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ORIGINAL ARTICLE

Radyological Comparison of Lumbar Nerve Root Thickness in Patients with Lumbar Disc Herniation

Lomber Disk Hernisi Olan Hastalarda Lomber Sinir Kökü Kalınlığının Radyolojik Olarak Karşılaştırılması

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ABSTRACT

Introduction: the aim of this study was to compare radiologically the effect of the disc on Root thicknesses in patients with acute disc herniation.
Methods: It was performed by measuring the same level of Root thickness in lumbar MRI images of patients presenting with acute disc herniation symptoms.
Findings: Lumbar MRI images of 95 patients were compared radiologically. It was statistically determined that the thickness of the nerve root on the side exposed to the compression of acute disc herniation increased compared to the other nerve root thickness at the same level.
Results: This study found statistically significant increase in the diameter of the affected nerve root in acute lumbar disc herniation. Especially in multi-level disc herniations, it may be useful to measure the nerve root thickness in determining the level that causes the actual clinic.

Keywords: Root thickness, lumbar, MRI, disc herniation

ÖZ

Giriş: Bu çalışmanın amacı akut disk hernili hastalarda diskin kök kalınlıkları üzerinde etkisinin radyolojik olarak karşılaştırılmasıdır.
Yöntem: Akut disk hernisi semptomlarıyla kliniğe baş vuran hastaların çekilen Lomber Mrı görüntülerindeki aynı seviye kök kalınlıklarının ölçülmesi ile yapıldı.
Bulgular: 95 hastanın Lomber mrı görüntüleri radyolojik olarak karşılaştırıldı. Akut disk hernisinin basısına maruz kalan taraf kök kalınlığının aynı seviyedeki diğer kök kalınlığına göre istatistiksel olarak arttığı tespit edildi.
Sonuçlar: Bu çalışma akut lumbar disk herniasyonundaki etkilenen sinir kökünün kök çapında istatistiksel olarak anlamlı bir artışa sahip olduğunu ortaya koymuştur. Özellikle çok seviyeli disk hernilerinde asıl kliniğe sebep olan seviyenin tespitinde kök kalınlığı ölçümü fayda sağlayabilir.

Anahtar Kelimeler: Kök kalınlığı, lomber, MRI, disk hernisi

Introduction

Spinal nerve root compression due to lumbar disc herniation (LDH) is the most common cause of radicular pain of the related leg in young and middle age population (1). Overstress, either through alterations in oxygenation, nutrition, microvascular architecture and/or inflammation and collagenase release are thought to be responsible for disc degeneration, tears of annulus fibrosus and at last disc herniation (2). Lumbar disc herniation affecting a spinal nerve root is the most common cause of radiating pain to the lower extremity. Although the mechanical compression effect of the herniated fragment is the major cause, a series of inflammatory phenomena induced by the extruded nucleus contribute to the radicular pain. Swelling of the nerve roots occur due to inflammatory mediators generated and is demonstrated as thickening of the affected nerve root on magnetic resonance imaging (MRI) (3). Up to date literature is mainly absent of measurements of healthy lumbar nerve root and compressed nerve root diameters on MRI. This paper compares the normal lumbar nerve root thickness to root thickening changes in patients with acute lumbar disc herniation via MRI.

Material and Methods

Our study was conducted in accordance with the ethical standards of the corporate responsible committee and the 1975 Helsinki Declaration as revised in 1983. A total of 160 cases were evaluated but 65 cases were excluded because they did not meet the criteria. All patients who were operated due to lumbar disc herniation between the years 2015 and 2016 at a single institution were identified. Patients who had leg pain lasting less than a month and had only L5 or S1 root compression due to L4-5 and L5-S1 disc herniation respectively were included in the study. All the patients had central and paramedian disc herniation. Patients, who had leg pain for more than a month, underwent a disc surgery or minimal invasive treatment such as foraminal injection and far-lateral and extra-foraminal disc herniation along with cases of lumbar stenosis or spondylolisthesis were excluded from the study. Compressed spinal roots thickness in related levels was measured and the mean thickness of the compressed spinal root was identified. In addition, uncompressed spinal L2, L3, L4, L5, S1 roots were measured bilaterally for all patients to identify the mean thickness of the healthy nerve roots. All lumbar nerve roots were measured according to interpedicular line as depicted in Figures 1 and 2 on a 1.5 Tesla MRI (Intera;. Philips Healthcare, Best, the Netherlands). MR imaging was performed with a spine-array coil with respect to spin-echo sequences, axial and sagittal turbo T2-weighted images (TR/TE, 3800/128 ms) were obtained. Compressed lumbar nerve roots related to herniated disc segments and normal spinal roots were compared with each other.

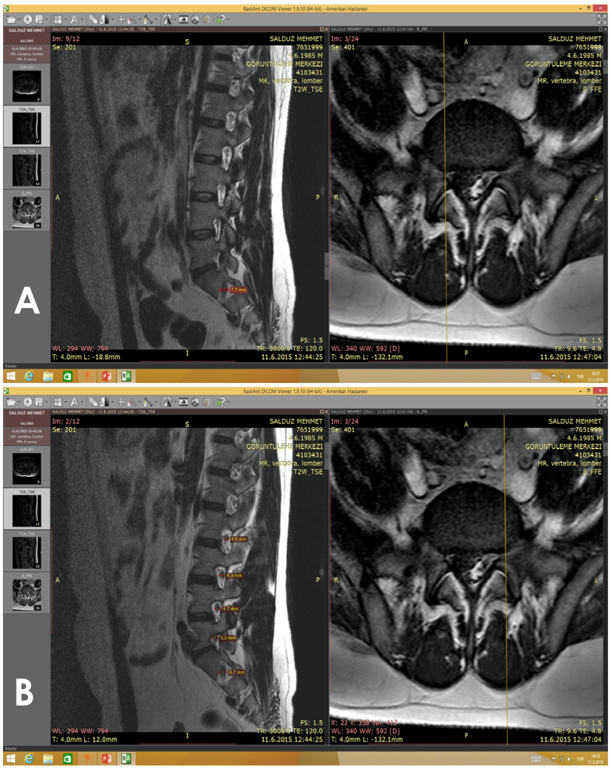

Figure 1. Measurement of lumbar roots on T2 sagittal MR Images

*1A: A right sided L5-S1 disc herniation causing a S1 root compression and swelling measured at 7.7mm. 1B: The same patient with the measurements of L2-S1 roots on the left side.

Statistical Analysis

All statistical analyses and data management were performed using IBM SPSS version 16.0 software. Chi square analysis was performed for dichotomous variables to assess representativeness of those with available imaging data. Numeric data were analyzed with an independent sample t-test. A p value of 0.05 was considered statistically significant.

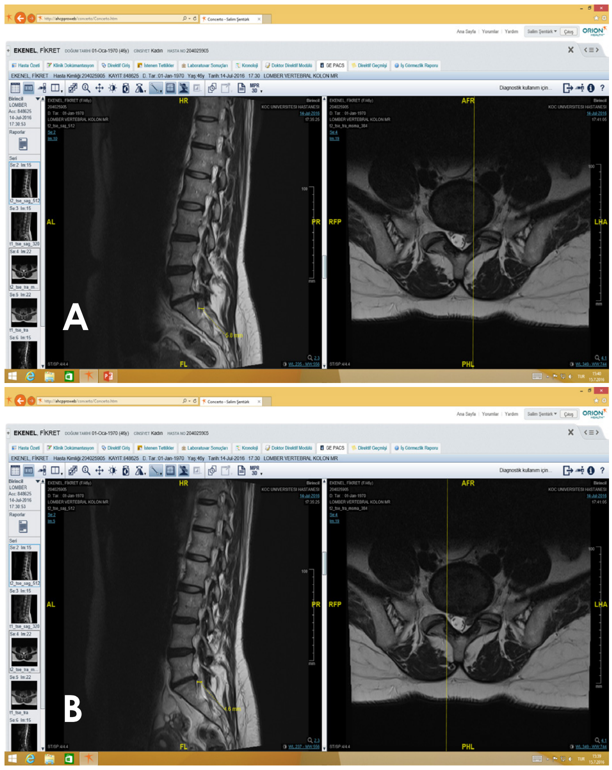

Figure 2. Measurement of affected root and contra lateral side

*2A: A left sided L5-S1 disc herniation causing a S1 root compression and swelling measured at 5.8 mm. 2B: The non affected right S1 root measured at 4.6mm.

Results

In the current study, 41 of the patients were female (43.2%) and 54 male (56.8%). The age of the patients ranged between 22 and 77. The mean age was 44.24. The average root diameters are summarized as mm in Table 1. Normal L2 roots on the right and the left side were measured as 3.37±0.45mm, 3.36±0.45mm respectively. The average diameter of the right L3 roots was 3.81±0.45mm and left L3 roots was 3.79±0.45mm. The average diameter of the right L4 right roots was 4.31±0.41mm and left roots was 4.27±0.42mm. The mean thickness of compressed right L5 spinal root was statistically greater than the normal spinal L5 root (6.27±0.64mm and 4.88±0.52mm $P<0.005$). The mean thickness of compressed left L5 spinal root was statistically greater than the normal spinal L5 root (6.40±0.95mm and 4.80±0.54mm, $P<0.005$). The mean thickness of compressed right S1 spinal root was statistically greater than the normal spinal S1 root (7.23±0.29mm and 5.28±0.26mm, $P<0.005$). The mean thickness of compressed left S1 spinal root was statistically greater than the normal spinal S1 root. (7.24±0.65mm and 5.74±0.55mm $P<0.005$).

Table 1. Measurement of Root Diameter Thickness (mm)

Lumbar Roots	Right	Left	p
L2	3.37±0.45	3.36±0.45	
L3	3.81±0.45	3.79±0.45	
L4	4.31±0.41	4.27±0.42	
L5	***6.27±0.64****	4.88±0.52	P<0.005
L5	4.80±0.54	***6.40±0.95****	P<0.005
S1	***7.23±0.29****	5.28±0.26	P<0.005
S1	5.74±0.55	***7.24±0.65****	P<0.005

* Compressed root due to disc herniation

Discussion

Lumbar disc herniation is a widespread pathology among the degenerative diseases of the lumbar spine and is the most common cause of spinal surgery. In particular, acute lumbar disc herniation causes severe leg and back pain due to radiculopathy. In the present study, the normal lumbar nerve root thickness was measured on T2-weighted MRI and the root thickening changes was evaluated in patients with acute lumbar disc herniation. It was concluded that the affected roots showed significant difference root thickness when compared to unaffected lumbar nerve roots in patients with acute lumbar disc herniation.

The starting point of radicular pain is presumably multifactorial; including mechanical incitement of the nerves of the outer part of the fibrous ring, direct compression of the nerve roots (with or without ischemia) and a progression of inflammation induced by the extruded nucleus pulposus (4). Mechanical compression or a chemically mediated inflammatory process can cause radicular symptoms of lumbar nerve roots. In some patients, no neuronal impingement was noted on MRI. Furthermore, some studies have concluded that inflammatory response can occur due to lumbar disc herniation (5, 6). The underlying mechanism behind this can be explained by the antigenic characteristic of the nucleus pulposus (NP). NP of the intervertebral disc is highly antigenic due to being in an immunoprotected setting in non-pathologic states. When the liquid component of the NP is exposed to the spinal canal through a defect in the annulus fibrosus, an autoimmune – mediated inflammatory cascade begins. Swelling of the nerve roots occurs due to inflammatory mediators generated. This situation can alter the nerve roots' electrophysiological functions, sensitizing the neurons and enhancing nerve root pain in the absence of mechanical compression. The mechanism behind the physical compression of the nerve root is well elucidated by many studies (7, 8). Compression of the neural tissues can result in the disruption of the vascular and structural integrity finalizing with inflammation (9). Nerve root compression can cause a disruption of vascular supply. Subsequently, local ischemia and intraneuronal edema formation occur. This pathological process triggers an inflammatory cascade that results in nerve root swelling as well. The root swelling corresponds to an increase of the nerve root diameter.

The main radiological examination for diagnosis of lumbar disc herniation is the conventional T2-weighted MRI. However, Studies in the literature have frequently focused on diffusion changes or contrast enhancement of compressed nerve roots on MRI. Diffusion-weighted MRI (DWI) and magnetic resonance neurography (MRN) publications displayed swelling of the nerve roots caused by LDHs and DWI has the potential to be used as a tool for the diagnosis of the affected nerve roots (10, 11, 12). Tyrrell et al reported a poor sensitivity of symptomatic nerve root enhancement due to lumbar disc prolapsed but conclude that the presence of large sequestrated discs however, may cause nerve root enhancement in 50% of the patients (139). In addition, both Diffusion-weighted MRI and gadolinium enhanced MRI need additional MRI sequences. Therefore, this increases the cost of diagnosis along with the need for additional radiological examinations which use contrast media. The current literature falls short in examining the differences between normal lumbar nerve root and compressed nerve root diameters after acute disc herniation on conventional T2 weight MRI. In this perspective, this study focused on T2-weighted MR images in patients with acute disc herniations not only to diagnose herniated disc fragment but also to determine affected lumbar nerve roots' thickness. More than 90% of the lumbar disc herniations occur at the L4-5 or L5-S1 level (14). Thus, the most common affected roots are L5 and S1. In this paper, L5 and S1 nerve roots that were compressed by acute disc herniation were measured and compared to the non affected contra lateral side.

The pathophysiology (15, 16) and pathomechanics (17,18) of radiculopathy are complicated. LDHs can result in different pain patterns and can frequently overlap myotomes and/or dermatomes, resulting in misdiagnosis of nerve root compression affecting the validity of the neurological tests to diagnose a specific level of disc herniation (19, 20, 21). Lauder et al. conclued that in patients with radiculopathy confirmed by electrodiagnostic tests, up to 31% had no signs of motor weakness and nearly 45% had no sensory deficits detected on clinical examination (22). Therefore, overlapping spinal nerves may mask compression or irritation of a single nerve root (23). Moreover, in patients with multi-level lumbar disc herniation, it becomes harder to diagnose affected nerve root. Therefore, in patients with radiculopathy, it is the suggestion of the authors of this paper to measure the root thickness to determine the corresponding affected nerve root. The affected roots showed significant difference in root thickness when compared to unaffected lumbar nerve roots in patients with acute lumbar disc herniation.

Conclusion

This study revealed that the affected nerve root in acute lumbar disc herniation had a statistically significant increase in root diameter. LDH can be diagnosed via patient history, neurological examination, radiological tools and electrodiagnostic tests. However, when spine surgeons face a difficult task in discriminating which root is affected and symptomatic, MRI can be confusing as multi level degenerative disorders may mask the actual pathology. In these patients along with non correlating EMG tests and physical examination, the measurement of root thickness on T2 weighted sagittal MR images may provide a valuable tool for the physician. This approach may be employed in additional to standard diagnostic procedures to avoid wrong level surgeries, additional interventions, legal and socioeconomic problems.

Conflict of interest statement: The authors have no conflict of interest declaration

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