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Is epidural and subcutaneous fat tissue thickness associated with lumbar disc herniation?

Irfan Atik[a,*], Seda Atik[b]

[a] Sivas Cumhuriyet University, Faculty of Medicine, Department of Radiology, Sivas, Türkiye
[b] Sivas Cumhuriyet University, Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Division of Rheumatology, Sivas, Türkiye

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Abstract

Aim: Lumbar disc herniations (LDH) cause important clinical symptoms such as low back pain (LBP) and have many causes. This study investigates the role of epidural and subcutaneous fat tissue thickness in LDH.

Materials and Methods: In this cross-sectional study, individuals aged 18-83 with lumbar magnetic resonance imaging (MRI) due to LBP were evaluated retrospectively between July 2023 and January 2024. According to lumbar MRI, they were divided into two groups: Those with or without herniation. Both groups measured epidural fat tissue thickness (EFTT) and subcutaneous fat tissue thickness (SFTT) at all lumbar levels. The relationship between the two groups in terms of EFTT and SFTT was examined statistically.

Results: According to lumbar MRI, herniation was detected in 292 patients, and no herniation was detected in 300 patients. SFTT was found to be greater in the group with herniation than in the group without herniation at all lumbar levels (p = 0.0001). EFTT was lower in the group with herniation at all levels (p = 0.0001). In the group with herniation, there was a statistically significant correlation between the number of hernia levels and SFTT (r: 0.54, p: 0.0001) and EFTT negatively (r: -0.22, p: 0.0001).

Conclusion: An increase in SFTT thickness and a decrease in EFTT are associated with disc herniation. This relationship is a result of the mechanical and inflammatory damage caused by obesity. In addition, the relationship between herniation and the decrease in EFTT demonstrates the protective function of epidural fat tissue.

Introduction

Low back pain (LBP) is the most common cause of disability, imposing a significant burden on national economies [1, 2]. Various factors have been implicated in the etiology of LBP, and various imaging modalities are used in its diagnosis. Among these, magnetic resonance imaging (MRI) is often preferred due to its ability to provide high-quality imaging of the lumbar spine without the use of radiation [1]. Identifying and treating the cause of LBP will not only improve patients' quality of life but also reduce healthcare costs [2].

Lumbar intervertebral disc degeneration (LIVDD) is one of the causes of LBP [3]. MRI can show multiple levels of disc abnormalities in patients with LBP. However, it is very difficult to determine its clinical significance. It may sometimes be impossible to distinguish it from other causes of pain [4,5]. Damage to the structures forming the lumbar spine, alone or together, may cause LBP [6]. A good physical examination and history are very important to reveal urgent and non-surgical causes of LBP. Imaging methods are required in case of pain that does not respond to traditional treatment approaches lasting longer than six weeks [7].

Smoking, limitation in physical activity, and obesity are important factors in LBP [8]. Previous studies have pointed out the relationship between obesity and LBP through inflammatory and mechanical pathways. The inflammatory pathway is thought to be triggered by proinflammatory mediators released from hypertrophic fat tissue [9]. The mechanical pathway is associated with excessive load on the spinal spine and fat infiltration in the paraspinal muscles [10]. It has been shown that lumbar region subcutaneous fat tissue thickness (SFTT) can predict LIVDD and modic changes well [11].

Although there are many causes of LBP, overuse, degen-

*Corresponding author:
Email address: irfanatik@cumhuriyet.edu.tr (Irfan Atik)

eration, and deformity in the anatomical structures that make up the lumbar spine are frequently encountered [12]. Additionally, obesity is a factor that significantly increases the risk of LBP and LIVDD. This reduces the patients' mobility and quality of life [13]. In one study, it was found that body mass index (BMI) showed a strong correlation with SFTT. Additionally, SFTT was found to have a stronger relationship with LBP and LIVDD than BMI [14].

Fat tissue is found almost everywhere in the body. It has many functions such as being an energy store and protecting against traumas [15]. The epidural fat tissue thickness (EFTT) serves as a cushion between the dura mater and the vertebra, allowing them to slide over each other [16]. Epidural fat tissue increases caudally in the lumbar region. In addition to its protective function, in cases characterized by abnormal fat tissue accumulation, such as Cushing's syndrome and obesity, its increase brings about the disease called epidural lipomatosis. This situation may cause clinical symptoms by causing a compressive effect on intraspinal structures [17]. In the study conducted by Wu et al., no relationship was found between obesity and gender and epidural fat thickness [18].

A herniation is when the annulus fibrosus crosses the boundaries of the disc space. Annular expansion of the disc is called bulging and is not considered herniation. Herniated discs are named according to the shape of the displaced tissue. If the distance between the edges of the base of the disc material extending outside the disc space exceeds the distance between the edges of the material outside the disc space, it's labeled as protrusion; otherwise, it's termed extrusion. When the displaced material loses continuity with the main disc, it's termed sequestration, and its displacement away from the main disc is termed migration [19].

This study aims to investigate the relationship between lumbar region SFTT and EFTT and intervertebral disc herniation.

Materials and Methods

The study was approved by the University's Non-Invasive Institutional Ethics Review Board and complied with the principles set out in the Declaration of Helsinki (Sivas Cumhuriyet University Non-Interventional Clinical Research Ethics Committee, Decision no: 2024/04-17, Date: 18.04.2024). This study was planned as a retrospective cross-sectional study, 878 lumbar MRIs of individuals between the ages of 18 and 83, taken with the preliminary diagnosis of LBP in the radiology department of the university hospital between July 2023 and January 2024, were identified. Steroid use, Cushing's disease, thyroid pathologies, LBP due to trauma, those who had surgery and/or had fixation material, those who could not be evaluated due to artifacts, primary or metastatic spinal malignancy, and infections were determined as exclusion criteria.

Images of all individuals in the study population were taken using a 1.5 Tesla MRI device (Siemens Magnetom, Erlangen, Germany) in our university hospital and a flexible spine coil. There are 4 sequences in our institution's lumbar MRI protocol: axial T2, sagittal T1, sagittal T2, and sagittal STIR (Short tau inversion recovery).

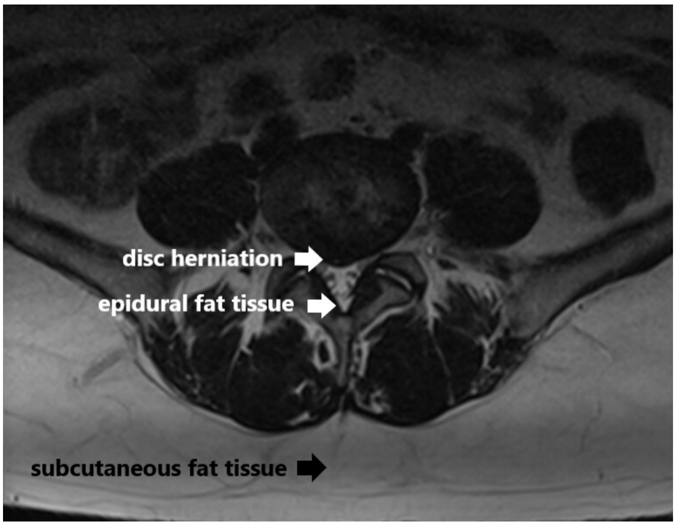

Figure 1. In axial T2-weighted lumbar MR images; disc herniation, epidural fat tissue, and subcutaneous fat tissue are shown with arrows.

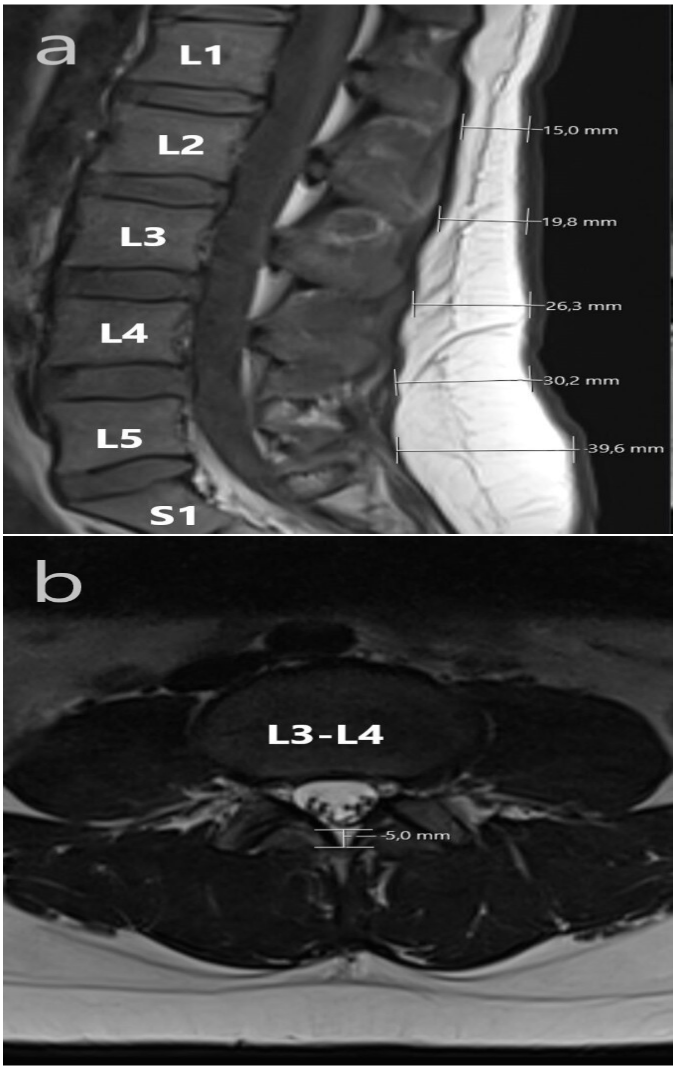

Figure 2. Measurement of EFTT and SFTT with lumbar MRI. SFTT measurement from sagittal T1 images (a), EFTT measurement from axial T2 images (b).

Table 1. Distribution of groups in terms of age and gender.

	Lumbar disc herniation (+) (n:292)	Lumbar disc herniation (-) (n:300)	p
Gender, (n, %)			
Female	179 (30.2%)	166(28.1%)	P=0.60[a]
Male	113 (19.1%)	134(22.6%)	
Age, year median (min-max)	49 (18-83)	47(19-81)	P=0.11[b]

[a]Chi-square analysis was used, [b]Mann–Whitney U test was used. p<0.05: Statistically significant.

Table 2. EFTT and SFTT its relationship with herniation between two groups according to lumbar levels.

Vertebral disc level	Epidural fat tissue thickness, mm, median(min-max)			Subcutaneous fat tissue thickness, mm, median(min-max)		
	Hernia(+)	Hernia(-)	P1	Hernia(+)	Hernia(-)	P2
L1-L2	4.00(1.00-7.80)	4.65(1.50-9.20)	**P=0.0001***	20.35(1.70-50.80)	12.60(2.50-35.90)	**P=0.0001***
L2-L3	4.45(1.60-8.60)	5.20(1.30-9.10)	**P=0.0001***	21.85(3.40-48.10)	12.40(2.30-30.10)	**P=0.0001***
L3-L4	4.65(1.20-9.40)	5.30(0.00-9.30)	**P=0.0001***	26.80(3.40-71.70)	16.20(1.60-42.10)	**P=0.0001***
L4-L5	3.45(0.00-7.90)	4.00(0.00-8.90)	**P=0.0001***	35.30(3.80-73.30)	20.65(1.70-55.70)	**P=0.0001***
L5-S1	1.30(0.00-6.70)	1.60(0.00-6.50)	**P=0.001***	35.90(5.80-76.00)	24.10(0.80-58.20)	**P=0.0001***
L1-S1 Average	3.65(1.56-7.16)	4.20(1.94-8.18)	**P=0.0001***	27.54(3.62-55.10)	17.09(2.18-40.06)	**P=0.0001***

P1 and P2 values were calculated with Mann-Whitney U *P<0.05: Statistically Significant.

Following exclusion criteria, 592 MRIs were evaluated by a radiologist and a physical medicine and rehabilitation specialist. The average of the quantitative measurements was taken, and when a discrepancy was detected in the evaluation of lumbar hernia, they were evaluated together and a common decision was made. 292 herniation (protrusion, extrusion, sequestration, or migration) was detected in any lumbar disc on lumbar MRI (Figure 1). No hernia was detected at any level in 300 lumbar MRI. In patients with a hernia, the number of levels of hernia was noted. EFTT and SFTT measurements were made at 5 intervertebral disc levels: L1-L2, L2-L3, L3-L4, L4-L5, L5-S1. While making these measurements, the level was determined from sagittal T2 images, and care was taken to make both measurements from the same level. Sagittal T1 images were examined and SFTT was measured from the interspinous ligament to the back skin (Figure 2a). EFTT was measured from the posterior edge of the thecal sac to the posterior edge of the spinal osseous canal on axial T2 images [15] (Figure 2b).

Statistical analysis

The data underwent statistical analysis using SPSS v. 22.0 software. Descriptive statistics for continuous variables were presented as median (min-max), while categorical data were expressed as frequencies and percentages (%). The normality of distributions was assessed using the Kolmogorov-Smirnov test. For continuous variables that did not adhere to a normal distribution, the Mann–Whitney U test was utilized. Qualitative data analysis employed the Chi-square (χ^2) test. Spearman correlation analysis evaluated relationships between continuous variables that did not meet normal distribution assumptions. The level of significance was less than 0.05 in all analyses.

Results

A total of 592 individuals constituted the study population. According to lumbar MRI, 300 of them had no herniation, while 292 of them had herniation. There was no significant difference between the two groups in terms of age and gender (Table 1).

In the group with herniation, EFTT was found to be decreased and SFTT was increased at all lumbar levels. This difference between the group with and without herniation was statistically significant (Table 2).

Correlation analysis was performed between mean lumbar EFTT and SFTT and no significant difference was detected ($r=-0.025$, $p=0.621$).

In the group with herniation, a positive (r: 0.54, p: 0.0001) correlation was found between the number of hernia levels and SFTT (Figure 3a) and a negative (r: -0.22, p: 0.0001) correlation was found between EFTT (Figure 3b) and it was statistically significant.

Discussion

In this study, it was observed that there was a decrease in EFTT and an increase in SFTT with lumbar intervertebral disc herniation. These results are independent of age and gender.

The relationship between obesity and LBP and LIVDD has been established in numerous studies. The protective function of EFTT has been mentioned and studies have been conducted showing that it is not associated with obesity. Wu et al. did not find a relationship between obesity, gender, and EFTT [18]. In this study, in line with the literature, it was concluded that decreasing EFTT increased the risk of herniation. Therefore, EFTT is thought to be protective for lumbar disc herniation.

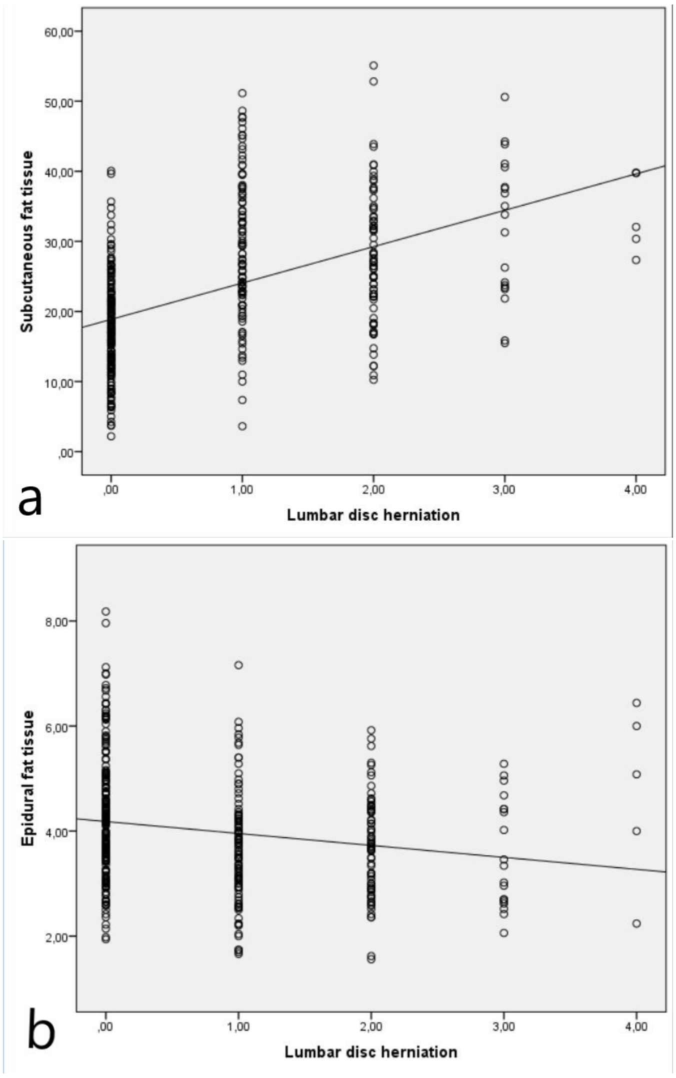

Figure 3. Spearman correlation analysis results between lumbar disc herniation and SFTT (a) and EFTT (b).

Epidural fat exhibits different distributions along the spinal canal. Fat within the epidural space fills the dural sac and protects its contents from external forces. An increase in epidural fat can cause compression on adjacent structures and alterations in the effects of anesthetic agents injected into this space. In the lumbar region, epidural fat forms two distinct structures on the anterior and posterior aspects of the epidural space, primarily located posteriorly. It also surrounds the dura of nerve roots, filling the vertebral arches and intervertebral foramina. Epidural fat reaches its maximum volume at the caudal lumbar levels, especially in regions of high mobility, indicating its protective function [20]. The reduction or absence of epidural fat has been linked to chronic painful spinal conditions, such as lumbar stenosis [21]. In a study by Jaclyn et al., excess epidural fat in patients with chronic LBP was found to be associated with better physical function [22], further supporting its protective role [20,23]. Consistent with the literature, this study also highlights a reduction in epidural fat tissue in patients with lumbar disc herniation. Additionally, as the number of lumbar disc herniations increases, a decrease in epidural fat tissue thickness (EFTT) has been observed, supporting the notion of the protective function of epidural fat.

In a study by Wang et al., it was demonstrated that SFTT, which has been shown to have a stronger correlation than BMI in previous studies, is associated with LIVDD. However, in the same study, no relationship was found between lumbar SFTT and EFTT [14]. In a study by Yuksel et al. involving 300 patients undergoing MRI, a significant relationship was found between cervical SFTT and the degree of LIVDD [24]. In a study by Jorge et al. involving 174 participants, who were examined the relationship between lumbar disc herniation and SFTT, no differences were observed in terms of age and gender, while a positive correlation was found between herniation level and lumbar SFTT. Particularly, the use of SFTT at the L5-S1 level was found to have high sensitivity and specificity in predicting herniation. Accumulation of adipose tissue in various body regions and increasing body weight result in increased load on intervertebral discs. This can lead to intervertebral disc herniations, especially in the lumbar region. Post-herniation pain can reduce physical activity, further increasing body weight [25]. In this study, it was concluded that an increase in SFTT contributes to lumbar disc herniation. Additionally, a significant correlation was found between the number of herniations and SFTT, further supporting this relationship.

The negative aspects of this study include its retrospective nature and lack of information about patients' clinical presentations. However, the evaluation of a large number of images, measurement at all lumbar levels, and assessment of both SFTT and EFTT to disc herniation contribute significantly to the literature.

Conclusion

This study indicates that an increase in SFTT is associated with disc herniation. Additionally, it was found that EFTT plays a protective role in lumbar disc herniation, and its decrease may lead to an increase in disc herniation.

Ethical approval

Ethical approval was obtained for this study from Sivas Cumhuriyet University Non-Interventional Clinical Research Ethics Committee (Decision no: 2024/04-17, Date: 18.04.2024).

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