Original Article

Pelvic incidence in Asian population

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Abstract

Background: Pelvic incidence is a measure formed by the upper end plate of sacrum with that of midpoint of line connecting the centre of femoral heads in standing position. It has been attributed as an important risk factor causing slippage of vertebrae at L5-S1 level. Its value has been documented in Caucasian population. Literature evidence of its value in Asian population especially in Indian population has not been documented. To find correlation between the three variables pelvic incidence, pelvic tilt and sacral slope. **Materials and Methods:** 77 patients with spinal complaints coming to Orthopaedic OPD were included in the study. All patients underwent standing AP AND LAT view of Lumbosacral spine, underwent analysis of Pelvic Incidence, Pelvic tilt, Sacral slope using Image Works CR 10.20 Mach 7 Technologies Software System[IWCR Rockey 10.20 DICOM Workstation]. **Results:** Mean±2S.D of Pelvic incidence, Pelvic tilt, and Sacral slope were 29* to 73*, 1* to 29*, 25* to 57* respectively. There was no correlation between Pelvic tilt and Pelvic incidence or Sacral slope and Pelvic incidence, whereas there was positive correlation between Pelvic incidence and summation of pelvic tilt and sacral slope. **Conclusion:** The above parameters range may be used as a measure of Pelvic incidence, Pelvic tilt, and Sacral slope in Indian population. However, the above parameters need to be analysed in asymptomatic healthy volunteers too.

Keywords: Pelvic Incidence, Pelvic Tilt, Sacral Slope, Asian Population,Lumbosacral Spine.

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INTRODUCTION

The relation of the pelvis to the spine has previously been overlooked as a contributor to sagittal balance. However, it is now recognized that spinopelvic alignment is important to maintain an energy-efficient posture in normal and disease states. The pelvis is characterized by an important anatomic landmark, the pelvic incidence (PI). The PI gradually increases during childhood period and during adolescent period but does not change after adolescence, and it directly influences pelvic alignment, including the parameters of pelvic tilt (PT) and sacral slope (SS) overall sagittal spinal balance, and lumbar lordosis. In the setting of an elevated PI, the spine adapts with increased lumbar lordosis. To prevent or limit sagittal imbalance, the spine may also compensate with increased PT or pelvic retroversion to attempt to maintain anupright posture. Abnormal spinopelvic parameters contribute to multiple spinal conditions including isthmic spondylolysis, degenerative spondylolisthesis, and impact outcome after spinal fusion.[1] Recent studies highlighted relationship between Degenerative Spondylolistheis and high pelvic incidence.[2]

The concept pelvic incidence was introduced by Duval Beaupere[3].It is the only morphometric parameter that is constant throughout life. It does not change with posture either standing or sitting, however that is not the same either with pelvic tilt or sacral slope.A strong correlation exists between pevlc incidence and lumbar lordosis. As it is, lumbar lordosis is greater than pelvic incidence by 10 degrees in normal individuals.[4] Pelvic incidence regulates the sagittal alignment of spine and pelvis.[4,5,6] A high pelvic incidence results in high forces at lumbosacral junction and has been shown to be associated with and increased degree of slippage.[7,8,9]

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PELVIC INCIDENCE[10] [PI] is defined as the angle between the line perpendicular to the upper sacral end plate and the line joining the middle of the upper sacral end plate and the hip axis. In contrast to Pelvic incidence, the pelvic tilt [PT] and sacral slope [SS] measure the orientation of the sacro-pelvis in the sagittal plane.SACRAL SLOPE[10] is defined as the angle between the sacral end plate and the horizontal line, whereas PELVIC TILT[10] is defined as the angle between the vertical line and line joining the middle of the sacral end plate and the hip axis.

Research has shown that spine pelvic parameters especially Pelvic incidence play an important role in degeneration of back muscle and the cause for chronic low back pain especially in asian population[11].

The importance of pelvic incidence is that one can calculate lumbar lordosis preop [L.L : P.I + 10*], can guide the surgeon to maintain intraop spinal balance[12], as P.I—L.L mismatch can cause Adjacent segment disease.[13,14].People with increased Pelvic Incidence and abnormal pelvic anatomy seems to appear at higher risk of presenting with spondylolisthesis, and increased PI, is considered as an important factor predisposing to progression in developmental spondylolisthesis.[15]Increased P.I contributes to increased arthritis and sagittal orientation of facet joints at lower lumbar spine.High grade L5-S1 spondylolisthesis patients have high pelvic incidence[16]. Low P.I is seen in patients with Schuermann disease[17].Pelvic Incidence helps in reduction of H-type sacral fracture with spinopelvic dissociation.[18]

MATERIALS AND METHODS

This is a Hospital based observational study carried out during the period between July 2015 to September 2015. Study has been carried out after obtaining ethical committee approval. The patients who had come to Chettinad Hospital and Research Institute Orthopaedic opd, during the above period on Monday, Thursday with complaints of low back ache of more than one day duration were included in the study. They were evaluated clinically and radiographically with radiographs of lumbosacral spine – AP and LAT view in standing position. Children, adolescents, and pregnant women were excluded from the study. During the exposure of lumbosacral spine – lateral view, the cassette was kept in proper position so that entire lumbar spine from first lumbar vertebrae upto coccyx, including both the femoral heads were visible radiologically, the beam was focused towards L5-S1 junction. The parameters Pelvic incidence, Pelvic tilt and Sacral slope were evaluated using Image Works CR 10.20 Mach 7 Technologies Software System[IWCR ROCKEY 10.20 DICOM Workstation]. The three parameters were independently measured by the first and second authors. A point is marked at the centre of two femoral heads, and the midpoint of the line connecting the centre of two femoral heads is marked. Another point at the middle of the upper end plate of sacrum was marked. A perpendicular line was drawn along the centre of the upper sacral end plate through the marked point on the sacrum[LINE A]. A line is drawn connecting the midpoint of centre of femoral heads to the perpendicular along the sacral end plate[LINE B]. The angle formed by this line with that of perpendicular line through the sacral end plate is measured as Pelvic incidence.

Figure 1

Figure 2

Figure 3

Figure 4

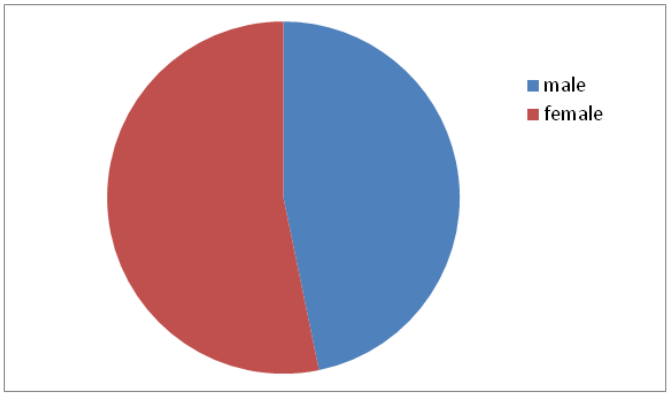

Figure 5

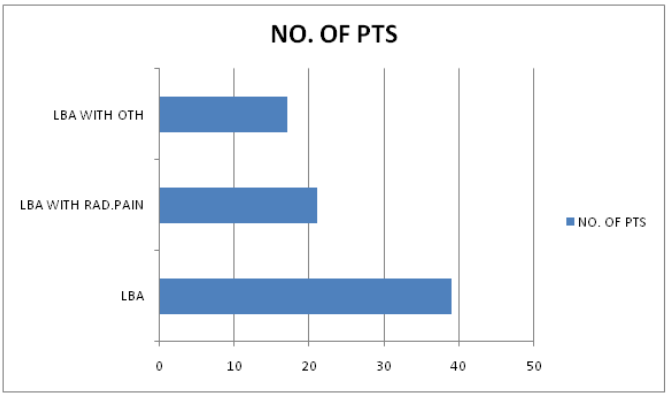

Figure 6

Figure 7

Figure 8

Figure 9

Figure 10

Figure 11

Figure 12

Figure 13

Figure 14

Legend

Figure 1: Pelvic Incidence

A line is drawn vertically from the midpoint of a line connecting centers of the two femoral heads[LINE C]. The angle formed by this line with that of line connecting the midpoint of centre of femoral heads to the perpendicular along the sacral end plate[LINE B] is measured as Pelvic tilt. A line is drawn along the upper endplate of sacrum [LINE D], and another line was drawn horizontally upto the top lateralmost point of sacrum. The angle between the two lines is measured as Sacral Slope.

Figure 2: Pelvic Tilt; **Figure 3:** Sacral Slope; **Figure 4:** Pelvic incidence, pelvic tilt and sacral slope(Total number of patients included in the study – 77; Male/female -- 36/41); **Figure 5:** Mean age of the patients included in the study – 51 years, range 21 to 79 years. Patients with isolated LBA alone were 39, patients with LBA and radicular pain were 21 and patients with LBA and pain involving sacro- iliac joints, other joints were 17.; **Figure 6:** Observation; **Figure 7:** L.S spine AP view (Case 1); **Figure 8:** L.S.spine –lat view[Standing] (Case 1); **Figure 9:** L.S.spine AP view(Case 2); **Figure 10:** L.S.spine lat view[Standing] (Case 2); **Figure 11:** L.S.Spine – AP VIEW(Case 3); **Figure 12:** L.S.spine lat view[Standing] (Case 3); **Figure 13:** L.S.Spine – AP VIEW(Case 4); **Figure 14:** L.S.spine lat view[Standing] (Case 4)

RESULTS

Table 1

	Pelvic incidence	Pelvic tilt	Sacral slope
Mean	51*	15*	41*
Median	51*	15*	41*
Mode	60*	10*	38*
Range	81* - 28*	45* - 2*	61* - 18*
Standard deviation	11*	7*	8*
Variance	121*	49*	64*

Mean of the pelvic incidence of the sample is 51*. Median, mode of the pelvic incidence of the sample data is 51* and 60* respectively. Range is from 81* to 28*. 68% of the sample data lies within Mean+/_1 S.D confidence interval, representing the sample data forming a Normal – Gaussian distribution Curve. Hence the sample is true representative of the population. Pelvic tilt, Sacral Slope values are given in the above table.

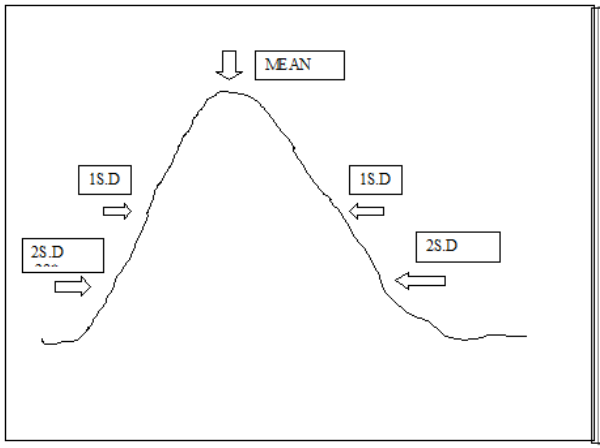

Figure 15

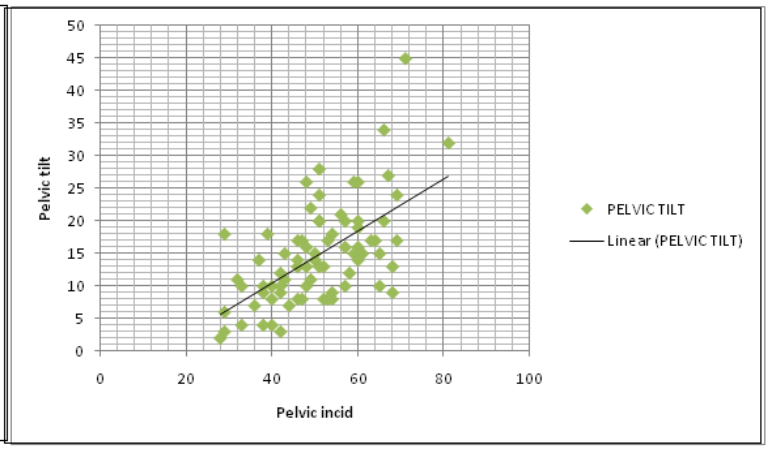

Figure 16

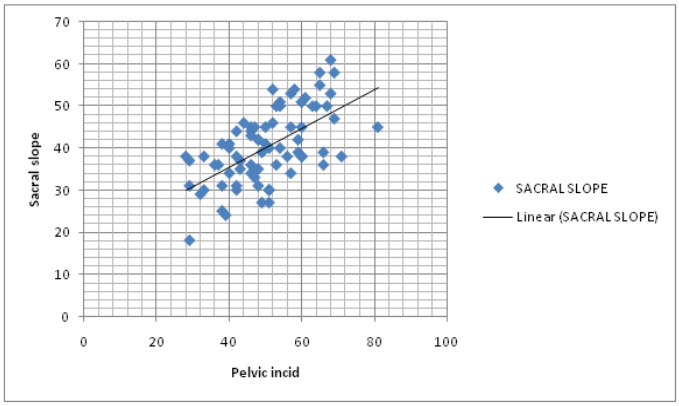

Figure 17

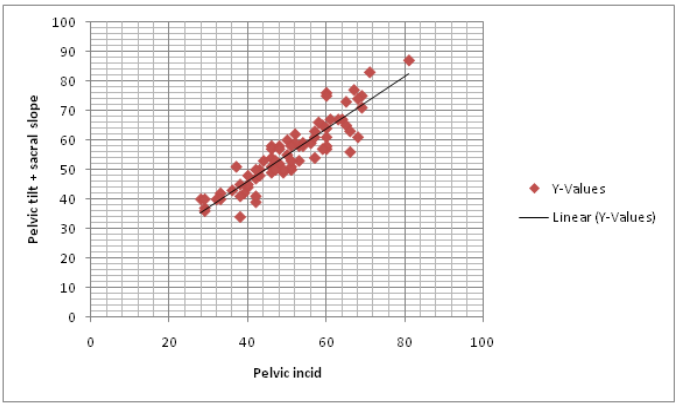

Figure 18

Legend

Figure 15: Correlation between pelvic incidence and pelvic tilt.

Figure 16: Correlation between pelvic incidence and sacral slope.

Figure 17: Correlation between pelvic incidence and summation of sacral slope and pelvic tilt

Figure 18: There seems to be no correlation exists between pelvic incidence and pelvic tilt or pelvic incidence and sacral slope, however a strong positive correlation exists between summation of pelvic tilt, sacral slope and pelvic incidence.

DISCUSSION

There are various studies in the literature documenting pelvic incidence in Caucasian population. However studies in asian population seems to be minimal.

	Canadian population [Adults][19]	Canadian population [Children and adolescents][20]	French Population[21]	French Population[22]	Japanese Population[23]	Our Study
Mean		49.1*	51*	55*	46.7*	51*
Median						51*
Mode						60*
Range						81* TO 28*
Std.dev		11*	9*	11*	8.9*	11*
Variance		121*	81*	121*	81*	121*
Mean±2SD	32* TO 74*	37* TO 71*	33* TO 69*	33* TO 77*	29* TO 65*	29* TO 73*
	Prospective study, 709 asymptomatic healthy adults	341 normal subjects, 3 to 18 years old	149 healthy adults aged 19 to 50 years	250 healthy volunteers	86 healthy adults	77 symptomatic adults
Authors	Mac-Thiong JM *et al*	Mac-Thiong JM *et al*	Boulay C *et al*	Guigui P *et al*	Endo K *et al*	

The Mean±2SD of pelvic parameters pelvic tilt, sacral slope in our study are 1* to 29*, 25* to 57* respectively. The major limitations of the study are Intra-observer and Inter-observer variation of the elicitated findings, difficulty in accurately marking the sacral end plate in dome shaped sacrum patients, study done in patients with symptomatic spinal complaints.

CONCLUSION

Mean±2S.D of Pelvic incidence, Pelvic tilt, and Sacral slope were 29* to 73*, 1* to 29*, 25* to 57* respectively. There was no correlation between Pelvic tilt and Pelvic incidence or Sacral slope and Pelvic incidence, whereas there was positive correlation between Pelvic incidence and summation of pelvic tilt and sacral slope. The above parameters range may be used as a measure of Pelvic incidence, Pelvic tilt, and Sacral slope in Indian population.However, the above parameters need to be analysed in asymptomatic healty volunteers too.

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