Evaluation of Lumbosacral Angle (LSA) and its Impact on Patients with Lumbar Disc Herniation

Lumbosakral Açının Lomber Disk Hernili Hastalardaki Etkisinin Değerlendirilmesi

Evaluation of Lumbosacral Angle

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Özet

Amaç: Bel ağrısının en sık sebeplerinden biri lomber disk hernisidir (LDH). LDH'nin tedavi yöntemlerinden biri cerrahi operasyondur. LDH'de, lomber lordoz açısında meydana gelen değişiklikler hastanın klinik durumunda olumsuz etkilere yol açmaktadır. LDH cerrahisi sonrasında ve kas spazmlarına bağlı olarak lordoz-sakral eğim açısında önemli değişikliklerin meydana geldiği bilinmektedir. Bu çalışmada, LDH'li hastalarda cerrahi operasyon öncesi ve sonrasında ölçülen lumbosakral açı değişikliklerinin hastaların klinik durumu üzerindeki etkisini araştırmayı amaçladık. Gereç ve Yöntem: Çalışmada, 2005-2007 yılları arasında lomber disk hernisi tanısıyla ameliyat edilen 139 hastanın operasyon öncesi ve sonrası lumbosakral açıları ölçüldü. Hastalar, Oswestry Skalası, Görsel Analog Skala, Narkotik Skor ve Hasta Memnuniyeti Değerlendirme Skalası kullanılarak değerlendirildi. Lomber lordoz açısı, sakral eğim açısı ve disk yüksekliği direkt radyografi kullanılarak hesaplandı. İstatistiksel analiz GraphPad Prisma V.3 yazılımı kullanılarak gerçekleştirildi. Bulgular: Lordoz açısı ve sakral eğim açısının postoperatif dönemde arttığı tespit edilmiştir. Bu artışın hastanın klinik durumu üzerinde olumlu bir etki sağladığı saptanmıştır. Tartışma: LDH'li hastalardaki biyomekanik açının klinik etkilere sahip olduğu bilinmektedir. Biyomekanik parametreler cerrahi öncesi ve sonrasında ve postoperatif kontrollerde akılda tutulmalıdır. Ameliyat kararı verilmeden önce hastaların lordoz açısı, komşu disk yapıları ve sakrum ile olan ilişki mutlaka değerlendirilmelidir.

Anahtar Kelimeler

Lomber Disk Hernisi; Lomber Lordoz Açısı; Sakral Eğim Açısı

Abstract

Aim: One of the most common causes of low back pain is lumbar disc herniation (LDH). One of the treatments for patients with LDH is a surgical operation. Changes in the lumbar lordosis angle have a negative impact on patients, clinically. The significance of changes in the lordosis-sacral inclination angle that are associated with muscle spasms and are seen after LDH surgery is known. In this study, we would like to examine the clinical impact on patients due to changes in the lumbosacral angle measured before and after surgical operations in patients with LDH. Material and Method: Between 2005–2007, preoperative and postoperative lumbosacral angles of 139 patients operated on for a diagnosis of lumbar disc herniation were measured. Patients were evaluated with the Oswestry Scale, Visual Analogue Scale, Narcotic Score, and Patient Satisfaction Evaluation. Lumbar lordosis angle, sacral inclination angle, and disc height were calculated by direct radiography. Statistical analysis was performed with GraphPad Prisma V.3 software package. Results: In this study, increases of lordosis angles and sacral inclination angles have been observed, postoperatively. It has been shown that these have a positive impact on the clinical course. Discussion: The clinical effects of the biomechanics of angles of patients with LDH are clear. Biomechanical parameters should be considered at preoperative treatment, postoperative treatment, and postoperative controls. The patient's lordosis angle, neighboring disc structure, and relationship with the sacrum must be carefully evaluated for surgical decision.

Keywords

Lumbar Disc Herniation; Lumbar Lordosis Angle; Sacral Inclination Angle

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Introduction

Back pain is one of the common reasons for absence from work and social activity [1,2,3]. Approximately 80% of the entire world population have complained of low back pain at least once in their lives [4]. Typically, younger individuals (40 to 50 year olds) are more likely to experience back pain; it is significantly more common among adults working in factories and the service industry [5,6,7]. 2-3% of all back pain syndromes are associated with lumbar disc herniation [8]. Recent developments in the field of radiology have increased the reliability of the diagnosis of disc herniation; simultaneously, new medical and surgical treatments have been widely applied [9].

The postural and angle changes of the spine in frontal, transverse, and sagittal planes were thought to be the cause of back pain and disc degeneration. However, the effect of lumbar lordosis reduction or increase is still unclear. There are negative effects of lumbar lordosis loss; the importance of the preservation of physiological stance is emphasized [10]. In recent years, high rates of lumbar disc hernia surgery and the widespread use of spinal instrumentation and increased fusion operations have provided for more-detailed investigation of the spinal cord contour [11, 12, 13]. The effect of increased or decreased lordosis is not fully shown but many researchers have reported negative effects of iatrogenic loss of lordosis after spinal surgery and have emphasized the importance of ensuring physiological lordosis [14, 15].

In this study, changes in the lumbosacral biomechanical angle parameters were investigated in the surgical treatment of patients diagnosed with lumbar disc herniation (LDH). Relations between pre-intervention angles, post-intervention pain, pain scores, and levels of patient satisfaction were examined.

In addition, sacral inclination angle differences according to gender and age, both before and after treatment, were investigated. Before and after treatment disc space height was evaluated according to age. In this study, we aimed to evaluate patients with lumbar disc herniation surgery, measure biomechanical angles preoperatively and postoperatively during specific periods, investigate the effects of these angles on each other, and follow up clinically.

Biomechanics of the Spine

The disc is a viscoelastic and anisotropic structure. When testing biomechanical and elastic properties of the disc, low-speed loading conditions are applied. On a compression test, the disc has low flexibility but it seems to behave solid form in order to increase stability in the large load value. Therefore the nucleus that maintains normal elastic properties under compressive loads during daily activity tends to herniate less [16].

In the static compressive strength test load performed on functional spinal unit (FSU), spinal end-plate damage before disc tissue was seen to occur [17]. Therefore, depending on the location of the nucleus of the vertebral body end-plate fracture, Schmorl nodes may occur.

In the first in vivo experiments to determine the amount of pressure inside a disc, a pressure transducer was placed inside. L3-L4 disc pressure 300% higher than normal was found at the sitting position, forward at 20 degrees flexion, or with 20 kg load [18].

Intradiscal pressure is different in different body positions: At lying it is 154 kPa (kilo Pascals), at standing 550 kPa, and at sitting 700 kPa. Moreover, disc pressure is known to increase with intradiscal degeneration [19].

Material and Method

This study was carried out between December 2005 and January 2007 in Neurosurgery Clinic, Vakıf Gureba Training and Research Hospital. The records of 139 surgical patients hospitalized with the diagnosis of lumbar disc herniation were studied retrospectively. Oswestry Scale, Visual Analogue Scale, Narcotic Score, Pain Score, Patient Satisfaction Evaluation, the measurement of lumbar biomechanical angles, age, gender, occupation, position of herniation, and disk type parameters in lumbar MRI were used to evaluate the patients. Relevant forms are shown below.

Patients were excluded from the study if they had a history of: surgery with a diagnosis of lumbar disc herniation; spinal surgery due to infections, inflammation, neoplasia, or fractures; instability problems such as spondylolisthesis, spondylolysis; recurrent disc herniation; and pregnancy. There was no age limit for patients in the study.

Parameters for follow up

1. Pain Assessment

-Visual Analogue Scale (VAS)

- Pain Score
- Narcotic Score

2. Measurement of functional impairment

Modified Oswestry Disability form was used for the measurement of functional disability. This scale, described by Fairbanks and then modified by Hudson-Cook, is recommended as a sensitive scale in the measurement of functional disability in patients with low back pain because of its validity and reproducibility.

L1-S1 Lumbar Lordosis Angle (LLA) (Picture 1), L1-L5 Lumbar Lordosis Angle (LLA) (Picture 2), within Lumbar Disc Herniation (LDH) Lordosis Angle (Picture 3), Lordosis Angle in Lumbar Disc Herniation (LDH) (Picture 4), Sacral Inclination Angle (SIA) (Picture 5), height of the disc at the disc herniation (Picture 6), height below the disc at the disc herniation (Picture 7), and height above the disc at the disc herniation (Picture 8) were measured in the lumbosacral lateral radiographs at preoperative, postoperative after 1 month, and postoperative after 6 months. On these x-rays, a total of 2085 angles and 1251 disc spaces of 139 patients were measured.

All of these parameters values were compared before treatment and after treatment. The relationship of postoperative pain and preoperative angle was evaluated, as was the relationship between percentage change of angles and percentage change of pain scores.

Statistical Evaluation

In this study, statistical analysis was performed with the GraphPad Prisma V.3 software package. Comparisons between groups were performed with Kruskal-Wallis test, subgroup comparisons with Dunn's multiple comparison test, group comparisons before and after treatment with Wilcoxon test, and the relationships between variables determined with Pearson's correlation

test. Also, we used descriptive statistical methods of evaluating the data (mean, standard deviation). Results are significant at $p < 0.05$ levels.


Picture 1


Picture 2


Picture 3


Picture 4


Picture 5

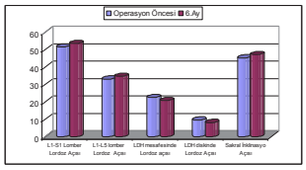

Picture 6


Picture 7

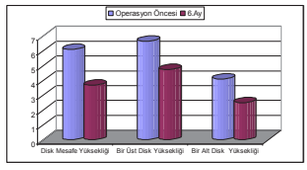

Picture 8

Table 1. Age distribution of patients

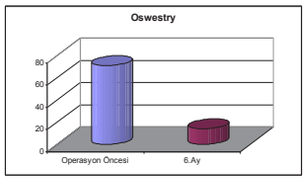
Total number (139)	Minimum	Maximum	Average	Standard Deviation
Age	23	84	45.68	10.38



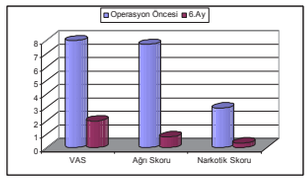
Graphic 2.a



Graphic 2.b



Graphic 2.c



Graphic 2.d

Discussion and Conclusions

Back pain is a very widespread public health problem, affecting three-quarters of the world's population at some period of their life. 75-85% of adults have experienced back pain during some period and 80% have faced recurrent episodes [20]. The fact that back pain is continuous and recurrent increases its public health cost. In some studies, a decrease of waist, back, and abdominal muscle strength and durability in chronic back pain patients has been shown to be a weakness that is a predisposing factor for back pain [21]. The majority of our patients were either housewives or workers employed in the textile factory; their physically demanding work is one of the main factors leading to chronic back pain.

In a study made by Mulholand and Sengupta, degenerative process, rather than abnormal movement patterns of abnormal load, can cause low back pain in some patients. Osteoarthritic disc joints may be the source of pain [22].

Lumbar disc herniation is one of the major causes of low back pain. The pathogenesis of disc degeneration remains unclear. Together, the effect of heavy physical work, heavy lifting, standing in the same position, and vibration creates a vicious cycle. Besides these environmental factors, some internal factors such as the mechanical properties of the patient's spine, biochemical characteristics of the intervertebral disc, and characteristics of the vessels supplying the discs are known to play a role in the development of degeneration. For example, smoking can disrupt blood supply to the disc and has been identified as an important factor in disc degeneration. Smoking causes progressive degeneration of the disc, hyalinization of the nucleus pulposus and necrosis [23]. The genetic structure that determines disc biochemistry is partially inherited [24].

Lotz and Ulrich studied experimental models of disc degeneration. As a result, they are convinced that the three factors related to the occurrence of discogenic pain are disc innervation, inflammation, and hypermobility [25].

The pathology of the spine can lead to the development of non-physiological movement or can restrict the range of movement. In individuals, these processes manifest in many ways, from pain caused by movement to neurological deficits. The purpose of spinal surgery is to make these pathological processes physiological as much as possible. The number of patients who receive spinal surgery is increasing every day. The aim of surgical treatment is to bring the contour of the spine in the frontal, sagittal, and transverse planes to as normal a position as possible. Spinal surgery makes energy absorption with cervical lordosis, thoracic kyphosis, and lumbar lordosis more effective and increases spinal muscular efficiency. In addition, this structural curvature contributes to erect posture in the patients [26,27].

The angle and posture changes of the spine in the frontal, sagittal, and transverse planes were thought to be the cause of low back pain and disc degeneration. The effect of lumbar lordosis reduction or increase is still unclear. The negative effects of the loss of lumbar lordosis and the importance of protecting the physiological position are emphasized [10].

In recent years, high rates in lumbar disc hernia surgery and the widespread use of spinal instrumentation and increased fusion operations have enabled more-detailed investigation of the spinal cord contour [11, 12, 13]. The effect of increased or decreased lordosis is not fully shown, but many researchers have reported negative effects of iatrogenic loss of lordosis after spinal surgery and emphasized the importance of ensuring physiological lordosis [14, 15].

Knowing that the limits of normal sagittal contour of the spine fulfill many functions in a healthy person is important. The spine supports the head and body with physiological contour and provides adequate and painless movement. Natural development of the sagittal contour of the spine is not fully understood. Lumbar lordosis, whether it has developed primarily or developed secondarily with thoracic kyphosis, continues to be a topic of discussion [26].

There are studies suggesting that reduction of lumbar lordosis is associated with low back pain [10,11,14,15,28]. In neurosur-

gery clinical practice, the lumbar lordosis of most low back pain patients is evaluated. However, the problem lies in associating the evaluations with subjective assessments such as decreased or increased lordosis.

Although it has recently become more routine, lumbar lordosis measurement technique hasn't yet become fully standardized [15]. In this study, we have calculated the segmental lordosis angles with total lumbar lordosis.

In this study, we have measured lumbar lordosis angle of the spine with different parameters before surgery for lumbar disc herniation. We evaluated the complaints of patients with a variety of scales. When we compare with the scale measure again in the postoperative period, existing preoperative pain due to flattening of lordosis is decreased in parallel with the increase in the angle of lordosis after surgery. There is also increase in patient satisfaction. We proved statistically that the increase in the sacral inclination is positive for patients.

In our study, the sacral inclination angle increased in parallel with the lumbar lordosis angle. The sacrum assumed a more inclined position. Also in parallel with changes in the lumbar lordosis angle, we see changes in the same direction in the sacral inclination angle. In a study made by Okcu et al., they have shown that the reduction in sacral inclination angle is associated with the reduction of lumbar lordosis and the movement of the sacrum into a more upright position. This is an indication that lumbar lordosis and sacral inclination balance each other.

Reduction of the lumbar lordosis angle is undesirable, because it adversely affects the biomechanical forces of the spine in the postoperative period and it may increase the mobility of the neighboring upper disc. This may accelerate the degenerative process and in the later stages may result in the emergence of adjacent segment disease. These results are based on follow up at 1 month and 6 months. It should be kept in mind that there may be a different result in long-term follow up.

İn the early preoperative and postoperative periods, flattening lordosis is a factor responsible for the patient's complaints (radiculopathy, neurological claudication, etc.). Because nerve regeneration cannot occur and deformed muscle structure cannot improve in the time frame of the early postoperative period, physiological lordosis cannot quickly be restored. Thus, the patient's complaints in this regard will continue during the early postoperative period. Based on the muscle mass after surgery and the duration of nerve regeneration, an increase of lordosis can be expected after 6 months, where it has been shown that the patient may come to the lowest level of postoperative complaints within an average 1-year period. Indeed, in our study, 1 month after intervention the change of lordosis angle was not statistically significant; however, lordosis angles did significantly increase at postoperative 6 months (hence the decrease of flattening lordosis). In addition, our study shows a positive impact on patients' clinical situation with respect to increase of biomechanical angles. Patients' complaints would be expected to decrease in this time frame.

When patient satisfaction and pain scores are compared with the patient's preoperative angles, there is a significantly positive correlation between a higher disc space height and patient satisfaction. If the preoperative disc space height is much higher, the patient satisfaction rate is much higher postoperatively. This helps to eliminate adjacent segment disease, secondary to the collapse of the evacuated disc space, due to the growing burden of foraminal narrowing and symptoms that develop due to the collapse of the upper disk.

The effects of biomechanical angles on patients' clinical experience with lumbar disc herniation are clear. Thus, biomechanical parameters must be considered during preoperative treatment, postoperative treatment, and follow-ups. For surgical decisions, the patient's lordosis angles, disc height, level of degeneration of the disc, the disc structure on neighbor distance, and the relationship of the disc with the sacrum must be carefully evaluated.

Competing interests

The authors declare that they have no competing interests.

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