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Intra-Tester and Inter-Tester Reliability of Measures of Pelvic Inclinometer in Standing Using Hand Held and Mounted Pelvic Inclinometer in Asymptomatic Individuals

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Abstract:

Background: Determination of innominate bone inclination in standing is frequently assessed in postural analysis of subjects. Currently, no goniometer for objective assessment of innominate bone inclination in standing is commercially available. PELVIN[®], patented and registered equipment, was designed indigenously by the author. The purpose of this study was to determine the intra tester and inter-tester reliability and validity of measures taken with a pelvic inclinometer when used hand held and when mounted on stand.

Aim: To assess inter tester and intra tester reliability measures of pelvic inclinometer in standing using hand held and mounted pelvic inclinometer in asymptomatic individuals.

Methodology: A cross-sectional study involving 105 asymptomatic subjects was conducted. The sample was age and gender matched homogeneous group, divided in three groups age wise, Group I: 20-35 years, Group II- 36 -50 years and Group III- 51-60 years. All the subjects were recruited at their will and they signed a consent form after understanding the process through a written information sheet provided to them prior to the conducting the study. The Ethics Committee of D.Y.Patil University, Nerul, Navi Mumbai granted us the permission to conduct this study.

Results: The mean values of 11.79 degrees and 9.03 degrees were obtained as right and left pelvic tilt angles respectively. As the data sheet indicates the ICC values and the Cronbach's alpha value demonstrates significant relationship between two sets of data. The reliability test which was done by using SPSS version 16 showed congruity between two sets of inclinometer data. Therefore demonstrating good Intertester reliability, Intratester reliability also shows similar results with good reliability.

When pelvic inclination angles measured by mounted and hand held inclinometer yielded ICC value of 0.8 to 0.9 and Cronbach's alpha value of .941 and 0.88 of the right and left innominates respectively throughout, thus demonstrating strong Intertester reliability between the two methods of measurement recorded by both the investigators.

Intratester reliability also demonstrated strong congruity with an ICC value ranging from 0.921-0.88 for the right and left innominates respectively, thereby demonstrating a strong Intratester reliability too. Anova test was used to compare the differences between the measures of pelvic tilt angle measured by the two investigators. A non-significant difference was obtained at $p < 0.05$ which are suggestive or less variability and validates the equipment for clinical use.

Conclusion: There is no difference in the pelvic inclination angles, when measured either by a mounted or a hand held validated pelvic inclinometer as a strong inter and intra reliability is demonstrated in two sets of data.

Keywords: Innominate Bone, Pelvic Tilt, Pelvic inclinometer, PELVIN[®], low back pain, Posture.

1. Introduction

Pelvic tilt is defined as the angle between the horizontal plane and line passing through the midpoint of the posterior superior iliac spine and midpoint of anterior superior iliac spine. It is usually measured using pelvic inclinometer.¹ (Refer figure 1)

Determination of innominate bone inclination in standing is frequently assessed in postural analysis of subjects. Currently, no goniometer for objective assessment of innominate bone inclination in standing is commercially available. The purpose of this study was to determine the intra tester and inter-tester reliability and validity of measures taken with a pelvic inclinometer when used hand held and when mounted on stand.

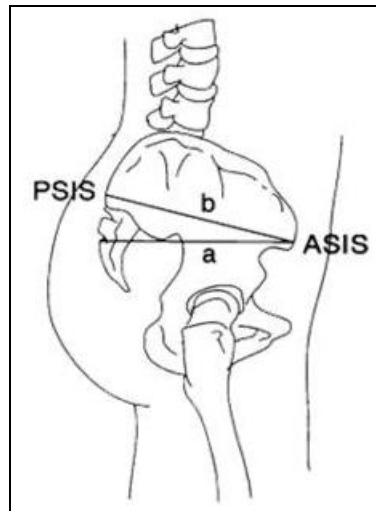


Figure 1: Schematic diagram of the pelvis. The pelvic inclination angle is defined as the angle between the horizontal and a line drawn between the ASIS and the PSIS.

This invention has to do generally with instruments for use by the medical profession. An object of the invention is to provide an improved instrument, termed a pelvic inclinometer, and designed indigenously- for clinical purpose in determining the inclination or tilt of the pelvis of the body. Another object is to provide an instrument of the type indicated which is easy to use and by means of which physician or doctor can readily determine the inclination or angle of the pelvis with relation to the horizontal. Another object is to provide a pelvic inclinometer of simple construction which can be readily and economical manufactured and marketed.

It is estimated that up to 80% of patients with low back pain have no diagnosed pathology for their pain. Non pathological causes of pain include possible biomechanical factors such as disturbed stress patterns at the sacroiliac joint and lumbar spine. One asymmetry that is commonly thought to be associated with disturbed stress patterns is unequal innominate bone inclination in the sagittal plane, often described as a pelvic asymmetry. Pelvic symmetry is often evaluated as part of the examination for postural deviations and leg length discrepancies. The credibility of postural assessments has been hampered by the fact that many clinical tests/measures for assessing pelvic asymmetry have been shown to lack precision, or the methods are unreliable. Given these facts, an instrument and method that yields precise and reliable measures of innominate bone inclination would enhance credibility for physical therapists as they evaluate and treat problems involving pelvic tilt angle or asymmetrical innominate bone inclination. Such a method would yield a determination of pelvic asymmetry by comparing measures of inclination of both innominate bones.

There have been many studies done on pelvic angle inclination using pelvic inclinometer and reliability of the instrument but their conclusion was to redesign or to use the stand to measure the tilts and check for reliability of it. (2); Loebl (3) had first described the use of an inclinometer. Sanders and Stavrakas (4) measured the pelvic tilt using the trigonometric formula to determine a relationship between ASIS and PSIS. Another study was done by Richard D. Crowell, MS, PT; Cordon S. Cummings et al (5) who had done inter and intra tester reliability of measurements of innominate bone.

The present study was designed to measure and check the reliability of pelvic inclinometer when used hand held versus mounted on stand in a group of asymptomatic population of adults [Group A being 20-35 yrs; Group B 36-50 yrs & Group C being 51-65 yrs].

Using valid, reliable, safe, portable and low price measurement tools is necessary in clinical evaluation. Use of registered medical equipments not only ensures safety but also efficiency of the examination tool to be used as diagnostic equipments in physiotherapy clinics. Use of a pelvic inclinometer clinically to measure pelvic inclination angles is a non-invasive, quick, user-friendly and harmless method. This tool was used in various studies done in different countries by several researchers. However, the unavailability of indigenously designed equipment in our country restricted the Indian physiotherapist in complete clinical evaluation of patients. We design such a reliable and a valid tool to be used by therapists to assess the pelvic inclination angle. The inter-reliability and intra-reliability of which was established in our previous published study (6). We further wanted to establish the method in which the therapists should record the pelvic angles and hence we conducted this study to ascertain the inter and intra reliability of measuring the same using hand-held or mounted pelvic inclinometer.

2. Aim of the Study

To assess inter tester and intra tester reliability measures of pelvic inclinometer in standing using *hand held* and *mounted pelvic inclinometer* in asymptomatic individuals.

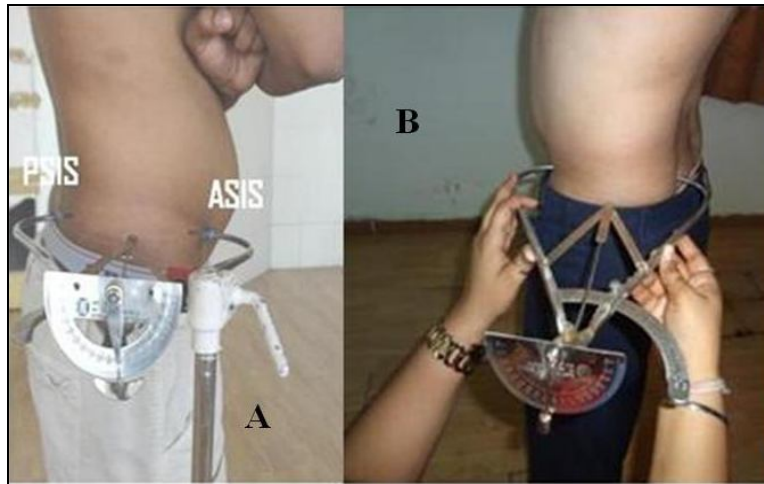


Figure 2: Method of measuring pelvic inclination angle using A- mounted inclinometer and B-Hand held inclinometer.

3. Materials and Methodology

Prior to collecting the experimental data two physiotherapists were taught and practiced using the PELVIN to become proficient in its use. When the two therapists became proficient in their tasks the data collection commenced. The asymptomatic subjects were drawn randomly from a pool of incoming patients and relatives visiting D.Y. Patil hospital and research centre, Nerul, Navi Mumbai. This provided us for a random mix of asymptomatic peoples of various age, backgrounds and location of origin. 105 asymptomatic subjects were randomly recruited in the study at their will where each subject had the nature and purpose of the study explained to them in a language best known to them via an information sheet following which they signed a written consent form indicating their willingness to be a part of the study. The Ethics committee of D.Y.Patil University granted us the permission to conduct this study. The subjects were independently and in turn, assessed by the two therapists using a handheld PELVIN and mounted Pelvin successively.

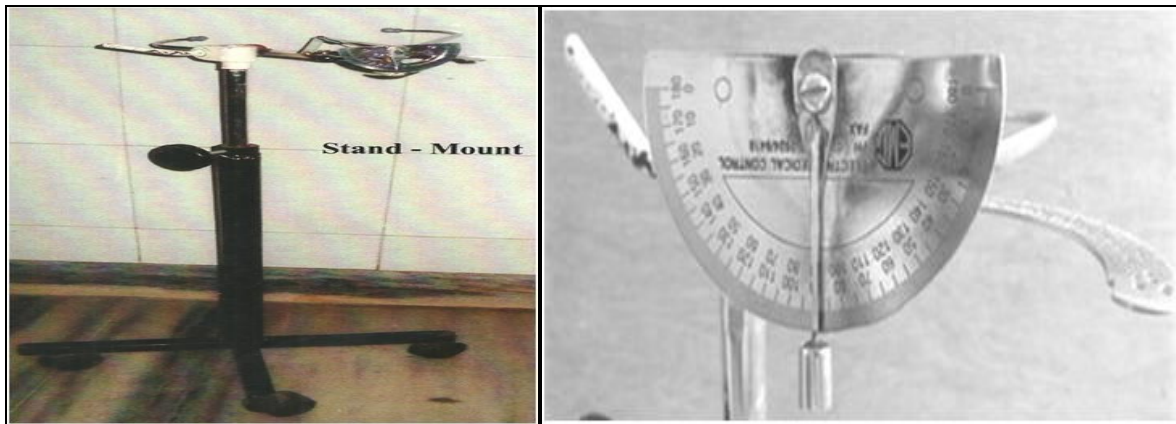


Figure3: Position of the mounted inclinometer and the pendulum on the protractor

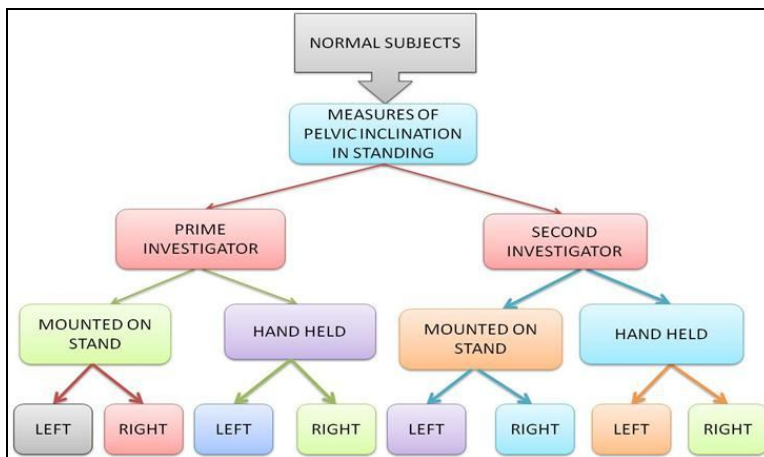


Figure 4: Flow chart of methodology of the study

Three readings of each method by each therapist were recorded. Therefore, each therapist recorded a total of six times on either side, using both the methodologies. A total of 12 readings comprising right and left innominate bone and also using the hand-held device and mounted device. The methodology of measurement was as per the method followed for the previous study (6). As shown in figure 2, for the hand-held device, the subject stands in a normal resting stance and examiner applies one tip of the calipers to the anterior-superior iliac spine (ASIS) of one of the subject’s ilia; he applies the other tip to the posterior-superior spine (PSIS) of the same ilium; and, finally, brings the closed end of the calipers to a position such that the pendulum hangs free over the protractor. In this position, the plane of the protractor is perpendicular to the floor and the therapist can thus measure the angle of inclination of that ilium from the protractor scale. Potter and Rothstein reported poor intertester agreement for palpation of PSIS and ASIS in standing (7). For the measurements recorded by the mounted inclinometer the subject simply stand in a relaxed stance in between the two tips pointed to the ASIS and PSIS respectively, such that the examiner is free to measure the angles independently without worrying to adjust the two ends of the inclinometer. Here the inclinometer is mounted on a metal stand such that the pendulum would remain in the neutral position at rest, as shown in Figure 3. The measurement is recorded when the plane of protractor lies in perpendicular to plane of floor, by protractors which measure pelvic inclination. Three such readings are recorded on the Right side first followed by left side measurements, and then reading is repeated again without stand in the same procedure with holding the instrument in hand, by each of the therapists. These readings were taken in 105 subjects who were divided into 3 groups’ age wise i.e. 20-35 years, 36-50 years, and 51-65 years old. For intra tester three readings on each side taken by one therapists reading of whom are then compared for reliability. For inter tester measurements were taken by 2 investigators whose readings were then compared for reliability. Refer flowchart in figure 4 for a summary of the methodology.

4. Results

It was ascertained that both the investigators are similar on either side with little variation when measured by a mounted or handheld pelvic inclinometer.

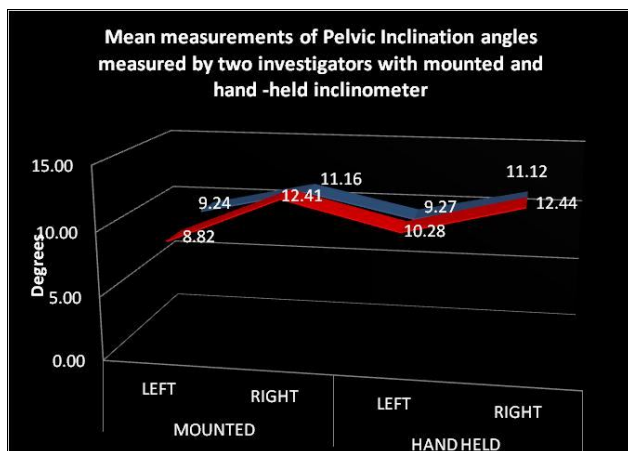


Figure 5

Investigators	Mounted		Handheld	
	Left	Right	Left	Right
1st investigator	8.82	12.41	10.28	12.44
2nd investigator	9.24	11.16	9.27	11.12

Table 1: Mean measures of Pelvic inclination angles as measured by the two investigators

The mean pelvic inclination angles measured by each investigator are as shown in the Table 1. Figure 5 depicts the graphical representation of the same.

Reliability of the methodology was tested using Intra-class correlation coefficient test and Cronbach’s alpha. Table 2 shows the values of the test.

- MSLT1st—Mounted stand Inclinometer readings on the left side measured by the 1st therapist
- MSRT1st-- Mounted stand Inclinometer readings on the right side measured by the 1st therapist
- MSLT2nd-- Mounted stand Inclinometer readings on the left side measured by the 2nd therapist
- MSRT2nd-- Mounted stand Inclinometer readings on the right side measured by the 2nd therapist
- HDLT1-- Handheld Inclinometer readings on the left side measured by the 1st therapist
- HDRT1st-- Handheld Inclinometer readings on the right side measured by the 1st therapist
- HDLT2-- Handheld Inclinometer readings on the left side measured by the 2nd therapist
- HDRT2-- Handheld Inclinometer readings on the right side measured by the 2nd therapist

Inter- reliability	ICC value	Cronbach's alpha
MSLT1st MSLT2nd	0.9	0.9
MSRT1st MSRT2nd	0.8	0.9
HDLT1st HDLT2nd	0.9	0.9
HDRT1st HDRT2nd	0.9	0.9
MSLT1st HDLT1st	0.8	0.9
MSRT1st HDRT1st	0.9	0.9
MSLT2nd HDLT2nd	0.8	0.9
MSRT2nd HDRT2nd	0.9	0.9
Intra—reliability		
MSLT1 MSLT2	0.92	0.96
MSRT1 MSRT2	0.95	0.98
HDLT1 HDLT2	0.95	0.98
HDRT1 HDRT2	0.96	0.98

Table 2: ICC values and Cronbach's values of Reliability testing

5. Discussion

The purpose of this study was to find out reliability of methodology of using a validated pelvic inclinometer (PELVIN). Sanders and Stavarakas et al (4) measured the pelvic tilt using the trigonometric formula to determine a relationship between ASIS and PSIS. However we devised the inclinometer in a way that it gives a uniplanar movement and it stabilizes the subject at the bony landmarks firmly so that noting the readings is easier and thus it reduces the 2 therapist requirement as shown in the study by Walker et al. (1) previous study done by Joseph A. Berg, Arcadia calif, et al (2); W. Humphrey et al (5) mentioned that pelvic inclination angle should be measured on stand, which would reduce the chances of errors which occurs while measuring the angle using on hand held pelvic inclinometer.

Two investigators participated in the experiment with two sets of reading of pelvic inclination on right and left sides. An average of the three repeated sets of reading of the principle investigator on either side using hand held as well as mounted inclinometer was considered. On analysis the value of intra class reliability shows Cronbach's alpha value of 0.96 and intra class correlation coefficient of 0.92 on left where as C alpha of 0.98 and 0.96 ICC on right side. And Intratester reliability of hand held pelvic inclinometer showed similar results.

Also for Inter tester reliability between measures of first and second investigator yielded interclass correlation coefficient (ICC) for of pelvic inclinometer on mechanical stand was 0.85 on either sides also the cronbach's alpha value of 0.92 on either side while ICC value with hand held pelvic inclinometer is 0.86 with cronbach's alpha value of 0.92 on either sides.

When the two methodology were compared the ICC values were observed to be 0.8 with cronbach's alpha value of 0.9 on left while an ICC value of 0.9 with cronbach's alpha value of 0.9 on the right. Similar readings were seen with the readings of second investigator. Therefore the contrasting results of our study as compared to the study by W. Humphrey et al (5) both the instigators result matched while using the pelvic inclinometer in either of the techniques wiz mounted or hand-held.

6. Conclusion

From the result of our study it can thereby concluded that there is no difference in the pelvic inclination angles. When measured either by a mounted or a hand held validated pelvic inclinometer as a strong inter and intra reliability is demonstrated in two sets of data.

7. Clinical Implications

The results of this study clearly indicate that an experienced physical therapist can make reliable measurements of innominate bone inclination with the inclinometer. The pelvic inclinometer offers promise as a useful measurement device for the clinician who treats postural problems related to pelvic tilt angle and pelvic asymmetry. The precision of the instrument and procedure will allow for normative data collection. Clinicians must have knowledge of how much normal variation in measures may occur from day to day, what percent of asymmetry can be expected in both the normal and patient populations, and whether measured changes are significant enough to be attributed to treatment intervention. Our study suggests that clinicians can learn to use the device with a few hours of practice and can achieve sufficient precision in measures to detect the small changes that we expect in pelvic position or innominate inclination. Testers familiar with the pelvic inclinometer were able to determine the inclination of both left and right innominate bones of a subject in less than 2 minutes. If a client has palpable landmarks and can stand for 2-4 minutes, then an objective assessment of his or her innominate bone inclination can be determined. Standardization of objectively assessing pelvic tilt, i.e., innominate bone inclination, should be accepted practice and be an integral part of goniometric measurements of the musculoskeletal system. It is not mandatory to have it mounted on a stand for increased precision. With this study we ascertain hand held inclinometers also give precise and reliable measurements of pelvic inclination angles.

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