International Journal of Medical Research Professionals
P-ISSN: 2454-6356; E-ISSN: 2454-6364
DOI: 10.21276/ijmrp

IJMRP

Original Research Article.

A Study to Find Correlation between the Lumbar Lordosis, Pelvic Incidence, Sacral Slope and Pelvic Tilt and Functional Status of Patients with Chronic Low Backache in Haryana (North Indian) Population

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ABSTRACT

Introduction: Pathology in any segment of the trunk or lower limb can disturb the global postural equilibrium resulting in compensatory changes in other segments. Human standing posture is the result of balance between spine and pelvis. Understanding the elements that comprise it is fundamental to the comprehension of its role in balance and corporal alignment. The present study was carried out to find correlation between the lumbar lordosis, pelvic incidence, sacral slope and pelvic tilt and functional status of patients with chronic low backache.

Materials and Methods: The present case control study was designed to determine the importance of lumbo-pelvic alignment in patient with chronic low backache in Haryana (North Indian) population. The present study was performed on 64 patients with clinical symptoms of chronic low back pain and 64 X-rays of normal populations. A total of 4 parametric variables studied were lumbar lordosis (LL), pelvic incidence (PI), pelvic tilt (PT) and sacral slope (SS). The lateral radiographs of lumbosacral spine of patient individual were taken after taking written consent. Unpaired t test was applied and the p value <0.05 indicated a significant difference between the groups.

Results: On univariate analysis, the mean value of lumbar lordoisis in Group I was 30.11 degree Group I and in Group II was 33.68 degree. On applying unpaired t test the p value came out to be 0.018 indicating a significant difference between the groups. On applying unvariate analysis, the mean value of pelvic incidence in Group I was 52.61 and that in Group II was 54.68. On applying unpaired t test, the p value came out to be 0.288 indicating no significant difference between both the groups. The mean pelvic tilt amongst subjects of group I and Group II were 13.77 and 13.63 respectively. Though the value was higher amongst patients with chronic back pain but there was no significant difference between the two groups.

Conclusion: The normal relationships between parameters of spinopelvic alignment are preserved in subjects with low back pain. From the study we can conclude that there was no significant difference in the pelvic incidence, pelvic tilt and sacral slope amongst normal subjects and subjects of chronic low back pain.

Keywords: Low Back Pain; Lumbosacral Spine; Spinopelvic Alignment.

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Article History:

Received: 04-10-2017, **Revised:** 01-11-2017, **Accepted:** 29-11-2017

Access this article online	
Website: www.ijmrp.com	Quick Response code
DOI: 10.21276/ijmrp.2017.3.6.102	

INTRODUCTION

Ambulatory humans maintain a stable and ergonomic upright standing position by co-ordinating the alignment of the spine, pelvis and lower extremity, particularly in the sagittal plane.[1,2] Pathology in any segment of the trunk or lower limb can disturb the global postural equilibrium resulting in compensatory changes in other segments. Low back pain is an important clinical, social, economic and public health problem affecting the population indiscriminately. It is considered the most common pain affecting the general population with a reported lifetime prevalence of up to 75%. It is recognized societal problem from both a disablement and economic perspective with cost exceeding that of coronary artery disease, Respiratory infection and diabetes.[3]

The spine is the principal support axis of the human body, essential to achieving both standing and locomotion. The alignment in modern humans is significantly different from the alignment presented by quadrupedal nonhuman hominoids as the biomechanical demands on the spine and pelvis of bipedal hominins has its unique demands.[4,5] Upright posture requires controlling the center of gravity above a small base of support two legged in hominins as opposed to four legged and a vertical position of the head in relation to the pelvis and lower limbs. During human evolution, the spinal curvature as well as pelvic and sacral orientation changed dramatically, from a very small pelvic incidence and spinal curvatures, which has been preserved in nonhuman hominoids, to large ones in modern humans, not to mention other additional morphological changes in these regions. This change was accompanied by a dramatic shift of the center of gravity, line of gravity, and plumb line from the thoracic vertebrae.[117] Human standing posture is the result of balance between spine and pelvis.[66] Understanding the elements that comprise it is fundamental to the comprehension of its role in balance and corporal alignment.[6-9] The present study was carried out to find correlation between the lumbar lordosis, pelvic incidence, sacral slope and pelvic tilt and functional status of patients with chronic low backache.

MATERIALS AND METHODS

The present case control study was designed to determine the importance of lumbo-pelvic alignment in patient with chronic low backache in Haryana (North Indian) population. Ethical clearance was obtained from the institutional ethical committee of Institute before the commencement of study. The present study was performed on 64 patients with clinical symptoms of chronic low back pain and 64 X-rays of normal populations already present in Department of Radiology of Shri Guru Gobind Singh Tricentanary Hospital (SGTH) having age between 19 – 70 years. The medical records of patients were reviewed, along radiographic studies. The sample was divided into two groups: Group I: Chronic low back ache patients (Study Group) and Group II: Normal populations (Control Group)

The controls were included if there was no diagnosis dealing with back pain complaints, no serious back pain history for 2 years and no back pain at all in the last 6 months. Patients with absence of spinal pathology confirmed after evaluation by an orthopaedic surgeon, predominant low back pain for a minimum of three consecutive months, no history of spine, hip, or pelvic disorder and patients with no contraindication for radiographic exposure were selected for the study. Patients with post-operative spinal fracture, pregnancy, spinal tumor, spinal deformity such as scoliosis or spondylolisthesis, previous spinal fusion, presence of motor deficit, history of hip or pelvic disorder and patients with presence of severe systemic disease were excluded from the study. A total of 4 parametric variables studied were lumbar lordosis (LL), pelvic incidence (PI), pelvic tilt (PT) and sacral slope (SS) The lateral radiographs of lumbosacral spine of patient individual were taken after taking written consent. Unpaired t test was applied and the p value <0.05 indicated a significant difference between the groups

Table 1: Complied result of both the groups

	Group	N	Mean	Std. Deviation	Std. Error Mean	P value
PI	**I**	**64**	52.61	11.477	1.372	0.288
	II	**64**	54.68	10.812	1.362	
PT	**I**	**64**	13.77	8.362	.999	0.910
	II	**64**	13.63	4.787	.603	
SS	**I**	**64**	39.99	10.061	1.203	0.310
	II	**64**	38.27	9.260	1.167	
LL	**I**	**64**	30.11	9.362	1.119	0.018
	II	**64**	33.68	7.634	.962	

PI= Pelvic Incidence; PT=Pelvic Tilt; SS=Sacral Slope; LL=Lumbar Lordosis

Table 2: Descriptive analysis

	N	Minimum	Maximum	Mean	Std. Deviation
Age	128	19	65	32.74	10.513
PI	128	30	90	53.59	11.173
PT	128	1	37	13.71	6.879
SS	128	20	66	39.17	9.692
LL	128	7	58	31.80	8.740

RESULTS

Table 1 shows the comparison of all variables between Group I and Group II. The mean value of pelvic incidence in Group I was 52.61 and that in Group II was 54.68. On applying unpaired t test, the p value came out to be 0.288 indicating no significant difference between both the groups. The mean pelvic tilt amongst subjects of group I and Group II were 13.77 and 13.63 respectively. The p value was 0.910, hence no significant difference between the two groups. The sacral slope showed the mean value of 39.99 in Group I subjects and 38.27 in Group II subjects. The p value was 0.310, therefore no significant difference between the groups. Lumbar lordosis had mean value of 30.11 in Group I and 33.68 in Group II. On applying unpaired t test the p value came out to be 0.018 indicating a significant difference between the groups.

Table 2 shows the descriptive analysis between the groups. The maximum age that was noted was 65 years and the minimum was 19 years. The standard deviation was 10.513. The maximum pelvic incidence was 90 and minimum was 30 with the standard deviation of 11.173. The maximum pelvic tilt in this study was 37 and minimum was 1 with the standard deviation of 13.71. The maximum sacral slope was 66 and minimum was 20 with standard deviation of 9.692. Lumbar lordosis showed maximum value of 58 and minimum of 7 with standard deviation of 8.740.

DISCUSSION

Low back pain is defined as a pain or discomfort located below the margin of the 12th rib and above the inferior gluteal fold with or without leg pain. This is a very common complaint where, most of the time, resolution and return to work occur within three months' time or less. The etiology of low back pain (LBP) is usually multifactorial. It is estimated that in all populations, an individual has an 80% probability of having low back pain at some period during their life time and about 18% of the population experiences low back pain at any given moment.[10] Some studies have shown that chronic low back pain that last for more than 3 months affects an estimated 15-45% of the population and is the most common cause of disability in individuals between the ages of 45 and 65 years.[11]

On univariate analysis, the mean value of lumbar lordoisis in Group I was 30.11 degree Group I and in Group II was 33.68 degree. On applying unpaired t test the p value came out to be 0.018 indicating a significant difference between the groups. The results were in accordance with the studies conducted by Rajnics et al[12] and Barrey et al[13] In the study by Rajnics et al, [12] they found that the sacrum was more vertical and the value of the lumbar lordosis was lower as was the amplitude of the spinal curvatures, when compared with those of the healthy group.

On applying unvariate analysis, the mean value of pelvic incidence in Group I was 52.61 and that in Group II was 54.68. On applying unpaired t test, the p value came out to be 0.288 indicating no significant difference between both the groups. The results were similar to the study conducted by Rajnics et al.[12] But according to Barrey et al,[13] they found that in younger subjects of degenerative disc disease, the mean pelvic incidence was significantly lower than that of control group and in patients of degenerative spondylolisthesis, it was significantly higher than that of control group.

The mean pelvic tilt amongst subjects of group I and Group II were 13.77 and 13.63 respectively. Though the value was higher amongst patients with chronic back pain but there was no significant difference between the two groups. The results were similar to the study conducted by Emmanuelle Chaleat-Valayer et al.[14] They also showed that pelvic tilt was larger amongst patients of lower back pain but there was no significant difference between them. The sacral slope showed the mean value of 39.99 in Group I subjects and 38.27 in Group II subjects. The sacral slope was larger in patients of lower back pain but the p value was 0.310, therefore no significant difference between the groups. This was contrary to a study conducted by Emmanuelle Chaleat-Valayer et al.[14] Patients with lower back pain had significantly smaller sacral slope as compared to the control group.

In the sagittal plane, the spine can be considered a linear chain connecting the head to the pelvis, in which the form and the orientation of each anatomical segment are closely related and influence the adjacent segments to maintain a stable posture with the least possible energy expenditure.[15] Any break in the alignment of this chain, whether in the coronal or sagittal plane is recognized as a spinal deformity.

The term spinopelvic alignment refers to the complicated relationship between the morphology and orientation of the pelvis to that of the vertebral spine and the center of gravity in erect posture.[16] The major variables that describe the spinopelvic alignment in the sagittal plane include three types of variables: the orientation of the sacrum and pelvis, the spinal curvatures and the relative position of the line of gravity to the spine and pelvis.[16] In most individuals, this deformity is asymptomatic, while in others pain and functional disability may occur, especially in adult deformities. Thoracic kyphosis and lumbar lordosis (LL) are also in balance with each other in normal standing posture so that the minimal amount of energy is used for maintaining posture.[17] Global sagittal balance must account for the position of the head in relation to the spine and pelvis.[18] The sagittal profile of the spine is usually characterized as being kyphotic between T1 and T12 and lordotic between L1 and L5 but this is not necessarily the case. The differences between normal and pathologic curvatures are less clear in the sagittal plane than in the coronal plane.[19-21] A correlation between the results of these quality of life measuring questionnaires and the radiographic parameters associated with vertebral and spinopelvic alignment has also been described in the literature.[22-24] These studies identified specific radiographic parameters that they demonstrated to have a correlation with pain and functional disability, such as lumbar lordosis,[25,26] vertical sagittal axis (C7 plumbline),[22.26] as well as parameters associated with spinopelvic balance (pelvic incidence, pelvic tilt, sacral slope and the relationship between pelvic incidence and lumbar lordosis).[23,27,28] The SRS-Schwab classification for adult deformity, which is gaining popularity takes three sagittal modifiers into account (vertical sagittal axis, pelvic tilt and the difference between pelvic incidence and lumbar lordosis) in addition to the type of curve. Recently, it was shown that there is a correlation between this classification system and the severity of the disease through a correlation with quality of life measurements.[29] Sagittalspino-pelvic malalignment is one of the most prevalent disorders of the aging spine. Sagittal malalignment concerns are reflected in reports of flat back syndrome, which is an iatrogenic malalignment after spinal instrumentation that results in persistent lower back pain.[30-32] The sagittal curvature of the spine and pelvis balance each other to maintain a stable posture and horizontal gaze. Once the sagittal alignment is abnormal more energy is required so that the body can remain balanced without external support.[33] Glassman et al reported that positive sagittal balance was significantly related to clinical symptoms and health-related quality of life in patients with adult spinal deformity.[22] In addition, patients with kyphosis often complain of decreased walking ability and an increased propensity of falling, thereby resulting in weaker back extensor strength and poorer balance as well as heartburn due to gastroesophageal reflux disease, dysphasia and respiratory symptoms.[34] Therefore, abnormal sagittal spinal alignment should be restored to normal.

PI is an important anatomic parameter that reflects the anatomic configuration of the pelvis and greatly affects sagittal spino-pelvic alignment. PI-LL has been considered to be a useful indicator in

intraoperative planning of lumbar deformity operation.[35,36] PI-LL is significantly correlated with clinical parameters. Schwab et al recommend that PI-LL should be corrected to less than 10˚ to achieve successful, harmonious spino-pelvic realignment in corrective operation of spinal deformity.[35]

It has also been observed that proper sagittal balance promotes an environment for bone consolidation and preservation of the adjacent level. Low back pain following arthrodesis is more likely to occur in individuals with sacral verticalization (high values of PT and low values of SS), a situation frequently accompanied by a reduction in lumbar lordosis, independently of other factors.[37] Sagittal spinopelvic balance in modern humans is achieved when spinal curvatures and pelvic/sacral orientation are aligned in the same manner. In a well-aligned spine, the line of gravity falls close to the acetabulum.[38,39] Pelvic incidence significantly influences the sagittal spinal geometry, specifically lumbar lordosis and CL, in healthy modern humans. Because pelvic incidence directly regulates lumbar lordosis in modern humans, a high PI will be followed by a high lumbar lordosis and a low pelvic incidence will be followed by a low lumbar lordosis.[40] As lumbar lordosis and CL are also highly correlated, a similar trend is seen in the cervical spine when a high LL is followed by a high CL. The interaction of PI, LL, and CL with the TK is somewhat more complicated it is not as straight forward as with the other spinal curvatures.[41]

CONCLUSION

The normal relationships between parameters of spinopelvic alignment are preserved in subjects with low back pain. From the study we can conclude that there was no significant difference in the pelvic incidence, pelvic tilt and sacral slope amongst normal subjects and subjects of chronic low back pain.

The lumbar lordosis was significantly higher in normal subjects compared to those having low back pain.

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Source of Support: Nil. **Conflict of Interest:** None Declared.

Cite this article as: Pawan Kumar Mahato, Amit Kumar Saxena, Bharat Bhushan Sharma, Hira Lal Kakaria, Prachi Saffar Aneja. A Study to Find Correlation between the Lumbar Lordosis, Pelvic Incidence, Sacral Slope and Pelvic Tilt and Functional Status of Patients with Chronic Low Backache in Haryana (North Indian) Population. Int J Med Res Prof. 2017 Nov; 3(6):459-63.
DOI:10.21276/ijmrp.2017.3.6.102