



Original Article

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INTRODUCTION

Low back pain is the most common reason for consulting a physician in the western population. 85% of people less than 45 years of age experience at least one low back pain episode which requires medical/interventional treatment during their lifetime.¹ Most of the acute low back pain episodes are not related to a specific pathology² but 23% of these patients develop chronic low back pain and it is strongly associated with disc degeneration if the patient has disc degeneration in 2 or more levels.^{3,4}

The importance of sagittal balance and spinopelvic param-

The Influence of Mechanic Factors in Disc Degeneration Disease as a Determinant for Surgical Indication

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Objective: Low back pain is the most common reason for physician visit in Western population. It's one of the factors that affect health-related quality of life. Intervertebral disc degeneration is one of the leading factors for low back pain and disc degeneration needs serious attention. In this article, we try to summarize biomechanical factors on the degenerative process.

Methods: Patients with low back pain in Neurosurgery Department between January 2012 and June 2019 are searched for this study. The patients were gathered under 2 groups; surgical intervention and conservative treatment groups. Intervertebral disc degeneration was assessed by Pfirrmann grading system. All spinopelvic parameters were measured by using standardized lateral plain standing lumbar radiographs.

Results: There were 165 patients in the surgical group (60 females, 105 males) and 84 patients in the conservative group (57 females, 27 males) after randomization. One hundred fifty patients had microdiscectomy and 15 patients had spinal instrumentation with transforaminal lumbar interbody fusion. There was not a statistically significant difference between surgical intervention and conservative treatment groups when comparing disc degeneration status. There was a statistically significant difference in parameters lumbar lordosis (LL), L4-S1, and pelvic incidence-LL (PI-LL) between the 2 treatment groups. In the surgical group when we further analyze the spinopelvic parameters in between the 2 different surgical techniques; L4-S1, pelvic tilt, and PI-LL showed a statistically significant difference.

Conclusion: Degenerative disc disease is related with multiple factors which can be detailed under the mechanic components and the genetic components. Of these factors, spinopelvic parameters seem highly penetrating to patients' surgery needs with degenerative disc disease independently.

Keywords: Disc degeneration, Spinopelvic parameters, Deformity

ters in spinal surgery is getting more attention. Especially for preoperative surgical planning and for the estimation of patient outcomes its importance is beyond omitting. It has been shown that in adult spinal deformity patients; spinopelvic parameters are directly related with health-related quality of life (HRQoL).⁵

At this point we came up with the questions that if the spinopelvic parameters are related with intervertebral disc degeneration process and furthermore, are these parameters define which patient will need a surgical intervention? In the up-to-date literature there are studies asking the question that if there is a difference regarding spinopelvic parameters between healthy

subjects and surgery requiring patient population, but those studies unfortunately cannot enlighten us about the symptomatic patients.⁶⁻⁸

The authors here present the data and differences from the biomechanical perspective about the surgical intervention needed population and conservative treatment group which both of them are clinically symptomatic.

MATERIALS AND METHODS

Retrospectively, all patients whom treated at the Neurosurgery Department in Bahçeşehir University School of Medicine Affiliated Hospitals (Medical Park Göztepe Hospital and Medical Park Pendik VM Hospital) due to the complaint of low back pain between January 2012 and June 2019 are searched for this study. Of these patients; whom needed lumbar microdiscectomy surgery or spinal fusion with instrumentation due to disc degeneration and conservative treatment patient groups were recruited randomly. For the patient population of the conservative treatment group a matching cohort with the surgical intervention group was established by randomization. The randomization of the patients was performed from a database which includes all patients' data under the topics of surgical and non-surgical treatment. The surgical intervention group was constituted from the patients whom were symptomatic despite 6 weeks of conservative treatment modalities (pain medication and physiotherapy). The patients who presented with cauda equina syndrome or progressive neurological deficit were operated before completion of 6 weeks of conservative treatment period. The patients which had a spinal deformity (degenerative scoliosis or spondylolisthesis), previous spinal trauma history or history of a spinal tumor surgery were excluded from the study. The study was approved by the local ethics committee of Bahçeşehir University School of Medicine (approval number: 2020-02/05).

A total of 249 patients were recruited at the end of the randomization. Of these patients; 165 of them constituted the operative treatment group (150 patients had lumbar microdiscectomy and 15 patients had spinal fusion) and 84 of them constituted the conservative treatment group. The surgical procedures which performed were standard microdiscectomy for one level disc herniation patients with accompanying leg pain and one or more level spinal fusion with transpedicular instrumentation with anterior support (TLIF) for patients whom had disc degeneration with accompanying axial pain. The surgical procedures were performed by the 2 senior spinal surgeons in the 2 centers mentioned above.

Pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), lumbar lordosis (LL), L4-S1, and PI-LL^{9,10} of all patients were measured by using standardized (distance, 180 cm; exposure time, 250 msec; current, 320 mA; and voltage, 105 kvp) lateral plain standing lumbar radiographs (Surgimap ver. 2.1.3.1) by 2 researchers in the different time periods. The standing lumbar radiographs were taken in fists-on-clavicle position. Intervertebral disc degeneration was also assessed according to Pfirrmann grading system¹¹ by the same team by using lumbar sagittal T2-weighted magnetic resonance images. Interobserver analyses for the measurements of the spinopelvic parameters were assessed by intraclass correlation coefficient and Pfirrmann grades were assessed by weighted Kappa coefficient. Kappa coefficients for intraobserver reliability for Pfirrmann grading were 0.86–0.90 and interobserver reliability was 0.70–0.82.

Statistical analyses were performed by using GraphPad Prism ver. 8 (GraphPad Software Inc., La Jolla, CA, USA). Unpaired t-tests was performed to compare the mean value of spinopelvic parameters between the 2 groups and correlations between the 2 quantitative values were determined using the Pearson correlation coefficient (Spearman coefficient when the size of the sample was less than 30). A value of $p < 0.05$ was considered for statistical significance and $p < 0.001$ was considered highly significant.

RESULTS

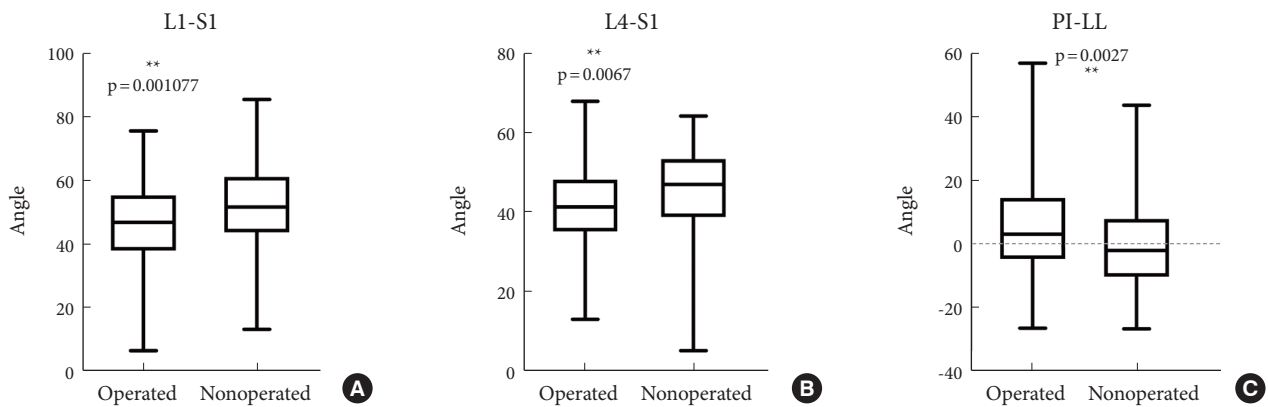
There were 165 patients in the surgical intervention group (60 females, 105 males) and 84 patients in the conservative treatment group (57 females, 27 males) according to the randomization. One hundred fifty patients of the surgical intervention group (90.8%) had lumbar microdiscectomy procedure and 15 patients (9.1%) had spinal fusion with TLIF procedure. The mean age for the surgical intervention group was 47.8 ± 13.2 (range, 18–81). The mean PI was $52.1^\circ \pm 12.3^\circ$ (range, 26.6° – 83.5°); mean PT was $20.0^\circ \pm 8.9^\circ$ (range, 0.6° – 55.0°); mean SS was $32.3^\circ \pm 9.6^\circ$ (range, 8.0° – 58.30°); mean LL was $46.5^\circ \pm 13.9^\circ$ (range, 6.7° – 75.7°); mean L4-S1 was $41.0^\circ \pm 10.4^\circ$ (range, 58.3° – 75.7°) and mean PI-LL was $5.56^\circ \pm 24.30^\circ$ (range, -26.40° – 56.80°) in the operated patient population. The mean age for the conservative treatment group was 44.7 ± 15.9 (range, 14–71). The mean PI was $52.5^\circ \pm 12.9^\circ$ (range, 12.9° – 88.2°); mean PT was $18.5^\circ \pm 8.4^\circ$ (range, 0.4° – 39.5°); mean SS was $34.0^\circ \pm 9.2^\circ$ (range, 9.18° – 57.6°); mean LL was $52.6^\circ \pm 13.7^\circ$ (range, 13.4° – 85.6°); mean L4-S1 was $44.9^\circ \pm 11.3^\circ$ (range, 5.2° – 64.1°) and mean PI-LL was -0.11 ± 19.61 (range, -26.6 – 43.6) in the conservative treat-

Table 1. The summary of the spinopelvic parameters and demographic data in between the treatment groups

Variable	Surgical intervention (n = 165)	Conservative treatment (n = 84)	p-value
Sex, male:female	105:60	27:57	
Age (yr)	47.8 ± 13.2 (18.0–81.0)	44.7 ± 15.9 (14.0–71.0)	
PI (°)	52.1 ± 12.3 (26.6–83.5)	52.5 ± 12.9 (12.9–88.2)	0.791
PT (°)	20.0 ± 8.9 (0.6–55.0)	18.5 ± 8.4 (0.4–39.5)	0.197
SS (°)	32.3 ± 9.6 (80.0–58.3)	34.00 ± 9.20 (9.18–57.60)	0.174
LL (°)	46.5 ± 13.9 (6.7–75.7)	52.6 ± 13.7 (13.4–85.6)	0.001
L4–S1 (°)	41.0 ± 10.4 (58.3–75.7)	44.9 ± 11.3 (5.2–64.1)	0.006
PI–LL (°)	5.56 ± 24.30 (-26.40–56.80)	-0.11 ± 19.61 (-26.60–43.60)	0.002

Values are presented as number or mean ± standard deviation (range).

PI, pelvic incidence; PT, pelvic tilt; SS, sacral slope; LL, lumbar lordosis.

**Fig. 1.** The difference of the lumbar lordosis, L4–S1 and PI–LL value in between the surgical intervention and conservative treatment patient groups. PI, pelvic incidence; LL, lumbar lordosis.

ment group (Table 1).

There was a statistically significant difference regarding the parameters LL ($p=0.0011$), L4–S1 degree ($p=0.0067$) and PI–LL ($p=0.0027$) between the surgical intervention group and the conservative treatment group (Fig. 1).

The levels of the herniated discs that required surgical intervention were; L1–2: 3 (1.81%); L2–3: 2 (1.21%); L3–4: 17 (10.3%); L4–5: 62 (37.5%) and L5–S1: 81 (49.09%) (Table 2).

Pfirrmann grade 3 or more were accepted as degenerated. There was not a statistically significant difference in between the surgical intervention and conservative treatment groups when comparing disc degeneration status according to Pfirrmann grade. Pfirrmann grade and spinopelvic parameters also did not have a statistically significant difference in the surgical intervention group when we compare the 2 different surgical intervention techniques.

PI also did not show a statistically significant difference in between the surgical intervention and conservative treatment

Table 2. The summary of the degenerated disc level in the operated patient population

Level	No. (%)
L1–2	3 (1.81)
L2–3	2 (1.21)
L3–4	17 (10.3)
L4–5	62 (37.5)
L5–S1	81 (49.09)

groups and furthermore there is not a significant difference in the surgical intervention group between 2 surgical intervention techniques.

In the surgical intervention group when we further analyze the spinopelvic parameters in between the 2 different surgical techniques performed we found that; L4–S1 degree, PT, and PI–LL values showed a statistically significant difference in between the 2 groups (Fig. 2).

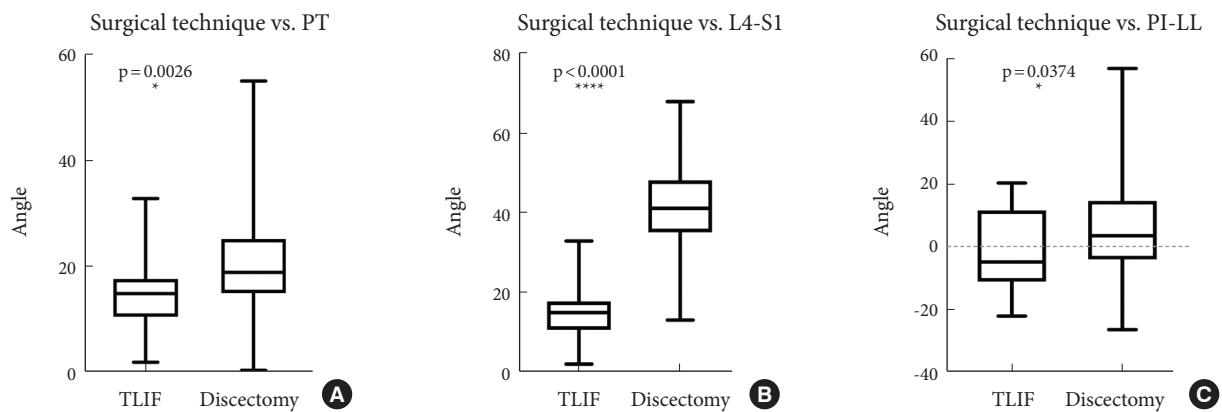


Fig. 2. The difference of the L4–S1 degree, PI–LL value, and PT degree in between the 2 surgical procedures performed. PI, pelvic incidence; LL, lumbar lordosis; PT, pelvic tilt.

DISCUSSION

Pelvic index (PI) was first described by During in 1985⁹ and its importance was highlighted by Duval-Beaupère in 1992.¹⁰ It is one of the major parameters that define the orientation of the pelvis and guides the deformity surgeons for proper surgical planning which is needed for each individual patient. Since the awareness of the deformity surgeons increase about PI and the other related spinopelvic parameters (SS, PT, LL, and PI–LL), our knowledge about the relationship with these factors and their biomechanical effects on spine is getting understood.^{12,13}

PI is accepted as a constant measurement after bone maturation had been completed and it is not affected with patient's position. Ideal LL is accepted to be 100 more than the PI⁵ and this is directly related with HRQoL in the operated adult spinal deformity patients in postoperative period.

In the recent publications it has been mentioned that; there is a correlation in between LL and SS. Higher PI is related with higher SS and increased LL that ends up with degenerative spondylolisthesis.^{14–16} In this study we could not be able to show a statistically significant correlation between disc degeneration degree and the PI values in between the surgical intervention group and the conservative treatment group and furthermore there is not a significant difference regarding PI in between the 2 surgical techniques performed.

It has been also shown that decreased LL is statistically correlated with lumbar disc herniation⁸ and furthermore we know that loss of LL initiates compensating mechanisms such as decrease in thoracic kyphosis, pelvic retroversion and flexed knee posture in the advanced stages and the process end up with degenerative adult spinal deformity that requires major surgical

corrections. In this study, we have shown that LL values are significantly lower in the surgical intervention group ($p=0.0010$) which was consistent with the previous literature. In the surgical intervention group, we could not see a correlation with degenerated disc degree and LL. Also, when we compared the 2 surgical techniques needed to be performed there was not a significant relation regarding LL.

PT shows us the response of the pelvis to sacral inclination. Since PI is a constant measurement and $PI = PT + SS$; PT increases when the SS decrease (retroversion) or vice versa (PT decreases when SS increase [anteversion]). There was not a significant difference between surgical intervention and conservative treatment groups regarding PT values. But there was a significant difference in between the 2 surgical procedures performed that was PT values are significantly lower in the spinal instrumentation group (mean, 14.99°) despite being in the normal range (50°–300°)¹⁷ with a lower L4–S1 (mean, 14.99°) and a lower PI–LL (mean, -2.06°).

When we analyze the results in a wider perspective; in this study there is a highly statistically significant difference between surgically treated patient population and conservative treatment patient population in 2 additional spinopelvic parameters besides LL which are; L4–S1 ($p=0.0067$) and PI–LL ($p=0.0027$) (Fig. 2). This finding is consistent with the literature and furthermore we can assume that these parameters can be a surgical need determinant in the degenerative disc patients. LL and L4–S1 values are statistically significantly lower in the surgical intervention group when compared with the conservative treatment group and furthermore the consistent finding with these measurements is that if the PI–LL values increase which shows us the PI–LL mismatch; the surgery need is manifesting. We

can assume that these parameters can be determinant factors in degenerative disc disease and can be a predictive factor for the surgical need of the patient.

In the further analysis of the spinopelvic parameters in between the 2 surgical techniques performed we came up with the result that for the patients whom needed spinal instrumentation had a statistically significant lower PI-LL, PT, and L4-S1 values than the discectomy group. In the ideally aligned spine L4-S1 angle constitutes the nearly 50%–80% of the LL¹⁸ between the range of 40.7°–28.7°. In the spinal fusion group L4-S1 values are (mean, 14.99°) lower than expected (normal range, 40.7°–28.4°) and which is highly significant when compared with the discectomy performed patient group (mean, 40.77°).

Further studies with larger cohorts are needed for to prove this particular finding in the up-coming studies but this study confirms that PI-LL value especially is important for both surgical need determination and the type of the surgery which will be performed.

CONCLUSION

Degenerative disc disease is arguably a ‘disease’ and is related with multiple factors which can be detailed under the mechanic components and the genetic components. Of these factors, spinopelvic parameters seem highly penetrating to the patients’ surgery needs with degenerative disc disease independently. LL and L4-S1 degrees are significantly lower with higher PI-LL values in the surgical intervention group in our study and furthermore L4-S1 degree with PT and PI-LL values are significantly lower in the spinal fusion group when compared with the microdiscectomy performed patient population.

This research, however, is subject to some limitations; first, it’s design is retrospective and secondly, the data regarding scales for evaluation of the patients’ status was not available.

CONFLICT OF INTEREST

The authors have nothing to disclose.

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