"Testing A New And Efficient Tool To Measure Anterior And Posterior Pelvic Tilt In Healthy Young Population"

Sagar Singh Bisht[1], Prof. (Dr.) Deepak Raghav[2]*, Dr. Tanvi Agarwal[3],

[1]Department Of Physiotherapy, Santosh College Of Physiotherapy, Santosh University, Ghaziabad India,7503729827, Email: Sagar.bisht@gmail.com
[2]*Department Of Physiotherapy, Santosh College Of Physiotherapy, Santosh University, Ghaziabad, India, 9868315824, Email: Deepak.raghav@santosh.ac.in
[3]department Of Physiotherapy, Santosh College Of Physiotherapy, Santosh University, Ghaziabad India,9654949353, Email: drtanviagg@gmail.com

***Corresponding Author:** Prof. (Dr.) Deepak Raghav
*Department Of Physiotherapy, Santosh College Of Physiotherapy, Santosh University, Ghaziabad, India, 9868315824, Email: Deepak.raghav@santosh.ac.in

Abstract
AIM: To develop, test and measure the reliability of a new tool for the measurement of pelvic tilt for application in clinical examination.
SUBJECTS AND METHODS: A convenience sample of 100 healthy subjects (All Males) were recruited. Of the 100 subjects, only 90 were included in the testre-test reliability assessment sessions were between 18-40 years of age, were able to stand unsupported for the duration of the measurement process (<10min) ,were free from existing low back injuries, had not experienced any low back injuries within the previous 3 months, pelvic tilt of the subject were measured and again measured after 10 min
RESULT: Testre-test reliabilities (within sessions) of the DPI for measuring pelvic tilt on the right and left sides, as assessed by intra-class correlation coefficient (ICC), standard error of measurement (SEM) to be considered real. The ICC and SEM for right pelvic tilt were 0.96** and 7.13 and for left pelvic tilt were 0.94** and 5.73 respectively. the mean and standard deviation of right side of pelvic tilt angle was 7.48 and 4.05 and left pelvic tilt angle was 7.31 and 3.32 and the difference was 0.17 and 0.73 respectively
CONCLUSSION: The results indicate that the DPI produces acceptably reliable measurements, although further research is required to establish the validity of the DPI in measuring pelvic tilt.

Key Words - Pelvic tilit, DPI, Test re-test

INTRODUCTION

Pelvic tilt is defined as the angle between the horizontal plane and the line passing through the midpoint of the posterior superior iliac spine and the midpoint of the anterior superior iliac spine. It is usually measured using a pelvic inclinometer. (Loot, 2007)[4] .Pelvic tilt has often been measured in clinical practice to identify the presence of abnormal postures that may cause dysfunction and lead to chronic musculoskeletal pain conditions (Herrington, 2011)[1], such as low back pain (Juhl, Cremin& Russell, 2004). However, in cross-sectional studies, anterior pelvic tilt has not often been identified as a risk factor for low back pain. Pelvic tilt is the orientation of the pelvis with respect to the thighbones and the rest of the body. The pelvis can tilt towards the front, back, or either side of the body. Anterior pelvic tilt and posterior pelvic tilt are very common abnormalities in regard to the orientation of the pelvis. Pelvic tilt (PT) is a position-dependent parameter defined as the angle created by a line running from the sacral endplate midpoint to the centre of the bifemoral heads and the vertical axis. The average ranges of anterior and posterior pelvic tilting are 13.0 ± 4.9°, and 8.9 ± 4.5°, respectively (Takaki S et al., 2019)

SUBJECT AND METHOD

Following a power analysis as described by Wolak, Fairbairn & Paulsen (2012)[81] a convenience sample of 100 healthy subjects (All Males) were recruited. Of the 100 subjects, only 90 were included in the test-retest reliability assessment sessions (for subject characteristics relevant to each assessment)

Subjects qualified for the study if they met the following criteria: were between 18-40 years of age, were able to stand unsupported for the duration of the measurement process (<10min), were free from existing low back injuries, had not experienced any low back injuries within the previous 3 months, and had no medical condition leading to clinically meaningful leg length inequality. Formal written permission was obtained from the study respondents before data collection. The purpose and the duration of the study were explained. The sample was to be selected and their consent was obtained. The sample was selected by using a probability convenient sampling technique. The study Performa was administered to collect the required information from the healthy young subjects. The collected data was recorded and analysed for each subject.

DEVICE BUILDING PROCEDURE

A metal piece measuring 23 cm in length is selected which will be used as the base of the device, while choosing the metal piece the rigidity of the device should be re-examined. Two more metal pieces with lengths 15 cm each are also selected which will act as the arms of the device These arms will function as the calipers of the device. These arms are then placed at the end of the base and they are fixed there with a rotter bolt and cap nut so that each side is freely movable 360 degrees in the horizontal plane. The ends of the arms can be easily placed on the bony landmarks (ASIS & PSIS). A mark is made with a marker on the base of the device at 11.5 cm to find the mid-point of the base. A digital inclinometer (INSIZE 2179- 360) is then selected for measuring the inclination angle which can measure up to(0-360 degrees) The accuracy of the digital device is (+-0.2) as mentioned by the device manufacturer. Over the centre of the digital inclinometer, a mark is also marked so as to find the midpoint of the digital device. Mid-point of the digital inclinometer is aligned with the mid-point of the metal base so that to find an exact variable angle. The digital inclinometer while aligned with the metal base will get attached to the base with inbuilt magnets Now device arms can be placed over bony landmarks and when the digital inclinometer is switched on, the outcome variable can be read off from the LCD of the digital device

Photograph 6.1 Base of the device with two arms

Photograph 6.2 Digital inclinometer

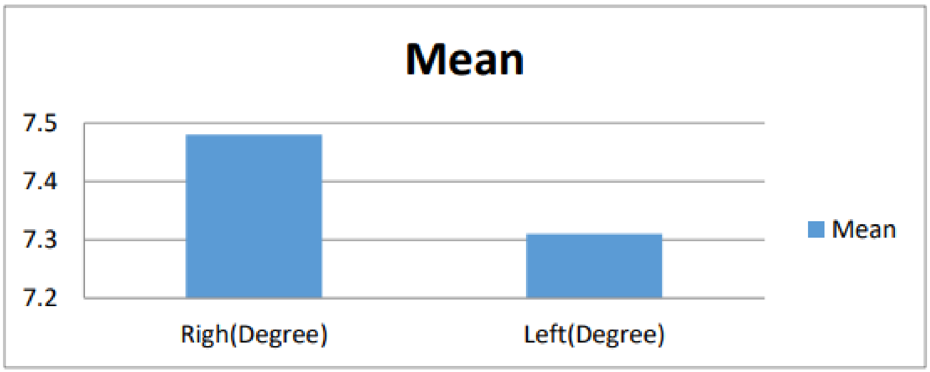
Photograph 6.3 completely assembled DPI

MEASUREMENT PROCEDURE

To measure the pelvic inclination angle, the subjects stood on a flat surface barefoot and looked at the front while their legs were as wide as their shoulders and their hands were crossed on their chests. Then, one arm of the tool was placed on the subjects' anterior superior iliac spine (ASIS) and the second one on their PSIS of the same side. The angle shown on the Digital inclinometer was reported as the pelvic inclination angle. In addition, the subject were blinded from the result, and could not pass details to subjects. The practitioner then reads off the degree of inclination from the LCD.

RESULT

and test_re-test reliability of the DPI for measuring pelvic tilt angle on both right and left sides of the pelvis were assessed, in a convenience sample of young, healthy males. Intra-rater and test re-test reliabilities (within sessions) of the DPI for measuring pelvic tilt on the right and left sides, as assessed by intra-class correlation coefficient (ICC), standard error of measurement (SEM) to be considered real. The ICC and SEM for right pelvic tilt were 0.96** and 7.13 and for left pelvic tilt were 0.94** and 5.73 respectively. the mean and standard deviation of the right side of the pelvic tilt angle was 7.48 and 4.05 and the left pelvic tilt angle was 7.31 and 3.32 and the difference was 0.17 and 0.73 respectively among the respondents in the group



Graph 1

	Right (Degrees)	Left (Degree)	Difference (Degree)
Mean	7.48	7.31	0.17
Standard Deviation	4.05	3.32	0.73

Table 1 Descriptive statistics for pelvic tilt angle

	Right	Left
ICC	0.96**	0.94**
SEM	7.13	5.73

Table 2intrarater and test-retest reliabilities of the DPI

DISCUSSION

For intra-rater and test-rest reliability, our findings (ICC = 0.94-0.96; SEM =5.73-7.13degrees) are broadly in line with those of other investigations in similar devices measuring pelvic tilt. In their trial of a very similar type of calliper-based inclinometer to the DPI, Crowell et al. (1994) reported good intra-rater reliability (ICC=0.92; SEM = 0.93 degrees; MD = 2.6 degrees) and good inter-rater reliability (ICC = 0.95; SEM = 0.78 degrees; MD = 2.2 degrees), Preece et al. (2008)] reported good intra-rater reliability (albeit in cadavers) (ICC = 0.98; SEM= 1.1 degrees; MD = 3.1 degrees), Gnat et al. (2009)] reported good intra-rater reliability (ICC = 0.99; SEM and MD not reported), Herrington (2011)[1] reported good intra-rater reliability (ICC = 0.87; SEM = 1.1 degrees; MD = 2.5 degrees), and Fourchet et al. (2014)[] reported good inter-rater and intra-rater reliability (coefficient of variation = 15.8%). The reliability of the PALM in assessing linear differences in iliac crest height has also been found to be good (Petrone et al., 2003)[] but whether such findings can be considered as directly comparable with the measurement of pelvic tilt angle is unclear. The reliability of a three-dimensional(3D) camera-based motion capture system reported by Levine & Whittle (1996) was also found to be good but interestingly no better than the PALM (ICC D 0.95; SEM = 0.96 degrees; MD = 2.7 degrees) and the calliper-based system used by Gajdosik et al. (1985)[also displayed similar reliability (ICC = 0.88; SEM = 1.4 degrees; MD = 4.0 degrees). Regarding pelvic tilt, our descriptive statistics (means of 10.5_10.6 degrees) are in line with the findings of other investigations, across various measurement devices. Using a PALM device, Herrington (2011)[1] measured pelvic tilt in a population of 120 young, healthy subjects (65 males and 55 females, aged 23.8 years). It was reported that 85% of males and 75% of females displayed an anteriorly rotated pelvis, in the range of 6_7 degrees. Also using a PALM device, Lee, Yoo& Gak (2011)[measured pelvic tilt in a population of40 young, healthy subjects (23 males aged 23.8 years and 17 females aged 21.4 years) and found that anterior pelvic tilt was 7_8 degrees. Gajdosik et al. (1985)[85] measured pelvic tilt in a population of 20 healthy males, aged 25.2 years, and reported a mean anterior pelvic tilt angle of 8.5 _ 4.1 degrees. Using a 3D camera-based motion capture system, Levine& Whittle (1996) measured pelvic tilt angle in a population of 20 healthy female subjects, aged 23.4 years, and reported a mean anterior pelvic tilt angle of 11.3 _ 4.3 degrees. Using radiography, Vaz et al. (2002)measured pelvic tilt angle in 100 healthy students from medical professions, aged 27 years, and reported a mean anterior pelvic tilt angle of 12.3 5.9 degrees. From this very brief review, it seems that calliper or caliper-inclinometersystems (Gajdosik et al.,1985[Herrington, 2011[Lee, Yoo& Gak, 2011) tend to report slightly lower values of anterior pelvic tilt (6_8 degrees vs. 11_12 degrees) than those found using more sophisticated methods (Levine & Whittle, 1996)[It is interesting that the values reported here using the DPI (means of 10.5_10.6 degrees) are at the higher end of the spectrum reported in the literature and closer to those observed using more sophisticated methods. Whether this is a feature of the population measured, the presence of a spirit level in the DPI to standardize measurements relative to the ground, systematic bias in the DPI, or systematic bias in the raters is unclear.

REFERENCES

1. Herrington L. Assessment of the degree of pelvic tilt within a normal asymptomatic population. Manual therapy.2011Dec1;16(6):6468.
2. Juhl JH, Cremin TM, Russell G. Prevalence of frontal plane pelvic postural asymmetry—part 1. Journal ofOsteopathicMedicine.2004Oct1;104(10):41121..
3. Takaki S, Kaneoka K, Okubo Y, Otsuka S, Tatsumura M, SHIINA I, Miyakawa S. Analysis of muscle activity during active pelvic tilting in sagittal plane. Physical therapy research. 2016 Dec 20;19(1):50-7.Available from:
4. Loots M. A multi-variate approach to posture (Doctoral dissertation, University of Pretoria).2007
5. López-Miñarro PA, Muyor JM, Belmonte F, Alacid F. Acute effects of hamstring stretching on sagittal spinal curvatures and pelvic tilt. Journal of human kinetics. 2012 Mar;31:69
6. Bond M. The new rules of posture: How to sit, stand, and move in the modern world. Simon and Schuster; 2006Nov29
7. den Bandt HL, Paulis WD, Beckwée D, Ickmans K, Nijs J, Voogt L. Pain mechanisms in low back pain: a systematic review with meta-analysis of mechanical quantitative sensory testing outcomes in people with nonspecific low back pain. journal of orthopaedic & sports physical therapy. 2019 Oct;49(10):698-715.

8. Defrin R, Brill S, Goor-Arieh I, Wood I, Devor M. "Shooting pain" in lumbar radiculopathy and trigeminal neuralgia, and ideas concerning its neural substrates. Pain. 2020 Feb 1;161(2):308-18.
9. Rubino FA. Gait disorders. The neurologist. 2002 Jul 1;8(4):254-62.
10. LaRoche DP, Cook SB, Mackala K. Strength asymmetry increases gait asymmetry and variability in older women. Medicine and science in sports and exercise. 2012 Nov;44(11):2172.
11. Flechas J, Abraham G. Alternative Treatment of Fibromyalgia Using the Oxytocin-Hormonal-Nutrient Protocol to Increase Nitric Oxide. The Original Internist. 2007;14(3).
12. Preece SJ, Willan P, Nester CJ, Graham-Smith P, Herrington L, Bowker P. Variation in pelvic morphology may prevent the identification of anterior pelvic tilt. Journal of Manual & Manipulative Therapy. 2008 Apr 1;16(2):113-7.
13. Cummings G, Scholz JP, Barnes K. The effect of imposed leg length difference on pelvic bone symmetry. Spine. 1993 Mar 1;18(3):368-73.
14. Young RS, Andrew PD, Cummings GS. Effect of simulating leg length inequality on pelvic torsion and trunk mobility. Gait & posture. 2000 Jun 1;11(3):217-23.
15. Betsch M, Wild M, Große B, Rapp W, Horstmann T. The effect of simulating leg length inequality on spinal posture and pelvic position: a dynamic rasterstereographic analysis. European spine journal. 2012 Apr;21(4):691-7
16. Wild M, Kühlmann B, Stauffenberg A, Jungbluth P, Hakimi M, Rapp W, Betsch M. Does age affect the response of pelvis and spine to simulated leg length discrepancies? A rasterstereographic pilot study. European Spine Journal. 2014 Jul;23(7):1449-56..
17. Krawiec CJ, Denegar CR, Hertel J, Salvaterra GF, Buckley WE. Static innominate asymmetry and leg length discrepancy in asymptomatic collegiate athletes. Manual therapy. 2003 Nov 1;8(4):207-13.. 18. Knutson GA. Anatomic and functional leg-length inequality: a review and recommendation for clinical decision-making. Part I, anatomic leg-length inequality: prevalence, magnitude, effects and clinical significance. Chiropractic & osteopathy. 2005 Dec;13(1):1-0..
18. Gurney B. Leg length discrepancy. Gait & posture. 2002 Apr 1;15(2):195-206..
19. Cooperstein R, Lew M. The relationship between pelvic torsion and anatomical leg length inequality: a review of the literature. Journal of chiropractic medicine. 2009 Sep 1;8(3):107-1