

## Association of Manual Examination with Radiological Examination in Assessment of Lumbar Intervertebral Mobility in Asymptomatic Subjects: A Cross-Sectional Study

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### Abstract

**Background and purpose:** Clinical examination of lumbar intervertebral mobility (LIVM) involves manual application of force on lumbar spinous processes to localize the symptoms while radiological examination involved functional (flexion-neutral-extension) radiography. The objective of this study was to evaluate the concurrent (criterion-related) validity of central postero-anterior (PA) pressure when compared to functional radiography in assessment of LIVM in asymptomatic participants. **Materials and methods:** Assessor-blinded cross-sectional study with random-order repeated-measures design was performed on 48 consented asymptomatic adult participants of either gender (34 male, 14 female), with mean age  $23.6 \pm 4.8$  years. Central PA pressure assessment was done and graded using the seven-point joint play grading scale of Stanley Paris (0- ankylosed, 6- unstable) while functional radiography and manual tracing were done to measure intersegmental anterior and/or posterior rotations and/or translations. Karl-Pearson's correlation co-efficient was used for analysis in SPSS version 11.5 for Windows. **Results:** It is evident that there was a comparable change in the segmental mobility measured using manual and radiological examination in all the subjects studied. This finding is specifically noted between the JPGS with posterior rotation and anterior translation. E.g., a normal mobility on JPGS at L1 was seen with normal anterior translation and posterior rotation values from X-ray but not in posterior translation and anterior rotation. **Conclusion:** The study showed that manual examination of intervertebral mobility using central PA pressure was comparable to the radiological assessment of intersegmental mobility of the spine in the five subjects studied. This significant correlation was noted especially for the anterior translation and posterior rotation radiological measurements with the manual assessment using the central PA pressure. The joint play grading scale was a useful clinical tool to measure and record intervertebral mobility in the normal subjects studied.

**Keywords:** Physical Examination; Concurrent Validity; Lumbar Spine Mobility; Manual Therapy.

### Introduction

Low back pain remains a very common condition that affects an estimated 80% of adults with recurrence rates ranging from 60-85% during some period in their life [1]. Low back pain ranks second only to common cold as a reason for the patient to visit a physician, and the leading cause for a visit to a physical therapist. Low back pain was shown to

be associated with recurrence and long-term disability if not properly detected and managed during the first episode of onset. To avoid recurrence and to prevent the potential complications, clinicians should be able to identify the exact source of pain as either syndromes or as mechanisms [1]. However, Spratt et al estimated that a precise diagnosis is unknown in 80 -90% of disabling low back disorders [1].

The lumbar spine is anatomically identified as the region involved in MLBP due to poor sitting/standing posture, abnormal stresses in the form of micro or macro trauma during regular and/or work-related activity [1]. Altered function of the spinal segment during postures and/or movements is defined as a spinal dysfunction. Vertebral dysfunctions can either be at single or multiple spinal levels of hypo/hyper- mobility. Various sophisticated assessment methods to detect spinal

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segmental motion are available but they are not cost-effective. Clinical examination thus remains as a gold standard next to surgery for diagnosis in MLBP.

For a better clinical diagnosis, subjective and objective examination findings obtained during physical examination findings of the patient are often correlated with laboratory and radiological findings. Although various clinical methods of lumbar spine examination exist, manual examination comprising of passive physiological intervertebral mobility (PPIVM) testing and passive accessory intervertebral mobility (PAIVM) testing was anecdotally recommended for localizing the dysfunctional spinal level in patients with mechanical low back pain (MLBP).

Postero-anterior mobilization is a commonly used technique among physical therapists to diagnose and treat MLBP patients [4]. During this technique, the tester applies vertically directed force (downwards to the plinth) on lumbar spinous processes to assess mobility and pain response amongst patients with MLBP [4]. Patients with non-specific low back pain (NSLBP) or MLBP commonly demonstrate a symptom-specific pain response and/or increased resistance of the dysfunctional lumbar spinal level during PA technique, thus mastering the PA technique is important for clinical judgment and treatment [7].

Functional Radiography can demonstrate abnormal motion between two vertebrae using dynamic plain radiographs obtained in both flexion and extension and it proves to be a simple and reliable method to determine motion segment instability and can also indicate the lesions located in specific areas based on the "dominant lesion" concept. The location of the dominant lesion determines the pattern of instability. If the dominant lesion is anterior primary restraint failure, there is excessive posterior horizontal translation in the extension views. If the dominant lesion is primary posterior restraint failure one should find anterior horizontal displacement in the flexion view and radiologically detectable abnormal patterns of coupling in the posterior elements [8]. Flexion-extension views can detect four types of segmental instability: forward translation of one vertebra over the other - anterior sliding instability; backward translation - posterior sliding instability; excessive angular movement of a motion segment / rotation - angular instability; and, abnormal axial rotation in which posterior margin of the vertebral body has a focal double contour during bending.

The purpose of this study was to correlate the manual examination of lumbar PAIVM (assessed

manually using the central PA pressure) with radiological method (using flexion- extension radiograph of the lumbar spine), at the lumbar spinal levels L<sub>1</sub> to L<sub>5</sub> in asymptomatic participants.

## Materials and Methods

### *Ethical clearance*

The study protocol was approved by the Institutional ethics committee of Kasturba Medical College (Manipal University), Mangalore. All participants were required to provide a written informed consent prior to their screening and participation in the study.

### *Study design:*

Cross-sectional study, with random-order repeated-measures design.

### *Study setting*

Out-patient treatment setting in a multispecialty university-affiliated teaching hospital.

### *Study location*

Dept of Physiotherapy Kasturba Medical College (Manipal University), Mangalore.

### *Sampling*

Convenient sampling

### *Subjects*

Asymptomatic participants were recruited upon providing one-one verbal information from staff, students and patient caregivers in Kasturba Medical College Hospital, Mangalore.

### *Participant selection*

The participants were selected based upon the following inclusion criteria: age between 18-45 years; no history of low back pain; nor previous trauma or surgery to lumbar spine; no previous medical illnesses in 6 months; and ability to provide consent. Those who had obesity, pregnancy or pain/ discomfort during manual examination were excluded.

*Tester 1:* Selected subjects were evaluated by a qualified physiotherapist who was a lecturer in

Musculoskeletal and manual therapy. He performed the manual assessment of intervertebral mobility using the central Postero Anterior pressure. He was blinded from the clinical and the radiological findings of the subjects found by the other testers.

*Tester II:* Performed the screening physical examination of the lumbar spine, was a student physiotherapist, who was blinded from the study.

*Tester III:* Performed the functional radiographs of the lumbar spine, who was an X-ray technician, was blinded from the study.

*Tester IV:* Performed the radiological measurement of lumbar intervertebral mobility using the flexion-extension radiographs, who was a qualified physiotherapist, was blinded from the study.

### **Testing instruments**

- Joint play grading scale
- Standard X-ray equipment
- Screening checklist (see appendix)
- Marker to indicate spinous processes of lumbar spine
- Cotton and spirit to erase the markings on the skin
- Plinth
- Pillow
- Ruler
- Goniometer
- Inch tape

### **Procedure**

Each subject served as their own controls. The order of procedure- manual and radiological examination were randomly assigned to each subject that is some subjects received manual examination first and then radiological whereas others vice versa.

Tester II did the screening examination of all the subjects according to the lumbar spine screening and evaluation form shown in appendix.

Tester I did the manual examination of the intervertebral mobility using the central postero anterior pressure.

The functional radiographs of the lumbar spine were taken at the department of radio diagnosis, Kasturba medical college hospital, Attavar, Mangalore by the same technician for all the subjects who was blinded from the study.

### **Independent observer**

Subjects were given a detailed description about the procedure and written consent was obtained for participation in the study. Subjects were assessed in the order of presentation to the department. All subjects were examined in the same time of the day (10 am to 12 pm) to minimize the effect of circadian variation on the findings of spinal examination [17]. Subjects were included after the screening examination (given in the appendix- II).

### *Technique of application of central PA pressure*

#### *Position of Subject*

During the procedure, he/she was asked to be as relaxed as possible and was asked to report any pain or discomfort immediately. During testing subject was asked to hold the breath at the end of normal expiration during each trial and was allowed to breathe between trials (since tidal breathing changes the PA stiffness) 9. Subjects were asked to turn the face to other side to that of examiner (to avoid bias in application of the grades relative to the facial expression).

The subjects were positioned prone with arms by the sides, pillow under the subject's shin to maintain the knees in slight flexion [3]. All the subjects were assessed on the same plinth (since difference in plinth padding changes the PA stiffness) [9] in the same position described (to avoid changes in lumbar PA stiffness with change of positions [10] and to avoid the sagittal plane rotation of pelvis [10] which might alter the PA stiffness).

#### *Surface Marking*

Level of L5 was traced from inter-space between L4 and L5 from the highest point of iliac crest and was marked with a marker. Level of L1 was traced from lower end of 12<sup>th</sup> ribs corresponding to L2 and was marked with a marker.

#### *Technique*

The therapist stands by the side of the plinth in walk stance position. The arms were aligned parallel to each other and straight such that both the thumbs are extended and opposing on each other's dorsum and vertically aligned to the spinous process of lumbar vertebra. The PA pressure was applied from the shoulders and upper trunk. The direction of application of the pressure was vertical, to both the

levels for all three grades for all the subjects (since lumbar PA stiffness changes with the change in direction of the applied force) [10]. The tester assessed

the amount of inter-segmental mobility and the resistance [3] (see figure).

**Fig. 1:** showing the technique of application of Central Postero Anterior (PA) Pressure on the lumbar spine



Then the joint play is graded according to the scale as follows:

*Grade 0:* Ankylosed, Rigid (similar to applying pressure on wood- no movement possible)

*Grade 1:* Considerable Hypomobility (minimal movement possible with applying greater pressure, may accompany with pain- pressure on thick rubber ball)

*Grade 2:* Mild Hypomobility (movement is possible with resistance starting at the beginning of range or staying throughout the range- pressure on thin rubber ball)

*Grade 3:* Normal Mobility (movement is possible with resistance felt at the end of range, with an elastic rebound or dense oily feel- pressure on soft rubber)

*Grade 4:* Mild Hypermobility (movement is possible with absence of resistance at end of range or resistance is felt later in the range than normal- pressure on oil inside a balloon)

*Grade 5:* Considerable Hypermobility (increased movement range possible without any resistance, may accompany with spasm- pressure on water inside a balloon)

*Grade 6:* Unstable (movement detected even without application of pressure, a visible or palpable step sign may be noted, thus contra indicating therapist from applying any pressure- pressure on air inside a balloon)

The scale was found to have acceptable intra and inter tester reliability in manual assessment of subjects with non-specific low back pain. Three trials of assessment were done at each level and the mode was taken as the grade of joint play at that particular spinal level.

#### *Functional Radiography*

The functional radiographs were taken and each of the film- flexion view and extension view are assessed by tester IV separately.

#### *Flexion Radiograph*

The radiograph is traced on to a transparency for the margins of the vertebral body. Then the postero-superior (PS) and postero-inferior (PI) points of the vertebral body are marked. Similarly the antero-superior (AS) and antero-inferior (AI) points are marked. This marking is done for all the vertebral bodies of lumbar vertebrae and the sacrum.

#### *For Measuring Anterior Translation*

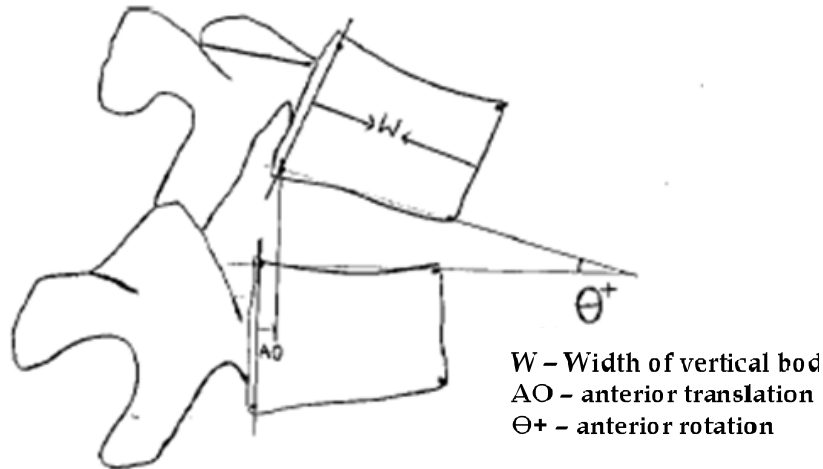
Join PS and PI of the lower vertebra. Draw a line from PI of the upper vertebra parallel to the earlier line. The perpendicular distance between the two lines drawn will measure the anterior translation of the upper vertebra over the lower one during flexion.

*For Measuring Anterior Rotation*

Join PI and AI of the upper vertebra. Join PS and AS of the lower vertebra. Project these two lines to

form the angle of anterior rotation of the upper vertebra on the lower one during flexion.

**Fig. 2:** Technique of measurement of anterior translation and positive / anterior rotation on lateral view of the lumbar spine in flexion.



*Extension Radiograph*

The radiograph is traced on to a transparency for the margins of the vertebral body. Then the postero-superior (PS) and postero-inferior (PI) points of the vertebral body are marked. Similarly the antero-superior (AS) and antero-inferior (AI) points are marked. This marking is done for all the vertebral bodies of lumbar vertebrae and the sacrum.

line. The perpendicular distance between the two lines drawn will measure the posterior translation of the upper vertebra over the lower one during extension.

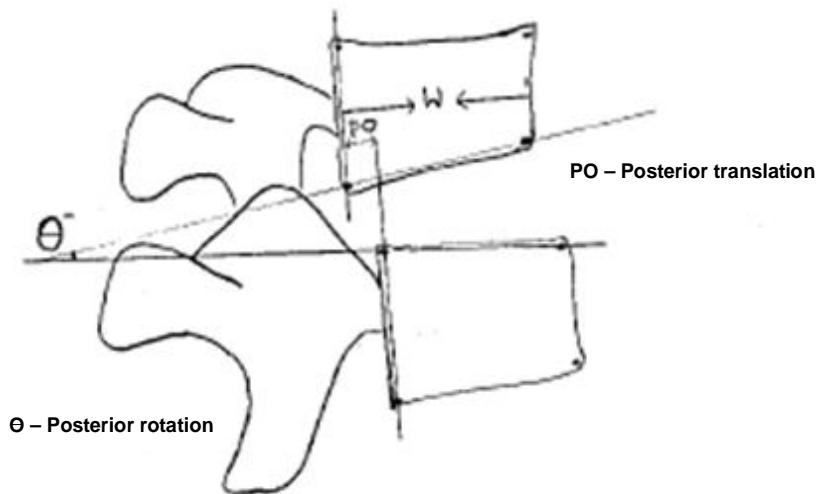
*For Measuring Posterior Translation*

Join PS and PI of the lower vertebra. Draw a line from PI of the upper vertebra parallel to the earlier

*For Measuring Posterior Rotation*

Join PI and AI of the upper vertebra. Join PS and AS of the lower vertebra. Project these two lines to form the angle of posterior rotation of the upper vertebra on the lower one during extension.

**Fig. 3:** Technique of measurement of posterior translation and negative / posterior rotation on lateral view of the lumbar spine in extension.



## Data Analysis

The grades of joint play obtained in manual examination of lumbar spine using central postero anterior pressure was compared with interpretation of lumbar inter-segmental mobility from functional radiography of lumbar spine using Karl Pearson Correlation Coefficient (KPCC). Confidence interval was kept at 95%. The analysis was done using SPSS 12.0.1 for windows.

## Results

### Key

JPGS- joint play grading scale

AT- anterior translation

AR- anterior rotation

PT- posterior translation

PR- posterior rotation

From the tables, it is evident that there was a comparable change in the segmental mobility measured using manual and radiological examination in all the five subjects studied. This finding is specifically noted between the JPGS with posterior rotation and anterior translation. E.g., a normal mobility on JPGS at L1 was seen with normal anterior translation and posterior rotation values from X-ray but not in posterior translation and anterior rotation. Following table showing Karl Pearson's Correlation Coefficient values for the variables measured.

Spinal levels	JPGS & AT	JPGS & AR	JPGS & PT	JPGS & PR
L1	.919 *	.745	.167	.913 *
L2	.913 *	-.327	-.200	.913 *
L3	.953 *	.620	.423	.930 *
L4	.919 *	-.134	.408	.919 *
L5	.913 *	-.645	-.408	.913 *

\* - indicate level of significance  $p < .05$

**Table 1:** Grades of joint play (as put forth by Stanley v Paris)

Grades of Joint Mobility	
Grade 0	Ankylosed
Grade 1	Considerable Hypomobility
Grade 2	Mild Hypomobility
Grade 3	Normal mobility
Grade 4	Mild hypermobility
Grade 5	Considerable hypermobility
Grade 6	Unstable

## Discussion

The current study showed that manual examination findings of intervertebral mobility correlated with the radiological findings in all the five asymptomatic subjects studied. This study has following implications:

- Manual examination of intervertebral mobility using the central postero anterior pressure is equivalent to radiological examination.
- The joint play grading scale could further be evaluated for its reliability and validity so that it could be easily applied to all subjects and it

would be a useful clinical tool in assessment of PAIVMs.

- The comparable nature of anterior translation and posterior rotation measured radiologically to manually could be because of the mechanics of the central postero anterior pressure that it produces anterior translation and posterior rotation of the tested vertebral segment.
- Further studies could be performed on a larger sample size and comparison with mechanical low back pain subjects.

## Conclusion

The study showed that manual examination of intervertebral mobility using central postero anterior pressure was comparable to the radiological assessment of intersegmental mobility of the spine in the forty eight asymptomatic participants studied.

This significant correlation was noted especially for the anterior translation and posterior rotation radiological measurements with the manual assessment using the central postero anterior pressure.

The joint play grading scale was a useful clinical tool to measure and record intervertebral mobility in the five normal subjects studied.

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## Other information

The study was previously presented as a platform presentation at 44<sup>th</sup> annual conference of Indian Association of Physiotherapists (IAP), at Ahmedabad in 2005.

## Conflicts of interest

None identified and/or declared.

## References

1. James A Porterfield, Carl De Rosa. Mechanical Low Back Pain, 2<sup>nd</sup> edition, 1988, W B Saunders, 4- 6.

2. G. A. Jull. Examination of the articular system, in Grieve Modern Manual Therapy- The Vertebral Column, 2<sup>nd</sup> edition, 1994, Churchill Livingstone, 520- 5.
3. G. D. Maitland. Vertebral Manipulation, 5<sup>th</sup> edition, 1986, Butterworths, 71, 72, 76, 96, 97, 98, 282.
4. Bjornsdottir S V, Kumar S. Postero Anterior mobilisation: state of the art and review. Disabil. Rehab. 1997; 19(2): 39- 46.
5. L. S. Gifford. Influence of circadian variation on spinal examination, in Grieve Modern Manual Therapy- The Vertebral Column, 2<sup>nd</sup> edition, 1994, Churchill Livingstone, 503- 509.
6. McGill S, Seguin J, Bennett G. Passive stiffness of the lumbar torso in flexion, extension, lateral bending, and axial rotation. Effect of belt wearing and breath holding. Spine, 1994; 74(9): 801- 9.
7. Latimer J, Holland M, Lee M, Adams R. Plinth padding and measures of posteroanterior stiffness. J Manip Physiol Ther, 1997; 20(5): 315- 9.
8. Radiological evaluation of lumbar intervertebral instability- Wg Cdr A Alam. Ind J Aerospace Med 2002; 46(2)
9. Edmondston S J et al. Effect of position on the posteroanterior stiffness of the lumbar spine. Man Ther, 1998; 3(1): 21- 26.
10. Lee M, Lau H, Lau T. Sagittal plane rotation of the pelvis during lumbar posteroanterior loading. J Manip Physiol Ther, 1994; 17( 3): 149- 55.
11. Viner A, Lee M. Direction of manual force applied during assessment of stiffness in the lumbar spine. J Manip Physiol Ther, 1995; 18(7): 441- 7.