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Original Article

Inequality in leg length is important for the understanding of the pathophysiology of lumbar disc herniation

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Abstract

Objective: Inequality in leg length may lead to to abnormal transmission of load across the endplates and degeneration lumbar spine and the disc space. There has been no study focusing on lumbar disc herniation (LDH) and leg length discrepancy. This subject was investigated in this study. **Materials and Methods:** Consecutive adult patients with leg length discrepancy and low back pain (LBP) admitted to our department were respectivelly studied. **Results:** A total number of 39 subjects (31 women and eight men) with leg length discrepancy and LBP and 43 (25 females and 18 males) patients with LBP as a control group were tested. Occurrence of disc herniation is statistically different between patients with hip dysplasia and control groups ($P < 0.05$). **Conclusion:** The results of this study showed a statistically significant association between leg length discrepancy and occurrence of LDH. The changes of spine anatomy with leg length discrepancy in hip dysplastic patients are of importance in understanding the nature of LDH.

Key words: Inequality, leg length, lumbar disc herniation (LDH)

INTRODUCTION

Degenerative disc disease is one of the most common diseases of the spine.[1,2] Generally, low back pain (LBP) is one of the most common problems.[3-5] It affects millions of people globally.[6] LBP is a common disorder with a lifetime prevalence of 85%.[7,8] In addition, it is one of the most common surgical practices performed by a spine surgeon.[9-11] Introduction of the microsurgical techniques lead to important evolution in lumbar disc surgery. However, not all patients will benefit from lumbar discectomy.[10] The surgical treatment of ruptured lumbar intervertebral discs is sometimes discouraging to both the surgeon and the patient.[10,11] Although, decompression of the nerve root and, therefore, the improvement of radicular pain is the mainstay of disc surgery, pain may persist or recur despite well-indicated and well-performed surgery.[12] Spinal imbalance may be important in all these situations, because one of the essential roles of the spine is to support mechanical loads in the upright position. Balance of the body essentially depends on how

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far the head is to the midline.[13] While in this position, humans are never completely immobile but are, in fact, continually adjusting their balance by means of micromovements, thereby ensuring that the body's center of gravity remains harmoniously within a base of support in a fashion requiring minimal muscular effort.[14] Developmental dysplasia of the hip is a condition in which the hip joint does not develop normally, and in this pathology, abnormality in size, shape, orientation, and organization of femoral head, acetabulum, or both anatomical structures are seen. Al-Eisa *et al*. demonstrated that subtle anatomic abnormality in the pelvis is associated with altered mechanics in the lumbar spine.[15] Many sacropelvic parameters were developed to characterize spinopelvic alignment in the sagittal plane.[16] However, human coronal balance may additionally be one of the causes of operative failure after disc surgery. Assessment of pathologic coronal imbalance requires a clear understanding of normal coronal alignment. The leg on the side of the dysplastic hip is usually shorter than the other side. Inequality in leg length may lead to abnormal transmission of load across the endplates and degeneration lumbar spine and the disc space. Leg length discrepancies with hip displacement may lead to disorders in postural movement coordination. It may lead to significant changes in spinal posture and deterioration of postural stability. We hypothesized that coronal imbalance with hip dysplasia would effect to disc herniation. A better understanding of etiology is required to determine and develop effective surgical management protocols. Any contribution to our knowledge of this cause of these operative failures is always welcome.

MATERIALS AND METHODS

A total number of 39 patients with inequal leg length and dysplasia of the hip and 43 normal subjects who had visited the outpatient clinic orthopedic and neurosurgical department for LBP treatment between January 2012 and July 2013 were retrospectively analysed. Work status, smoking, etc. were not questioned, because the aim of this article is an investigation of relationship of LBP patients with dysplasia of the hip and disc degeneration. The inclusion criteria were: Adult male or female patients, 20 years or older, with chronic LBP symptom duration of at least 6 months. The exclusion criteria were patients who had spinal trauma and spinal tumor or other malignancy. Once the subject was entered in the study, multiplanar magnetic resonance imaging (MRI) and plain films were done from the first lumbar to the first sacral vertebra with a 1.5-tesla imaging system. All magnetic resonance (MR) images and plain films were assessed independently. Each level from L1-S1 was assessed for disc degeneration. Disc degeneration reportedly causes LBP and is often observed concomitantly with end plate signal change and/or Schmorl's nodes on MRI. Controversy persists regarding the association of abnormal MRI findings with chronic axial and mechanical back pain.[17] The degree of disc degeneration on MRI was classified into five grades based on the Pfirrmann classification system, with grades 4 and 5 indicating disc degeneration.[18] The presence of dysplasia was blinded to the investigator. The causes of shortness of leg length discrepancy were congenital hip dysplasia in all cases. There was no case with leg length discrepancy after trauma. Any disputes were resolved by discussion between the authors. Extremity length was calculated by measuring the distance between the anterior superior iliac spine and the medial malleolus. A frequently used technique to measure leg length is the supine tape measure method. It is a valid and reliable clinical method.[19]

Statistical analysis

Demographic data is described with means ± standard deviations, median, minimum, maximum, and ranges by descriptive statistics. All data were tested for normal distribution and homogeneity of variances. We used the Pearson's chi-squared test. The level of significance was set at $P = 0.05$.

RESULTS

A group of 38 patients with hip dysplasia were investigated. The group consisted of 31 women (81,5%) and seven men (18,4%), aged 26-69 years [Table 1]. In the control group, there were 25 females and 18 males with a mean age of 42,3 years (range, 26.3-55.0 years). All included patients had a history of LBP. Short extremity length and lumbar disc herniation (LDH) (24 versus 15) were more prominent on the right than the left side ($P = 0{,}663$). Herniated disc was diagnosed in 30 cases. Table 1 shows disc herniation in patients with hip dysplasia and control groups. Study power is 92,1%. The type of disc hernias were as follows: No disc in nine cases (23.07%), bulging in 20 cases (51.2%) protrusion in eight cases (20.5%), extrusion in two cases (5,1%). Inequality in leg length and severity of lumbar disc crosstabulation was shown in Table 2. There were no significant differences in age and sex. Occurrence of disc herniation is statistically different between patients with short leg and controls ($P < 0.05$).

DISCUSSION

At present, neurosurgical practice is confronted by an explosion of technology.[20-22] In the 1990s, the advent of MRI and the progressive increase in definition of this modality of imaging have considerably contributed to the knowledge of spinal disorders. With the time and in parallel to the technological advancement, new and more complex spine procedures were

Table 1: Shows disc herniation in patients with hip dysplasia and control groups

Type of disc herniation	Groups		Total
	Control G	Hip dysplasia	
Disc			
No disc	19	9	28
Bulging	23	22	45
Pro-Ex	1	8	9
Total	43	39	82

performed.[23] However, many patients with LBP fail to improve following a successful surgery. Treatment of spine pathologies should consider anatomic and physiologic rules.[24] The evolution of bipedal posture and ambulation in humans has transformed the horizontal vertebral column of vertebrates into a load-bearing erect spine that is required to efficiently transfer weight, provide stability, and permit motion.[10] Through the spinal column, the body load is shifted to the base of the sacrum and then, through the pelvic girdle to inferior extremities.[10] Due to the erect position, the pelvic bone system is subjected to new static and dynamic relations that play a very important role in definite formation of this region.[25] Onset of lumbar disc in humans is often associated with bipedal ambulation. Theories propose that this transformation in the mechanics of locomotion is the inciting evolutionary event that made the lumbar spine susceptible to degenerative disease. Barrey reported that the patients with chronic LBP have a minor balance defect.[26] Inequality in leg length is important for the understanding of the pathophysiology of lumbar disc degeneration and herniation. In a degenerate disc, where the load is transferred to the vertebrae, depends on the position of patient.[2] Sipko *et al.* found that the patients with intervertebral disc disease are characterized by asymmetrical leg loading[27] Our study, the first time, showed that patients with hip dysplasia are not same with control groups in terms of the LDH. An asymmetrical loading pattern may deteriorate spine biomechanics. Figures 1 and 2 show ipsilateral disc herniation of a patient with left hip dysplasia.

Importance of the present study

The pathophysiology of LBP can be various, depending on the underlying problem. Only in about 10% of the patient's specific underlying disease processes can be identified. Patients with scoliosis, spondylolisthesis, herniated discs, adjacent disc disease, disc degeneration, failed back surgery syndrome, or pseudoartrosis, all have symptoms of LBP in different ways.[8] Leg length discrepancy may be another causative condition. To the best of our knowledge, there are no studies on LDH in patients with leg length discrepancy. The X-ray and MRI presented in this study [Figures 1 and 2] demonstrates a case of leg length discrepancy due to dysplasia additionally demonstrates significant degenerative changes. This study shows that if an individual has a short leg, stress on the lumbar spine will be increased; the lumbar disc degeneration could in fact be the more significant issue than a leg length inequality in these patients. The standard surgical treatment of the lumbar disc disease reduces pain. It is difficult to explain why the surgical treatment of LDH does not always lead to improved outcome. In these patients, abnormal coronal balance may be an important issue. Correction of abnormal load transmission across the spine and degenerated disc may, therefore, be beneficial; however, it is not easy. In this setting, fusion systems may be in part useful. This system may assist to shift abnormal load transmission. Pain may sometimes be caused by the loss of distribution of load.[24] If correction of abnormal load transmission is an important factor, our study suggests dynamic stabilization systems have not theoretical advantages over rigid spinal implants. Both systems should allow similar outcomes in patients with abnormal load tranmission. LDH is the most common cause of LBP.[1,2] However, to our knowledge, hip dysplasia and LDH have not been well-investigated in humans. Ten Brinke *et al.* investigated the association between leg length discrepancy and the side of the radiating pain in LDH.[28] Our study is different from their study, because Ten Brinke *et al.*

Table 2: Inequality in leg length and severity of lumbar disc crosstabulation was shown

	Severity of lumbar disc				Total
Disc severity	No disc	Bulging	Protrusion	Extrusion	
Degree of IL					
Slight	5	8	4	0	17
Moderate	2	9	4	0	15
Severe	2	3	0	2	7
Total	9	20	8	2	39

Degree of inequality; 0-15 mm shorness, slight; 15-30 mm, moderate; More 30 mm is accepted as severe inequality of leg length

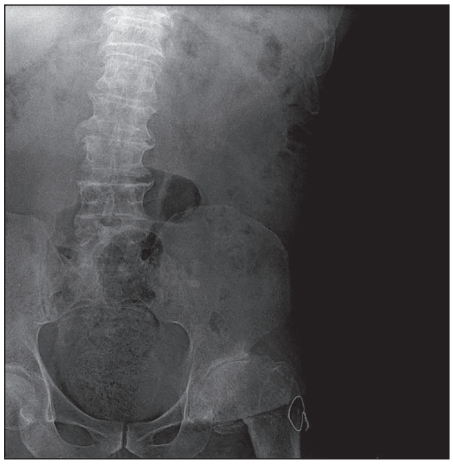

Figure 1: Shows conventional X-Ray of patient with left hip dysplasia and short left leg

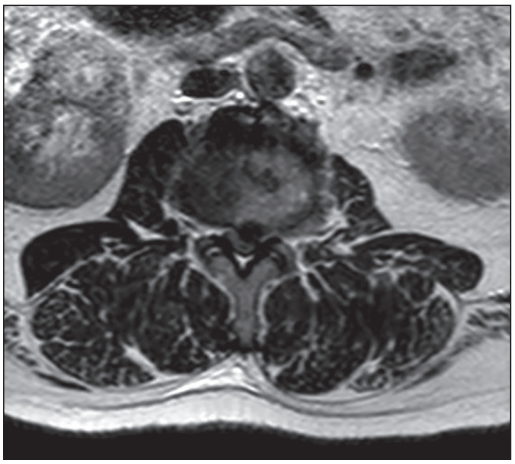

Figure 2: Lumbar MRI of same patient. He has left L4-5 disc herniation

investigated the side of the radiating pain in LDH. In this paper, we compared the occurrence of LDH between patients with leg length discrepancy and controls. Our result showed statistically significant difference.

Limitations of the study

The most important limitation of this study is its retrospective design. Prospectively designed studies with large patient populations are needed. All these 39 patients showed a typical walking pattern featured by their one short lower extremity. We acknowledge the lack of assessment of level and number of disc degeneration, Cobb angle of patients. However, this study, for the first time, first time shows that disc herniation is actually a result of some underlying congenital and morphological issue that was additionally affected by the leg length. The recognition of this fact may be important. If indeed one is the first to report something and that something is of value.[29,30]

CONCLUSION

Our study suggests that LDH may implicate abnormal loading due to leg length discrepancy rather than motion as the primary source of pain. A coronal imbalance of the spine is usually noted in patients with leg length discrepancy, however, the disc herniation secondary to leg length discrepancy has not been well-documented in humans. Abnormal patterns of load transmission may be accepted as a principal cause of degenerative changes in these cases. The concept is particularly appealing with greater recognition of the negative effects of abnormal patterns of load transmission on L4-5, L5-S1 spinal segments. Our observations suggest that LBP may have etiologies related to abnormal load transmission due to coronal imbalance. It seems that a successful treatment may sometimes exist beyond good surgery. In these situations, abnormal coronal balance may be an important factor.

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Conflicts of interest

None declared.

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