Lumbosacral Angle Variations in Middle Aged Patients with Chronic Low Back Pain - A Retrospective Study

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ABSTRACT

BACKGROUND

Chronic low back pain (CLBP) is one of the common debilitating condition in middle-age population. Often the pain is "non-specific" or related to mechanical origin; so, often it is termed as chronic mechanical low back pain. Among the various predisposing factors, abnormal lumber lordosis is more often seen. Radiographic assessment of lumbar lordosis can be done by measuring lumbosacral angle (LSA). Therefore, study of variations in LSA among these patients can give important clues in both pathogenesis and management. The aim of the study is to determine different factors leading to the variations of lumbosacral angle amongst the middle-aged patients presenting with chronic mechanical low back pain.

METHODS

This retrospective study was conducted by analysing records of 105 CLBP patients of both sex (male = 32, female = 73) in the age group of 45 - 65 years. LSA was directly measured digitally by Ferguson technique from the selected patients' lateral lumbosacral radiographs. Data was collected in Microsoft Excel 2016 and analysis was done with International Business Machines Statistical Package for the Social Sciences (IBM SPSS) Statistics version 23.

RESULTS

The difference in median of LSA of male [Median (IQR) = 37.00 (10.00)] and female [Median (IQR) = 45.00 (8.50)] patients was statistically significant (p-value 0.000). Significant positive correlation was also found between LSA and BMI for both sexes, but more in case of female (Spearman's rho 0.806 p = 0.000) than male (Spearman's rho 0.680 p-value 0.000).

CONCLUSIONS

Variation of LSA was found to have significant relations with sex and body mass index (BMI), but not with the age. Statistically significant positive correlation between LSA and BMI alongside higher BMI of the females in the study group suggested that they are more prone to develop CLBP. To formulate proper rehabilitation protocol for middle aged CLBP patients, LSA variations and related factors can be kept in mind.

KEYWORDS

Chronic Low Back Pain (CLBP), Lumbosacral Angle (LSA), Lordosis, Rehabilitation, Body Mass Index, Lordosis, Spine, Radiography, Rehabilitation

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BACKGROUND

Chronic low back pain (CLBP) is defined as the persistence of low back pain beyond 3 months of symptom initiation.[1] Lifetime prevalence of low back pain is as high as 84 %.[2] Among them approximately 10 % to 15 % of back pain becomes chronic.[2] A specific diagnosis is not derived upon for as much as 85 % of patients seeking medical care for chronic low back pain.[2] Usually the pain is "non-specific" or related to mechanical origin, so often termed as chronic mechanical low back pain.[1,2] It is one of the most common cause of PMR OPD attendance. Individual, psychological and socio-professional factors result in postural deviations and associated abnormal lumber lordosis which in turn play an important role in determining chronicity and severity of the pain.[1,2,3]

Lumbar lordosis is defined as the anteriorly convex curvature of the intact lumbar segment of the vertebral column compensating for the sacrum inclination and restoring an upward orientation.[4,5,6] The presence of normal lumber lordosis has several biomechanical advantages in terms of its mobility and weight bearing function.[6,7] Regarding development of lumbosacral angle (LSA) proposition has been made that the lumbosacral part of the spine has undergone several modifications during evolution of bipedal gait and erect posture.[6,8] Radiologically evident abnormal lumbar lordosis and chronic mechanical LBP develop due to deviations from normal and healthy erect posture.[8,9]

Over the years there are several methods like goniometry, flexible rulers, software methods, spinal mouse, inclinometer etc. measuring different angles to quantify lumber lordosis. But till date, LSA measurement by Ferguson's technique is considered one of the simplest and effective tool for radiographic measurement of lumber lordosis.[4,10-12] LSA is the angle [Figure 1] which is formed between a line across the plane of the superior margin of S1 with the horizontal line in a lumbosacral radiograph.[4,12] Literature review shows lumber lordosis alongside LSA vary with the changes in age, sex, BMI, ethnicity among normal population as well as in symptomatic patients with LBP.[4,5,7-15] But to the best of our knowledge, scientific evidence to enlighten us in this regard is less in this part of the country.[6] Proper treatment plan including posture care and integrated rehabilitation program can only be formulated once these variations of LSA in CLBP patients are detected and dealt thoroughly. Therefore, this retrospective study was taken up amongst middle aged patients with chronic mechanical low back pain to determine the variations of the LSA and factors contributing to this.

METHODS

Study Design and Participants

This is a retrospective study which included analysis of radiographic findings and clinical details of middle aged (45 - 65 year age) patients of both sexes diagnosed with chronic mechanical low back pain and attended Physical Medicine and Rehabilitation OPD of a tertiary care hospital, West Bengal, India during the time span of three months, October-December, 2019. Through total enumeration approach, the records of all the patients registered in PMR OPD during the time span of 3 months i.e., October-December, 2019 were considered for the study after applying exclusion criteria. Due permission from the institutional ethics committee was sought before the records were used for analysis.

Inclusion Criteria

Middle aged (45 - 65-year age) patients diagnosed with chronic mechanical low back pain.

Exclusion Criteria

Presence of any recorded "Red Flags.[2]" like – i) Past history of violent trauma, ii) History of cancer, iii) Systemic steroid use, iv) Drug abuse, v) Immuno compromised or HIV infected, vi) Unintentional weight loss, vii) Systemically ill, concomitant infection with signs like fever or night sweats, viii) Severe pain awakening at night, ix) Pre-existing spinal and / or lower limb structural deformity, x) Presence of inflammatory arthritis, Ankylosing Spondylitis, xi) Present / past history of Tuberculosis, xii) Presence of any sensory-motor, autonomic and / or gait disturbances.

Figure 1. LSA Measured Digitally by Ferguson Technique

Lumbosacral Angle (LSA) Measurement

LSA was directly measured digitally [picture 1] by Ferguson technique from the selected patients' lumbosacral radiographs which were tagged with patients' particulars and archived at the departmental computer.[10,11] The study center usually does its lumbosacral radiographs in lateral recumbent posture using standard positioning and exposure technique described by Ferguson in his original article.[9,11]

Data was entered in Microsoft Excel 2016 spreadsheet and analysis was done with the help of the software IBM SPSS Statistics version 23. Normality assumption for continuous variables were tested with Shapiro-Wilk Test and distributions of age and LSA of female patients were not found to be normal. Descriptive statistics for continuous variables were calculated in terms of mean with standard deviation (SD) for variables normally distributed and median

with Inter-Quartile Range (IQR) for the variables having non-parametric distribution.

Correlation study was performed wherever required between two continuous variables and Spearman's rho was considered as correlation coefficient if any of the variables had non-normal distribution whereas Pearson's correlation coefficient was considered when both the variables were normally distributed. For variables with non-parametric distribution tests like Mann-Whitney U test were performed. In all statistical tests adopted confidence interval (CI) was taken 95 % and p-value less than 0.05 was considered as statistically significant.

RESULTS

The total number of study participants were 105 out of which 32 (30.48 %) were males and 73 (69.52 %) were females. For the male patients the median (IQR) of age (in years) was 59.0 (7.50) and of lumbosacral angle (LSA) was 37.00 (8.50) whereas the mean (± SD) BMI (in Kg / m^2) was 22.64 (± 3.19). On the other hand, for the female patients, median (IQR) of age (in years) was 53 (8.50), of LSA was 45.0 (10.0) and the mean (± standard deviation) BMI (in Kg / m^2) was 23.72 (± 3.50). The difference in median of LSA of male and female patients was found to be statistically significant (p-value 0.000) with Mann-Whitney U Test.

With increasing BMI, the LSA was found to increase more in case of female patients than in male patients whereas the correlation of LSA with BMI for female was strongly positive (Spearman's rho r = 0.806 p-value 0.000) and for the male patients was moderately positive (Spearman's rho r = 0.680 p-value 0.000). On the other hand, positive correlation was also found between LSA and age of the patients, both for the male (Spearman's rho r = 0.201 p-value 0.269) and female patients (Spearman's rho r = 0.102 p-value 0.392) but not statistically significant.

Gender	Variables Age (in years) Median (IQR)	 LSA Median (IQR)	 BMI (in Kg / m^2) Mean (± SD)
Male (n = 32)	59.0 (7.50)	37.00 (8.50)	22.64 (± 3.19)
Female (n = 73)	53 (8.50)	45.0 (10.0) *	23.72 (± 3.50)

Table 1. Gender-Wise Distribution of Age, Lumbo-Sacral Angle and BMI of the Study Participants

* Significant difference in LSA of male & female patients, p-value 0.000

Variables		LSA
Age (in years)	Male	r = 0.201 p = 0.269
	Female	r = 0.102 p = 0.392
BMI (in kg / m^2)	Male	r = 0.680 p = 0.000*
	Female	r = 0.806 p = 0.000*

Table 2. Correlation of LSA with Age and BMI of the Patients

r = Spearman's Rho, p = p-value, * Significant correlation at p-value < 0.05

DISCUSSION

The lumbar spine receives certain amount of resilience and protection from compressive forces from normal lumber curvature.[9] But it often alters mostly in the middle age group probably due to ongoing spinal cord muscle weakness, age related wear and tear effects, postural abnormalities etc. and thereby this middle aged population suffers most from chronic mechanical LBP.[2,3] Majority of these patients are likely to have multifactorial causes, but postural deviations along with abnormal lumber curvature or lordosis often associated with it.[2,3] According to Kuofi (1992), measuring the curvature of lumbar spine is useful in investigating lumbosacral stability and low back pain.[9] Therefore, measuring the alteration of lumber lordosis in this age group can provide important clues for managing these patients in our population.

Various radiographic and non-radiographic methods are used for measuring lumber lordosis (LL) in different studies, but till date radiographic method remains the gold standard with supine lateral lumbosacral spine radiograph measuring it most accurately.[9,17-19] As conventionally, at our centre supine lateral radiographs were taken on regular basis which were used in our study. Though the concern about posture and its possible effect on spinal curvature may give rise to preference for erect radiographs, it has been found that recumbent position radiographs are not much different in the estimation of LL.[4,9,20] Some of the radiographic angular measures of LL incorporates lumbosacral angle (LSA), lumbosacral joint angle (LSJA), and tangential radiologic assessment of LL (TRALL) angle.[9] Lumbosacral angle (LSA) has also other synonyms like sacro horizontal angle, sacral angle, sacral inclination angle and Ferguson's angle etc.[4] As perceived from the study by Agichani S in 2017, LSA amongst the various angles measured, is the most important determinant of the degree of lumber lordosis and this is alike the lumbosacral angle measured in this present study by Ferguson's technique.[6]

The median (IQR) lumbosacral angle (LSA) in our study population was 43.00 (10.00). It is slightly higher than value of mean (SD) LSA, i.e., 38.03^0 (+ 8.07) found by Agichani S 2017 in their study of LSA amongst central Indians, which can be explained by the study by Murrie VL 2003 discussed in subsequent paragraphs.[6,13] By Ferguson's method, in 41 - 50 years age group, Agichani S found mean LSA to be 38.27^0 (± 8.66) in males and 40.57^0 (± 7.18) in females.[6] Mean LSA shows some variations probably due to different ethnicity in other studies like that of Hellems 1971 (41.1^0), Pate et al. 1991 (41^0), Maduforo et al. 2012 (36^0 ± 9.4), Okpala 2014 (44.5^0 ± 9.9), Onyemaechi 2016 (37.8^0 ± 9.2).[12,21,15,4,22]

In our study among the 105 patients, 73 (69.52 %) were females. This can be explained by the selected age group, i.e., peri- and post-menopausal females. Age related wear and tear effects are more in this female age group due to poor or decaying bone health as a result of decreasing oestrogen support which is also responsible for central or disproportionate fat distribution among them resulting in higher BMI (mean + SD = 23.72 + 3.50) compared to the male patients (mean + SD = 22.64 + 3.19) in our study**.** LSA was also significantly higher (p = 0.000) in females [Median (IQR) = 45.00 (8.50)] compared to the male population of our study [Median (IQR) = 37.00 (10.00)]. In correlation study, with increasing BMI the LSA was found to increase, more in case of female patients (Spearman's rho r = 0.806

p-value 0.000) than in male patients (Spearman's rho r = 0.680 p-value 0.000). But no statistically significant relationship was found between age and LSA, both for male (Spearman's rho r = 0.201 p-value 0.269) and female (Spearman's rho r = 0.102 p-value 0.392). Like our study, Murrievl 2003 also found 7.7^0 more lordosis in women and opined that the genetically determined shape of the pelvis plays pivotal role here.[13] As per Murrievl 2003, the concept that lumbar lordosis is likely to be less prominent for men with low back pain did not reach any statistically significant conclusion.[13] According to them, 'reduced lumbar lordosis' is more related with acute LBP due to associated para-spinal muscle spasm, but should be regarded as a very weak clinical sign in case of CLBP.[13] They also found a positive correlation between BMI and LSA and simply explained as the excess central weight in abdomen pulls the lumber spine anteriorly and thereby increasing the lumber lordosis.[13] But Onyemaechi (2016) found no significant correlation of LSA bearing on age, sex and BMI of the participants.[22] Abittbol (1987) and Okpala (2014) also found that, LSA is not related to those parameters.[8,4]

Though the incidence of low back pain was not found to have significant association with abnormal lumbosacral angle (Azar et al., 2010), Hughton et al. in 2015 revealed that there are positive correlations between degree of LSA and ageing, chronic LBP intensity as well as LBP related functional limitations among females.[23,24,6] Therefore, suggestions came for the clients aged 50 years or more and having LSA above 30^0 to put emphasis on core lumbosacral stability activities.[6,24] Higher incidence of back pain was found to be statistically related with kyphosis or hypolordosis ($< 10^0$) as evident in a retrospective study by Pun et al. 1990.[6,7] Hence, apt rehabilitation protocol is needed in preserving the normal angle and reducing the probability of kyphosis development. Another study done by Endo et al. (2010) revealed that more the sacral inclination angle more is the probability of intervertebral disc degeneration while Ergun et al. (2010) reported that the development of disc degeneration and disc herniation are favoured by the lumbosacral spine having more vertical orientation.[25,5,6,26] Metgud et al. (2016) while assessing different factors affecting spinopelvic parameters in their study on 30 low back pain patients, found out weak core muscle activation.[27] Therefore, they concluded that the increase in lumbosacral and pelvic inclination angle in those patients was mainly due to weak spinal cord muscle activation.

Limitations of this study can also be treated as the future prospects. Being a record-based study, it has the disadvantage of no follow ups. So, in future, with the help of the information gathered from our present study, a prospective study can be drawn up to find out the relationship between intensity of LBP and LSA in different age groups as well as changes happening with targeted intervention thereafter.

CONCLUSIONS

In conclusion, after a thorough study, it becomes obvious that the average values of LSA in different studies are variable, possibly due to different ethnicity, age, sex and BMI of the study population. In our study, we can clearly state that variation of LSA is statistically significant with respect to sex and BMI of the patients, but not age. Females seem to be more prone to develop CLBP.

Deductions regarding LSA variations in the middle age group patients with CLBP are expected to help in formulating proper rehabilitation protocol like specific individualized strengthening exercises of anterior abdominal and spinal cord muscles, appropriate nutritional supports, maintenance of proper posture, and ergonomics alongside work place modifications to prevent abnormal lumbar curvatures.

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