

## ORIGINAL ARTICLE

## Distribution of Lumbar Microdiscectomy Cases by Tuffier's Line Levels

## Lomber Mikrodiskektomi Olgularının Tuffier Çizgi Seviyelerine Göre Dağılımı

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## ABSTRACT

**Objective:** The most used method in the surgical treatment of lumbar disc herniation (LDH) is lumbar microdiscectomy (LMD). In this study, we aimed to show the relationship between Tuffier's line (TL), which is widely used in determining the L4-5 distance in lumbar spinal interventions, and LMD levels.**Materials and Methods:** In this study, a total of 204 patients who had LMD or had low back pain were reviewed retrospectively. According to the projection of TL at the spine level; it was divided into 5 categories as L4 corpus, L4 lower endplate, L4-5 disc space, L5 upper endplate, L5 corpus. The cases were analyzed according to age, gender, disc level and changes in TL.**Results:** 92.1% of the cases were operated at the L4-5 or L5-S1 level. TL was mostly at L5 upper endplate level in women, L4-5 disc space and above in men, and there was a significant relationship between TL and gender in both groups ( $p<0.05$ ).**Conclusion:** In our study, we found that although TL were caudally in patients operated at L5-S1 level, they displaced cranially in patients operated at L4-5 level. However, it was observed that LDH development in the lower lumbar region and increased at the upper levels with ageing.**Key words:** Tuffier's line, Lumbar disc herniation, Lumbar microdiscectomy

## ÖZ

**Amaç:** Lomber disk hernisinin (LDH) cerrahi tedavisinde en sık kullanılan yöntem, lomber mikrodiskektomidir (LMD). Bu çalışma ile, lomber spinal girişimlerde L4-5 mesafesini tespit edilmesinde yaygın olarak kullanılan Tuffier's çizgisi (TL) ile LMD seviyeleri arasındaki ilişkiyi göstermeyi amaçladık.**Gereç ve yöntem:** Bu çalışmada, LMD yapılan veya bel ağrısı şikayeti olan toplam 204 hasta retrospektif olarak incelendi. TL seviyesinin omurga düzeyindeki izdüşümüne göre; L4 korpus, L4 alt endplate, L4-5 disk aralığı, L5 üst endplate, L5 korpus olmak üzere 5 kategoriye ayrıldı. Olgular yaş, cinsiyet, disk seviyesi ve TL seviyesindeki değişimlere göre analiz edildi.**Bulgular:** Olguların % 92.1'i L4-5 veya L5-S1 seviyesinden opere edilmişti. TL seviyesi, kadınlarda sıklıkla L5 üst endplate seviyesinde iken erkeklerde L4-5 disk aralığı ve üstünde idi ve TL seviyeleri ile cinsiyet arasında her iki grupta da anlamlı bir ilişki mevcuttu ( $p<0.05$ ).**Sonuç:** Çalışmamızda, TL seviyeleri, L5-S1 seviyesinden opere edilen hastalarda kaudalde olmasına karşın, L4-5 seviyesinde opere edilenlerde kraniale doğru yer değiştirdiğini tespit ettik. Bununla birlikte, LDH gelişiminin alt lomber bölgeden başladığı ve yaşın ilerlemesi ile birlikte üst seviyelerde arthığı görüldü.**Anahtar kelimeler:** Tuffier çizgisi, Lomber disk hernisi, Lomber mikrodiskektomi

## Introduction

Lumbar disc herniation (LDH) is one of the most important causes of back pain that is observed commonly in the community and causes labour loss (1). Thirty-nine percent of the cases of back pain are caused by LDH, and LDH is observed with a rate of 9% throughout the world (2). Surgical treatment with the lumbar microdiscectomy method (LMD) is performed in 17-70/ 100.000 of the cases of LDH and causes a significant economic burden (3). Age, sex, body weight, occupation, lifestyle as well as concordance of the spinopelvic complex are involved in the etiology of LDH (4,5).

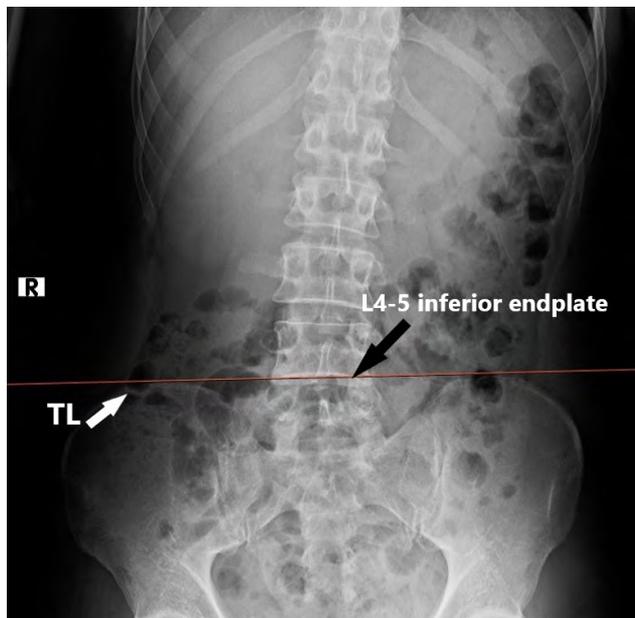
Tuffier's line (TL), which is defined as a horizontal line connecting the two superior iliac crests of the pelvis, is being commonly used to identify the L4-5 space in

lumbar spinal interventions (6). The level of the Tuffier's line changes according to the pelvis' relationship with the lumbar vertebrae and its positioning in the sagittal plane (7-9). The relationship between the sagittal spinopelvic balance and LDH has been demonstrated in many studies conducted in recent years (10-12). In the literature, numerous studies have been conducted on LDH and LMD. However, as far as we know it has not been clearly elucidated if there is a relationship between the changes in TL level and LDH. In our study, we aimed to demonstrate the changes in the TL level in patients who underwent LMD after LDH to elucidate this relationship.

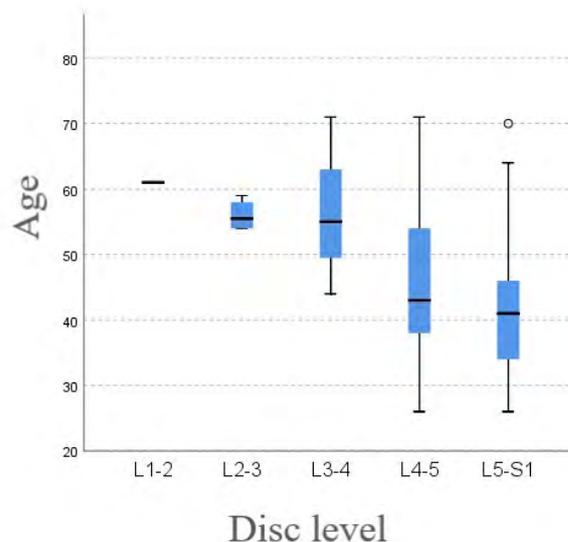
## Material and Method

This study was conducted in accordance with the principles of the Declaration of Helsinki after consent was obtained from our university's Medical Faculty Clinical Research Ethics Committee with the date and number 06.09.2021/2021-06. One hundred and two patients aged between 26 and 72 years, who underwent single level LMD because of LDH in our clinic between 2017 and 2021, were included in the study. Patients who had two or more level LMDs, who had lumbar spinal tumor, whose lumbar axis was disrupted because of trauma and who had sacralization and lumbalization, were excluded. In the control group, the subjects who had vertebral compression fracture, sacralization, lumbalization, de novo or congenital scoliosis, lumbar spondylolisthesis, lower extremity asymmetry, spinal stenosis, spinal infection and congenital hip dislocation were excluded from the study. Our study was conducted retrospectively, and the data obtained were transferred to the Statistical Package for the Social Sciences (SPSS) program. Presence of LDH and data related to LMD levels were obtained from the lumbar MRI images in the PACS (Picture Archiving and Communication Systems) and from operation notes.

The TL level was categorized by using a horizontal line drawn between both superior iliac crests on antero-posterior lumbosacral graphies as described in the literature (9,13,14). The TL level was classified in five categories including L4 body, L4 inferior endplate, L4-5 disc space, L5 superior endplate and L5 body according to the projection of the TL level on the vertebral level (Figure 1).



**Figure 1:** Appearance of TL on A-P lumbar graphy. (The white arrow indicates TL (Tuffer's line), the black arrow indicates that the TL passes through the level of L4-5 inferior endplate.).



**Figure 2:** Age and disc level.

## Statistical analysis

The distribution of the groups by age and sex was calculated as categorical and percentage segments. The Kolmogorov-Smirnov normality test was used to analyze if the data had normal distribution or not. It was found that our data did not have a normal distribution according to the normality test performed. Thus, we used non-parametric tests in our analyses performed for correlation and comparison. In the LMD and control groups, the Crosstabulation chi-square test (multiple comparison test) was used in comparison of levels at which the TL passed. The Kruskal Wallis test was used to demonstrate the distribution and statistical significance of LDH levels according to the TL. The Kruskal Wallis test was also used in analysis of the distributions of the TL levels belonging to the LMD and control groups by age. The chi-square test was used in analysis of the distribution of the TL levels belonging to the LMD and control groups by sex. A "p" value below 0.05 was considered statistically significant.

## Results

Each group included in the study contained 102 subjects. The mean age was 44.6 years in the LMD group and 48.6 years in the control group. The LMD group included 38 female patients and 64 male patients, while the control group included 64 female patients and 38 male patients (Table 1). In the LMD group, 92.1% of the patients were operated at the level of L4-5 or L5-S1. Sixty-three percent of the female patients were operated at the level of L5-S1, while 48% of the male patients were operated at the level of L4-5. (Table 2).

The mean age was 41.8 years in the patients in whom LMD operation was performed at the level of L5-S1 and 45.4 years in the patients in whom LMD operation was performed at the level of L4-5. The difference between the disc level of operation and age was found statistically significant ( $p < 0.05$ , Figure 2). Thus,

the mean age was lower in the patients in whom the operation was performed at the level of L5-S1.

In the LMD group, TL passed through the level of L4 body with a rate of 29.4% and through the level of L4-5 disc space with rate of 29.4% independent of sex, while it passed through the level of L4 body with a rate of 34.3% and through the level of L4-5 disc space with a rate of 27.5% in the control group. However, there was no difference between the two groups when the TL levels were compared ( $p>0.05$ , Table 1). When the distribution of TL level by sex was examined in the LMD group, it was found that TL passed through the level of L4 body in 23 patients (35.8%) and through the level of L4-5 disc space in 21 patients (32.8%) in the male patient group, while it passed through the level of L5 superior endplate in 14 patients (36%) in the female patient group.

When the LMD patients whose TL levels passed through the level of L5 superior endplate were compared by sex, there was a significant difference in favour of female patients ( $p<0.05$ , Table 1). In the control group, TL passed through the level of L4-5 disc space in 22 (34.4%) of 64 female patients while it passed through the level of L4 body in 20 (57.1%) of 32 male patients, and a significant difference was present between the sexes ( $p<0.05$ , Table 1). In conclusion, there was a significant relationship between TL levels and sex in both groups ( $p<0.05$ , Table 1). In addition, these results showed that TL generally passed through the level of L5 superior endplate in women and through the level of L4-5 disc space and above in men.

In the LMD group, there was no statistically significant difference between TL levels of the patients who were operated at the levels of L5-S1 and L4-5 ( $p>0.05$ ). When the disc level is at the caudal region (L5-S1), TL level is also displaced towards the caudal region (L5 superior end plate). On the other hand, it is observed that the TL levels cluster towards the cranial region in patients whose disc level is at L4-5 (Table 3).

**Table 1:** Distribution of the TL levels by groups.

TL level	LMD group n=102 (%)			Control group n=102 (%)		
	Female	Male	Total	Female	Male	Total
L4 body	7	23	30 (29,4)	15*	20*	35 (34,3)
L4 inferior endplate	6	12	18 (17,6)	10	6	16 (15,7)
L4-5 disc space	9	21	30 (29,4)	22 <sup>β</sup>	6 <sup>β</sup>	28 (27,5)
L5 superior endplate	14 <sup>α</sup>	7 <sup>α</sup>	21 (20,6)	12	5	17 (16,7)
L5 body	2	1	3 (2,9)	5	1	6 (5,9)
Total	38 (37,3)	64 (62,7)	102	64 (62,7)	38 (37,3)	102

Distribution of the TL levels in group and by sex. There is a significant difference between the “\*”, “α” and “β” groups (Chi-square crosstabulation,  $p<0.05$ ).

**Table 2:** Distribution of the disc levels by gender.

Disc level	Gender		n (%)
	Female	Male	
L1-2	0	1	1 (1)
L2-3	0	4	4 (3,9)
L3-4	0	3	3 (2,9)
L4-5	14	31	45 (44,1)
L5-S1	24	25	49 (48)
Total	38	64	102

**Table 3:** Table disc level TL level.

TL level	Disc level n (%)					Total n=102 (%)
	L1-2	L2-3	L3-4	L4-5	L5-S1	
L4 body	0 (0)	1 (3,3)	2 (6,7)	16 (53,3)	11 (36,7)	30 (29,4)
L4 inferior endplate	0 (0)	1 (5,6)	0 (0)	10 (55,6)	7 (38,9)	18 (17,6)
L4-5 disc space	1 (3,3)	2 (6,7)	1 (3,3)	13 (43,3)	13 (43,3)	30 (29,4)
L5 superior endplate	0 (0)	0 (0)	0 (0)	5 (23,8)	16 (76,2)	21 (20,6)
L5 body	0 (0)	0 (0)	0 (0)	1 (33,3)	2 (66,7)	3 (2,9)

## Discussion

It was observed that the patients who were operated because of LDH and included in our study clustered in the 30-50 year age group and in male sex. LMD was frequently found at the level of L5-S1 in female patients and at the level of L4-5 in male patients. In addition, we found that upper level LMDs increased with ageing. The TL level frequently passed at the level of L4 body and L4-5 disc space in the LMD and control groups. When compared by sex, it was observed that a significant difference was present between the male and female sexes in the patients whose TL level passed through the level of L5 superior endplate in the LMD group and in the patients whose TL level passed through the level of L4-5 disc space and L4 body in the control group. We found that the TL level was displaced towards the caudal region in the patients who were operated at the level of L5-S1 and towards the cranial region in the patients who were operated at the level of L4-5.

Since the time when Mixer and Barr defined LDH causing radiculopathy for the first time in 1934, comprehensive studies on the epidemiology, pathophysiology, clinical picture and treatment have been conducted (15-18). Understanding the clinical picture of LDH fully will enable clinicians to give more reliable information to patients about the diagnosis and treatment. Although the peak incidence of LDH occurs between the 4th and 5th decades of life, it may also rarely be observed in the first two decades of life (15,16). In addition, LDHs occur at the level of L4-5 and L5-S1 with a rate of 85-95%, and more frequently in men (55-65%) (19-21). Although numerous studies on lumbar disc herniation

have been conducted, the pathogenesis has not been fully elucidated yet. While standing, the discs at the level of L4-5 and L5-S1 are the regions that are exposed to maximal mechanical load. In addition, these two levels are responsible of the majority of the movement in the lumbar region (5). LDH develops at relatively younger ages at these two levels because of physiological and histopathological characteristics of the lower lumbar region. In addition, it is known that disc degeneration in the lumbar region starts in the caudal region and increases towards the cranial region with ageing (16). These alterations explain why upper lumbar region LDHs increase with ageing. In our series, the mean age was 44.6 years (26-71) and 92.1% of the patients were operated at the level of L4-5 or L5-S1. Besides, the mean age was lower in the patients who were operated at the level of L5-S1 compared to the patients who were operated at the level of L4-5. In conclusion, we found that the disc level increased with ageing with a statistically significant difference. In addition, LMDs were found more frequent in male sex (62.7%). It is thought that this is due to the fact that male sex takes part in working life with a higher rate and works in hard labours.

The pelvis is considered a significant part of the vertebra and has important roles in accomplishing the upright position and in walking. It is known that the pelvis' reference position by the vertebra is important to achieve global balance (22). TL is an anatomic landmark that combines the pelvis' both superior iliac crests and that is used to determine the L4-5 disc space level (8, 23). It has been reported that TL generally passes through the level of L4 body and L4-5 disk space and may vary by age, sex, body weight and the pelvis' position by the vertebra (13,14). Snider et al. reported that TL passed through the level of L5 superior endplate and L5 body in women and through the level of L4 body and L4 inferior endplate in men, while Horsanali et al. and Chowdhury et al. reported that TL passed through the level of L4 body in women and men (7, 9, 13). In addition, Horsanali et al. reported that TL was affected by age, but Chowdhury A et al. reported that TL was not affected by age (7,13). In our study, it was observed that TL frequently passed through the level of L4 body (29.4%) and L4-5 disc space (29.4%) in the LMD group and through the level of L4 body (34.3%) and L4-5 disc space (27.5%) in the control group independent of sex. However, a significant difference was not observed between the two groups.

It is known that alterations in the spinopelvic parameters are involved in development of lumbar disc degeneration and LDH (10,12,24). Xia et al. showed that lumbar lordosis (LL), pelvic tilt (PT) and sacral slope (SS) were involved in disc degeneration and modic changes, while Xi et al. showed that pelvic incidence (PI) among spinopelvic parameters was involved (12,24). Endo et al. reported that sliding of the sagittal vertical axis (SVA) anteriorly and reduced SS and LL were involved in development of LDH (10). In another study, it was proposed that pathological conditions in

the pelvis' spatial position and shape might lead to lumbar degeneration or LDH by affecting the vertebral sequence (25). The pelvis' spatial position and shape also affect the TL level and these alterations may lead to degeneration in the lumbar discs (24). In our study, we found that the TL level was displaced towards the caudal region (L5 superior endplate) when the disc level was in the caudal region (L5-S1) and the TL level was displaced towards the cranial region when the disc level was at L4-5.

### Conclusion

In our study sample, the mean age was 44.6 years in the patients who underwent LMD, and the frequency of LMD was higher in the male sex (62.7%). LMDs were performed at the level of L4-5 and L5-S1 with a rate of 92.1% and this finding showed us that disc degeneration started from the lower lumbar region and also developed in upper level discs with ageing. In addition, we concluded that TL levels were displaced towards the cranial region in men. In LMD patients, the TL levels were located in the caudal region when the disc level was at L5-S1 and in the cranial region when the disc level was at L4-5. More comprehensive and high impact studies are needed to determine if alterations in the TL level affect LDH level and degeneration in discs.

### Author Contributions

Design: Ü.A.M., Data Collection and/or Processing: Ü.A.M., Literature Search: A.A., Writing: A.A.

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