST (MST) by measuring the apprehension of skin marks when they approach each other during backward bending position.¹ The inter- and intra-rater reliability of MST using intraclass correlation coefficient (ICC) was reported to be 0.83 to 0.9 for spinal flexion, and 0.74 to 0.83 for extension.¹³

The MST was questioned when it was assessed that only four spinal segments i.e. L2-S1, seemed to be included in the measurement of spine flexion. A study reported that half of their healthy subjects presented with a diameter of lateral lumbar fossa 1cm to 2.5cm which had highest significant impact on the repeatability and reliability of MST.¹⁴

The MST was then further modified to remove the shortcomings, and, hence, was called the Modified MST (MMST). In this technique a line is drawn between two posterior superior iliac spines (PSIS) and a landmark on spine at 5cm, 10cm, 15cm and 20cm in order to obtain the overall lumbar spinal flexion.¹⁵ Adding the 15cm and 20cm points in the midline can cover the whole lumbar vertebrae which was lacking in MST.¹ MMST has shown some reliable measurements on spinal flexion and extension range in LBP patients. The pearson correlation coefficient for flexion ranged from 0.78 to 0.89, and for extension it was from 0.69 to 0.91 compared to double inclinometer ($r=0.13-0.87$ for flexion, and $r=0.28-0.66$ for extension) with less time-consumption.¹⁵

The latest version of MMST includes two improvements: the uses of PSIS instead of lumbosacral junction, so that the movement between L5 and sacrum can also be recorded, eliminates the difficulty of marking the point at the lumbosacral junction, and a better estimate of ROM of all

the lumbar segments by marking a 15cm proximal landmark.¹⁶

Another important point observed is that lower thoracic and upper lumbar region was not included in ST and MST even though thoracolumbar junction has always been the important component in different lumbar pathologies. That is why it is required to measure the ranges in thoracolumbar junction as well as sacroiliac joint, especially in the case of ankylosing spondylitis.¹⁷ Hence, using MMST provides measurement 15cm above the skin landmark, including lower thoracic and upper lumbar spine.¹¹

A non-stretching millimetre measuring tape was used in order to ensure that there was no change with repetitive usage. After informed consent from the subjects, a proforma was used to record demographics and anthropometric data along with history of lumbar radiculopathy or healthy back.

Lumbar flexion and extension measurements were taken using the MMST three times on two occasions over three days. The first two measurements were taken with the difference of five minutes each on the first occasion to examine the within day reliability. The third measurement was taken after three days to examine between-days reliability. The same examiner took all the three measurements.

The subjects were asked to remove their shoes and stand erect on a set of paper footprints in order to provide similar characteristics for all in each trial. The heels were 15cm apart, eyes looking horizontally and arms hanging by their sides as the subjects exposed their backs from the mid-thoracic spine to the spinal region.¹⁸ Before taking the measurements, each subject also performed lumbar flexion stretches for 5 minutes in order to warm up the muscles

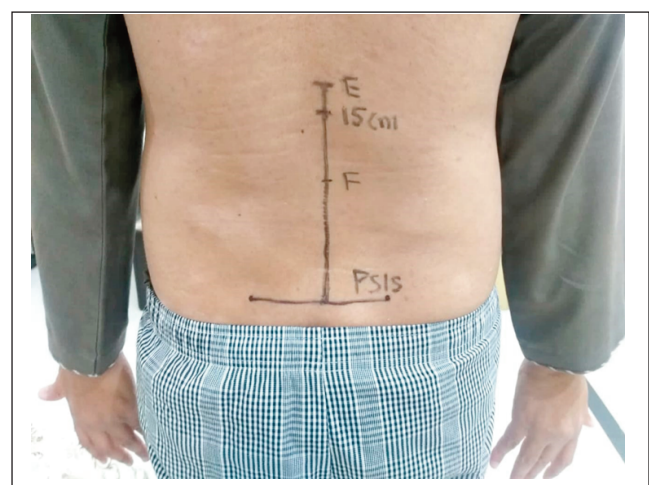


Figure: Land-marking method for Modified-Modified Schober's test (MMST).

and surrounding structures. The examiner knelt behind the standing subject to look for the PSISs and the skin mark was drawn horizontally (Figure). The subjects were then asked to bend forward as much as they could with the knees locked while keeping the pelvis fixed, and then with full flexion and extension, the distance between the two marks was measured. All measurements were taken by trained and qualified physiotherapists and the readings were recorded on a new sheet on each occasion.

Data was analysed using SPSS 25. Baseline data was compared using independent sample t-test. The intra-rater reliability of MMST was assessed by calculating ICC_{2,1} using two-way random analysis of variance at 95% confidence interval (CI). The values of ICC were used to determine the within-day (between first and second reading) and between-days (between first and third reading) intra-rater reliability of lumbar ROM, including flexion and extension movements. ICC values suggested by Richman et al. (1980) were used to detect the level of reliability; ICC value 0.59 or less show questionable reliability, 0.60 to 0.79 show moderate reliability and 0.80 to 1.00 show high reliability.¹⁹ Measurement error was calculated by means of standard error of measurement (SEM) and minimal detectable change (MDC). The formula used for computing SEM was: $SEM = SD \times \sqrt{1 - ICC}$, and for MDC it was: $MDC = 1.96 \times \sqrt{2} \times SEM$. Lesser the value of SEM and MDC, more reliable was the test. The values of SEM between ≤ 2.15 to 6.5 and the values of MDC between ≤ 6 and 13.7 are usually considered acceptable.^{20,21} Since SEM was already calculated, 2SEM was two times the standard error where 1SEM provides a value with 68% confidence to the clinician that the true measurement value is within 1 SEM of the clinical measurement, while 2SEM indicates a value with 95% confidence.²² For body mass index (BMI) categorisation, values recommended by the World Health Organisation (WHO) and the National Institute for Health and Clinical Excellence (NICE)²³ were used.

Results

Of the 40 subjects, 20(50%) were in group A with a mean age of 45.00 ± 6.72 years, and 20(50%) were in group B with a mean age of 49.60 ± 6.65 years. Overall, there were 16(40%) male and 24(60%) female subjects. At baseline, a significant difference ($p=0.03$) was observed in terms of age between the two groups (Table 1).

Table-1: Demographic data.

Variables		Mean±SD	Range	p-value
Age (years)	Healthy	49.60±6.65	35-59	0.03*
	LR patients	45.00±6.72	35-60	
Weight (kg)	Healthy	71±7.44	58-88	0.82
	LR patients	71±6.74	53-82	
Height (cm)	Healthy	167.81±8.51	155.45-179.83	0.68
	LR patients	168.85±7.87	158.5-182.8	
BMI (kg/m ²)	Healthy	24.93±2.21	20.3-28.5	0.51
	LR patients	25.68±3.82	19.84-33.11	

* p-value < 0.05 was considered significant. LR: Lumbar radiculopathy, SD: Standard deviation, BMI: Body mass index.

Table-2: Descriptive statistics.

Movement Stats		Healthy Subjects			Lumbar Radiculopathy Patients		
		R1	R2	R3	R1	R2	R3
Flexion	Mean	6.67±1.05	6.85±0.99	7.00±1.21	3.65±0.54	3.75±0.69	3.97±0.62
	Range	5-8	5-8.1	5-9	3-4.5	3-5	3.2-5
Extension	Mean	5.40±1.14	5.50±1.10	5.55±1.01	2.62±0.53	2.62±0.53	2.65±0.49
	Range	4-7	4-7.2	4.1-7	2-3.4	2-3.6	2-3.5

R1: First reading at baseline, R2: Second reading after 5 minutes, R3: Third reading after 3 days, SD: Standard deviation.

Table-3: Intra-rater reliability of MMST for the patients and the controls.

Movement	Intra-rater reliability	Healthy Subjects		Lumbar Radiculopathy Patients	
		Within day (5 min.)	Between days (72h)	Within day (5 min.)	Between days (72h)
Flexion	ICC	0.93 (0.84-0.97)	0.91 (0.80-0.96)	0.94 (0.84-0.97)	0.83 (0.63-0.93)
	SEM	0.27	0.34	0.15	0.38
	2SEMs	0.54	0.68	0.3	0.76
	MDC	0.75	0.94	0.41	1.05
Extension	ICC	0.96 (0.91-0.98)	0.94 (0.87-0.98)	0.95 (0.88-0.98)	0.92 (0.82-0.97)
	SEM	0.22	0.62	0.12	0.14
	2SEMs	0.44	1.24	0.24	0.28
	MDC	0.61	1.71	0.33	0.38

MMST: Modified-modified Schober's test, ICC: Intraclass correlation coefficient, SEM: Standard error of measurement, MDC: Minimal detectable change.

The three readings of both the groups for flexion and extension movements were noted (Table 2).

Within-day lumbar flexion and extension measurements were highly reliable in controls (ICC 0.93 for flexion and 0.96 for extension) as well as in patients (ICC 0.94 for flexion and 0.95 for extension). The high values of ICC 0.91 for flexion and 0.94 for extension in the controls and 0.82 for flexion and 0.92 for extension in the patients showed high reliability also for between-days measurements. SEM ranged 0.12-0.62 and MDC ranged 0.33-1.71, indicating high reliability of MMST (Table 3).

Discussion

Reliability of an assessment tool is an integral element while choosing it as an evaluation tool. ST is one of the reliable methods of measuring lumbar ROM for evaluating the effectiveness of given intervention in patients of any

lumbar pathology and for assessing the spinal mobility in healthy subjects.^{11,15} However, MMST was found to be a more effective and easy-to-use technique in measuring different lumbar ranges.¹¹ In the current study, the intra-rater reliability of MMST was assessed for both healthy and lumbar radiculopathy patients and it was found to be a highly reliable technique for measuring lumbar flexion and extension in both populations.

Although the reliability of MMST has already been studied, the study population was different i.e. patients of ankylosing spondylitis who were compared with healthy subjects.⁵ Excellent intra-rater reliability of MMST was found in patients of ankylosing spondylitis, but due to an existing limitation of the study population, as ankylosing spondylitis may lessen skin flexibility, increase the inflammation or subcutaneous fat under the skin, the results could not be generalised. Therefore, the present study was conducted to assess the reliability of MMST in patients with lumbar radiculopathy. A weak correlation was found between radiographical analysis and MMST, showing weak validity of MMST, though it was not the objective of the present study.

In another study, the reliability of MMST and double inclinometer methods for measuring lumbar flexion and extension ROM was assessed on LBP patients with age ranging from 25 years to 53 years.¹⁴ The present study was conducted on the patients of lumbar radiculopathy with age range 35-60 years, and MMST was not compared with any other assessment method. The ICC values were found to be high for both lumbar flexion and extension. Similarly, in an earlier study, MMST was proven to be a reliable method for measuring lumbar ROM in LBP patients regarding flexion and extension. However, for the double inclinometer technique, perfection and improvement was required for both lumbar flexion and extension.¹⁵

The intra-rater and inter-rater reliability of dual inclinometer was assessed by using three different methods of landmarking the lumbar spine, for measuring the lumbar flexion and extension movements. All the three methods of surface land marking were found to be reliable, but the use of PSIS to 15cm cephalad method, as used in MMST, was found to be highly reliable (ICC=0.80). It was therefore recommended in clinical practice, as it is also the simplest method to perform.²³ Some facts for the measurement of flexion and extension using tape method were also attributed i.e. it did not include the same portion of spine for people with different heights, and certain back conditions may also affect the results. Therefore, it was recommended to determine SEM to retain absolute reliability.²⁴ However, it is the strength of the present study that SEM was also calculated which was within the

recommended ranges.²¹ Similar to a previous study,²⁴ the values of MDC were also within the acceptable range.²¹ This shows minimum variability and higher reliability.

Future research take into consideration the age strata because the present study included participants aged 35-60 years in whom symptoms and spinal conditions may vary. Secondly, the small sample of the current study was also a limitation. Further studies could be designed to examine the inter-rater reliability of MMST in patients of lumbar radiculopathy. Lastly, the current study did not focus on assessing the validity of MMST which is a strong recommendation for future studies.

Conclusion

MMST was found to be a highly reliable tool for the measurement of lumbar flexion and extension. It was easy to use, time-saving, convenient and simple, requiring no specialised equipment.

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Conflict of Interest: None.

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