RESEARCH ARTICLE

Reliability of dual inclinometer for lumbar range of motion using two different Landmarking techniques

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Abstract

Objective: To measure the intra-rater and inter-rater reliability of active lumbar extension and flexion movements using dual inclinometer with two different landmarking techniques.

Method: The reliability study was conducted at the Physical Therapy Department of the University Teaching Hospital, The University of Lahore, Pakistan, in January 2020, and comprised patients of either gender aged >18 years with mild or symptomatic lower back pain, and healthy subjects s controls. Repeated measurements with dual inclinometer were taken by two examiners and data was recorded by two separate observers. A set of three active lumbar extension and flexion movements were performed for an initial warm-up. The examiners repeated a palpation of bony landmarks prior to each trial. The two different landmarking techniques were applied on the lumbar spine to identify the start and end points. Both the examiners measured each participant thrice. For each examiner and each landmarking technique, the three data sets were acquired for active lumbar extension and flexion for a total of 120 sets per session per examiner per landmarking. Each set comprised three alternating active lumbar extension and flexion movements. Data was analysed using SPSS version 26.

Results: Of the 40 subjects with mean age 27.8+11.0 years, 19(48%) were males and 21(52%) were females. There were 15(38%) cases; 6(40%) males and 9(60%) females. The remaining 25(62%) were controls. The two landmarking techniques with dual inclinometer produced a high to very high intra-rater reliability (intraclass correlation coefficient:0.73-0.91) for both lumbar extension and flexion movements with moderate to low standard error of measurement values (0.36-1.31), while a high inter-rater reliability (intraclass correlation coefficient: 0.72-0.76; standard error of measurement: 0.52-0.63) for extension measurements and only moderate inter-rater reliability (intraclass correlation coefficient: 0.59-0.65; standard error of measurement: 1.36-1.49) for flexion measurements.

Conclusion: Dual inclinometer along with skilled examiners and accurate landmarking methodology provided clinically reliable measurements.

Keywords: Dual inclinometer, Inter-rater reliability, Intra-rater reliability, Landmarking. (JPMA 72: 1994; 2022)

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Introduction

Lower-back pain (LBP) is a commonly occurring musculoskeletal disorder worldwide with 60-80% incidence rate.[1] Range of motion (ROM) is a major indicator out of many other impairments due to LBP.[2-4]

Many different tools have been tested in order to measure spinal mobility, like goniometer, fingertip-to-floor, tape measures, visual-photographs, flexicurve, plumb line and dual inclinometer.[3,5,6] None of them has been found to be superior over the others. Somehow, radiographs have priority over others to assess absolute joint motion, but they are not time- and cost-effective in clinics.[5,6] On the contrary, ROM assessment provides numerical measures of physical dysfunction and motion.[6,8]

Dual inclinometer is commonly used to assess joint motion in clinical and research settings.[5,6,8,9] Nitschke et al.[3] found dual inclinometer a reliable tool that provides a moderate to high inter-rater values and very high to perfect intra-rater values. It was mostly due to raters' skill difference, palpatory inaccuracies and the positioning of master and slave heads on the spine.[3-5] However, dual inclinometer has priority over modified-modified Shobers technique (MMST).[5] This is due to its expression of results in degrees.[5,6]

A great number of measurement categories are essential in making routine clinical decisions. A number of factors may affect the reliability results that include expertise of the rater, instrumental errors, sample selection and pain status.[1,2,9] Landmarking is considered a major factor for measuring the joint motion.[8-11] In order to cope with this issue, different landmarking techniques have been used that are feasible, time- and cost-effective as well as produce reliable measurements.[5-11]

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"The current study was planned to measure the inter-rater and intra-rater reliability of lumbar extension and flexion movements using dual inclinometer with two different landmarking techniques."

Patients and Methods

The repeated measures reliability study was conducted at the Physical Therapy Department of the University Teaching Hospital, The University of Lahore, Pakistan, in January 2020. After approval from the institutional ethics review board, the sample size was calculated using the using Open-Epi tool.[12] The sample was raised using non-random convenience sampling technique. Those included were subjects of either gender aged >18 years having mild/symptomatic LBP without any underlying pathology. Age-matched healthy controls were also enrolled. Those excluded were individuals having any trauma, spinal fracture, ankyloses, disc prolapse, spondylosis, stenosis, sacroiliac joint dysfunction or any back surgery. Informed consent was obtained from all those included. Two landmarking techniques were applied according to lumbar spine anatomy and biomechanics as per MMST.[5,6] The first technique was straight palpation of posterior superior iliac spin (PSIS) and 1st lumbar vertebra (L1).[6] The PSIS points of the subject were palpated on both sides which were connected by a line that represented the sacral spinal nerve 2 (S2) level. The upper landmark was identified by numbering up the spinous processes starting from S2 to L1.

The second technique was PSIS to 15cm cephalad.[6] The PSIS points of the subject were palpated on both sides which were connected by a line that represented the S2 level. The upper landmark was identified through a tape that measured exactly a distance of 15cm from the located S2 level in the upward direction.

Repeated measurements with dual inclinometer were taken by two examiners, coded E1 and E2, and data was recorded by two separate observers. A set of three active lumbar extension and flexion movements were performed for an initial warm-up. The examiners repeated a palpation of bony landmarks prior to each trial. "The two different landmarking techniques were applied on the lumbar spine to identify the start and end points. The lower and upper spinal landmarks were made on a piece of adhesive tape, drawing a horizontal line, and this procedure was repeated for each data-set.[3] The two heads of the dual inclinometer were placed at the low marked levels along the spine; the master head was placed at the upper landmark, and the slave head at the lower landmark. The subjects performed a sequel of three active lumbar flexion and extensions in alternate manner during each set. It was ensured that the participants stood upright with barefoot in such way that their feet were shoulder-width apart and both their knees were straight during the whole process. The lumber spine of the participants was exposed for measurements. Each participant was instructed to tuck in the chin to the chest and slowly bend down towards the toes. Then, with straight knees and hands on the waist, they were asked to bend backwards as much as they could.

All readings through the dual inclinometer were taken for each set of repeated movements at the end ranges. Both the examiners measured each participant thrice (3 sessions: within a day i.e., morning and evening, and then after one week) in a random order. For each examiner and each landmarking method, the three data sets were acquired for active lumbar extension and flexion for a

Table-1: Data-collection procedure.

	EXAMINER-1 & 2							
		Landmarking Technique-1				Landmarking Technique-2		
	Subject	Set	Flexion	Extension	Subject	Set	Flexion	Extension
Session-1								
		1	3	3		1	3	3
	1	3	9	9	1	3	9	9
	Total 40	120	360	360	Total 40	120	360	360
Session-2								
		1	3	3		1	3	3
	1	3	9	9	1	3	9	9
	Total 40	120	360	360	Total 40	120	360	360
Session-3								
		1	3	3		1	3	3
	1	3	9	9	1	3	9	9
	Total 40	120	360	360	Total 40	120	360	360
Total	40	360	1080	1080	40	360	1080	1080

total of 120 sets per session per examiner per landmarking. Each set comprised three alternating active lumbar extension and flexion movements (Table-1). The new adhesive marks were ensured for each set.

Data was analysed using SPSS 26. Intra- and inter-rater reliability was measured through intraclass correlation coefficient (ICC) and standard error of measurement (SEM). ICC values vary between 0 and 1, where zero indicates no reliability and 1 indicates perfect reliability.[13-15] The higher is the reliability, the lower is the SEM.

-ICC score 1 indicated perfect reliability, 0.90 to 0.99 meant very high reliability, 0.70 to 0.89 suggested high reliability, 0.50 to 0.69 showed moderate reliability, 0.26 to 0.49 was taken as low reliability, and 0.00 to 0.25 was a sign of little, if any, reliability.[13,15]

Results

Of the 40 subjects with mean age 27.8±11.0 years, 19(48%) were males and 21(52%) were females. There were 15(38%) cases; 6(40%) males and 9(60%) females. The remaining 25(62%) were controls (Table-2).

The two landmarking techniques with dual inclinometer produced a high to very high intra-rater reliability (ICC: 0.73-0.91) for both lumbar extension and flexion movements. The extension measurements for both techniques showed a high to very high intra-rater reliability (ICC: 0.82-0.91) with low SEM (0.36 to 0.59), while a high intra-rater reliability (ICC: 0.73-0.85) with moderate SEM (0.82 to 1.31) were noted for flexion measurements. None of the two techniques was superior to the other (Table-3).

The two landmarking techniques showed a high inter-rater reliability (ICC: 0.72-0.76) with low SEM (0.52 to 0.63) for extension measurements, while moderate inter-rater reliability (ICC: 0.59-0.65) with moderate SEM (1.36 to 1.49) for flexion measurements (Table-4).

Table-2: Demographic data.

Categories	Values
Participants (n)	40
Male: Female	19 (48%) : 21 (52%)
Age (years)	19 - 45 years
Mean age (years)	27.8 ± 11.0
Mean age in years (Male: Female)	29.4 : 26.2 years
LBP (Yes: No)	15 (38%) : 25 (62%)
LBP (Male: Female)	6 (40%): 9 (60%)

LBP: Lower back pain.

Discussion

The study found that dual inclinometer had a very high intra-rater and a high inter-rater reliability for active lumbar extension and flexion movements irrespective of the landmarking method used.

Currently, it is not evident that lumbar ROM is related to LBP, as asymptomatic patients usually have more restrictions in lumbar motions compared to symptomatic patients. A study did not find any association between the lumbar spine ROM and magnetic resonance imaging (MRI) findings.[13] Further research is needed in this area of interest.

Table-3: ICC (2, 1) for intra-rater reliability.

Reliability	Variable	Examiners	Mean ± SD	ICC	SEM (degree)	Z-score a (0.05)	CI (95%)	Up Lim	Lo Lim
Method 1- PSIS to L1	Flexion	E1	46.1 ± 2.8	0.78	1.31	1.96	2.6	48.7	43.5
		E2	47.3 ± 1.91	0.81	0.83	1.96	1.6	48.9	45.7
	Extension	E1	18.2 ± 1.4	0.82	0.59	1.96	1.2	19.4	17.0
		E2	18.4 ± 1.13	0.9	0.36	1.96	0.7	19.1	17.7
Method 2 - PSIS to 15 cm cephalad	Flexion	E1	47 ± 2.12	0.85	0.82	1.96	1.6	48.6	45.4
		E2	46.5 ± 2.5	0.73	1.3	1.96	2.5	49.0	44.0
	Extension	E1	18.1 ± 1.4	0.91	0.42	1.96	0.8	18.9	17.3
		E2	19 ± 1.3	0.85	0.5	1.96	1.0	20.0	18.0

SD: Standard deviation, ICC: Intraclass correlation coefficient, SEM: Standard error of measurement, E1: Examiner one; E2: Examiner two; CI: Confidence Interval; Up Lim: Upper limit; Lo Lim: Lower limit.

Table-4: ICC (2, 2) for inter-rater reliability.

Reliability	Variable	Mean ± SD	ICC	SEM (degree)	Z-score a (0.05)	CI (95%)	Up Lim	Low Lim
Method 1- PSIS to L1	Flexion	46.7 ± 2.33	0.59	1.49	1.96	2.9	49.6	43.8
	Extension	18.3 ± 1.20	0.72	0.63	1.96	1.2	19.5	17.1
Method 2- PSIS to 15 cm cephalad	Flexion	46.67 ± 2.35	0.65	1.36	1.96	2.7	49.3	44.0
	Extension	18.5 ± 1.06	0.76	0.52	1.96	1.0	19.5	17.5

SD: Standard deviation; ICC: Interclass correlation coefficient; SEM: Standard error of measurement; E1: Examiner one; E2: Examiner two; CI: Confidence Interval; Up Lim: Upper limit; Lo Lim: Lower limit.

Nitschke et al.[3] used a J-Tech CDI for assessing thoracolumbar extension, flexion, rotation and lateral flexion, but found a moderate intra- and inter-rater reliability. The current study showed a fair to good reliability with appropriate landmarking techniques. This difference can be attributed to the positioning of inclinometer used in the Nitschke et al. study.

The important factors that can restrict the lumbar spine and pelvic movements include proper landmarking and flexibility of hamstrings.[14] The current study had proper exposure of lumbar spine for the ascertainment of accurate landmarks. The flexibility of the hamstrings was improved by performing some prior warm-up.[14,15]

There might be present considerable errors during the application of dual inclinometer that include the positions of the master and slave heads of the dual inclinometer as well as the capacity of maintaining a continuous pressure on the heads with the skin, particularly in the measurement of lumbar extension as there is a great chance of skin folding. Moreover, in case of highly flexible participants, the prevention of collision between the heads is another problem. Though the current study showed the dual inclinometer as a reliable tool for measuring active lumbar extension and flexion, the matter needs further studies.

The location of a specific spinal level is a difficult task for which different landmarking techniques have been developed by clinicians. Studies showed that even skilled examiners are inconsistent in an absolute finding of spinal level, indicating that palpatory methods of measurements have inherent limitations.[11] That was why most patients in the current study went MMST as it may produce more reliable findings. A limitation of this method is that it does not indicate the same spinal level for people with different heights which means a further study is needed in this regard.

Conclusion

Dual inclinometer along with skilled examiners and accurate landmarking methodology can provide clinically reliable measurements. The results of the two techniques were almost the same.

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