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EDUCATION

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The Lasegue test: Defining its specificity and sensitivity based on geometry

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Abstract

The Lasegue test -also known as the straight leg raise test-, used for diagnostic purposes in cases of lumbar disc herniation can be explained by geometrical rules. This study aimed to describe the relationship between the apical and basal size of the herniated disc and the Lasegue test, and to describe the specificity and sensitivity of the herniated disc as a function of its height, location, and size. The study evaluated cases diagnosed with lumbar disc herniation with available MRI scans and Lasegue test results. The radix length to the foramen was calculated by recording the apical length and the base length of the herniated disc. The level and apical direction of the herniated discs were also recorded to determine the specificity and sensitivity of the test. Data from a total of 865 cases were analyzed. The apical length of the herniated disc was the most critical criterion for determining the Lasegue test. The Lasegue test is most sensitive and specific in lateral herniated discs at the level of L4-5. The specificity and sensitivity are decreased in L3-4, migrated, and sequestered disc herniations. In these cases, false-negative results may occur. Sensitivity decreases in the median and paramedian herniated discs. Compression of the sciatic nerve reduces herniated disc straightness. The Lasegue test is a test that can be defined according to the rules of geometry. Knowing the factors that decrease specificity and sensitivity and cause false positive/negative results will facilitate correct diagnosis.

KEYWORDS
diagnosis, Lasegue test, lumbar disc herniation, straight leg raise test

1 | INTRODUCTION

Lumbar disc herniations (LDHs) are the most common and frequently diagnosed cases in neurosurgery clinics. LDH occur most often in the lower levels, and one of the essential examination findings before diagnosing disc herniations in these levels is the Lasegue test. This test examines the traction and compression of the herniated disc on the radix and a positive evaluation of fewer than 70 degrees is considered radicular compression or traction. (Rade et al., 2016; Vroomen et al., 1999).

The Lasegue test is a test that can be theoretically explained by geometric rules. In geometry, the measurement of sides and angles on the figure described as a right triangle determines the rationality of this test.(Boyd et al., 2013) In magnetic resonance imaging (MRI) examinations of disc herniations, the base length of the right triangle corresponds to the base length of the disc herniation; the size of the herniated disc protruding from the posterior longitudinal ligament (PLL) corresponds to the apical length of the right triangle, and the hypotenuse equals to the length of the radix. Localization, orientation, and shape of the disc herniation affect the hypotenuse length and thus the length of the radix.

Any portion of the contents of the paper has not been presented previously.

Also, migrated or sequestered disc material can often be detected in the lumbar MRI scans of cases whose Lasegue test is not positive to 70 degrees. This situation of the Lasegue test, which can be described as pseudo-negative, can also be explained by geometric rules.

This study aimed to define the factors that influence the specificity and sensitivity of the Lasegue test with analytical data within geometric rules.

2 | MATERIAL AND METHODS

The cases presenting to the outpatient clinic with a prediagnosis of LDH, the findings of the Lasegue test were recorded, and the patients with unilateral disc herniation after lumbar MRI examination were evaluated in the study. By creating a database in an Excel file, the demographic data of the cases, symptoms and findings, grade, and side of the Lasegue test were recorded. The patients were evaluated in 4 groups with Lasegue degrees <30, 30–45, 45–70, and over 70 degrees. For MRI examinations of the lumbar spine, images were evaluated in T2 weighted sagittal sequences on the Picture Archiving and Communication System (PACS), and the level of disc herniation was recorded. T2 weighted axial sections of the same level were also examined, and the longest distance of the herniated disc from the PLL to the herniation was documented and referred to as the apical length (a). The portion of the herniated disc protruding from the midline was recorded as the base length (b) (Figure 1).

To determine the apical direction of the disc herniation, axial sections were divided into three regions by drawing four vertical lines (Figure 2). Herniated discs located in the lateral portion of the dural sac were classified as laterally located disc herniations. Herniated discs situated in the median section were defined as median disc herniations. Herniated discs located directly lateral to the median disc were categorized as paramedian disc herniations. (Figure 2).

Apical lengths and base lengths of disc herniations were recorded. The side of the right triangle, called the hypotenuse, considered equal to the radix length, was calculated by the formula $a^2 + b^2 = c^2$ in an Excel file. The apical size of the herniated disc, the length of the base, and the hypotenuse length were recorded, and the relationship between the herniated disc and the Lasegue test was determined. According to the degree of positivity of the Lasegue test, the values of apical length, base length, and hypotenuse length were recorded.

Cases with a history of disc herniation in two or more levels on MRI examinations of the lumbar spine were not evaluated because this would bias the test's specificity. Cases with a history of surgery due to a previous diagnosis of LDH were excluded from the study. Because different criteria can explain the description of the Lasegue test in far lateral disc herniations, these disc herniations were not evaluated in the study.

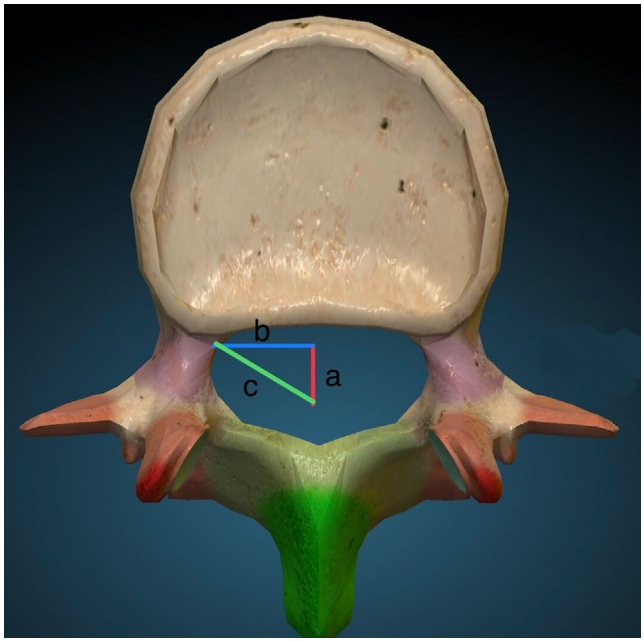

FIGURE 1 The right triangle formed by a disc herniation is schematized.

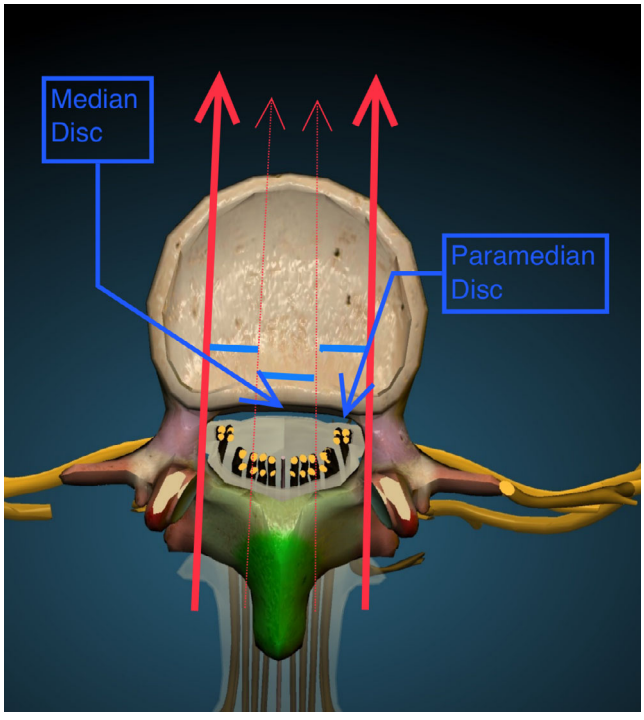

FIGURE 2 Classification of disc herniation according to its apical direction.

TABLE 1 Distribution numbers of disc herniations by localization

	Median	Paramedian	Lateral
L3-4	7	22	12
L4-5	136	210	92
L5-S1	142	173	71

2.1 | Statistical analyses

Numerical data from the database created in the Excel file were transferred to SPSS-22 software, and a statistical comparison between the groups was performed. A one-way ANOVA test was used to compare the Lasegue grades and orientation of the herniated disc in each group, and $p < 0.05$ was considered statistically significant.

Winautomatization Tool software was used to transfer the data in the database to SPSS software and to perform statistical analysis. This software is used to create macro files and automate repetitive computer operations.

2.1.1 | Ethics committee approval

Ethics Committee approval for this study retrieved from Ahi Evran University Clinical Trials Ethics Committee. File number: 2021-11/121.

3 | RESULTS

Data from 865 cases that met the study criteria were analyzed. The mean age of the cases was 47.69 ± 12.41 years, 462 patients were male, and 403 were female. MRI examinations of the lumbar spine revealed disc herniation at the L5-s1 level in 386 cases, at the L4-5

TABLE 2 Hypotenuse lengths calculated according to apical and base length measurements of disc herniations according to their levels

	Apical length (a)	Base length (b)	Hipotenusal length (c) $= a^2 + b^2 = c^2$
L3-4 ($n = 41$)	6.06 ± 0.74	10.14 ± 1.99	11.91 ± 1.52
L4-5 ($n = 438$)	5.54 ± 1.26	7.05 ± 1.69	9.13 ± 1.27
L5-S1 ($n = 386$)	6.08 ± 0.87	6.94 ± 1.93	9.37 ± 1.29

TABLE 3 Apical length results according to Lasegue degree (as the apical length increases, a decrease is noted in the Lasegue test)

	<30	30–45	45–70	>70
L3-4	6.71 ± 0.29 ($n = 10$)	6.26 ± 0.24 ($n = 11$)	6.14 ± 0.39 ($n = 6$)	5.43 ± 0.86 ($n = 14$)
L4-5	6.55 ± 0.67 ($n = 62$)	6.42 ± 0.60 ($n = 78$)	5.68 ± 0.81 ($n = 162$)	4.40 ± 1.30 ($n = 136$)
L5-S1	6.99 ± 0.12 ($n = 46$)	6.69 ± 0.17 ($n = 61$)	6.16 ± 0.32 ($n = 198$)	4.89 ± 1.07 ($n = 81$)

TABLE 4 Results of hypotenuse length by Lasegue degree

	<30	30–45	45–70	>70
L3-4	12.07 ± 1.62 ($n = 10$)	12.10 ± 1.66 ($n = 11$)	12.15 ± 1.40 ($n = 6$)	11.30 ± 1.51 ($n = 14$)
L4-5	9.21 ± 1.22 ($n = 62$)	9.13 ± 1.42 ($n = 78$)	9.09 ± 1.08 ($n = 162$)	8.98 ± 1.17 ($n = 136$)
L5-S1	9.60 ± 1.44 ($n = 46$)	9.36 ± 1.21 ($n = 61$)	9.32 ± 1.28 ($n = 198$)	9.10 ± 1.32 ($n = 81$)

Note: As the length of the hypotenuse (radix) decreases, the increase in the Lasegue test draws attention. In L3-4 disc herniation, the hypotenuse must be significantly longer for the Lasegue test to be positive.

TABLE 5 Base length results by Lasegue grade (as base length increases, Lasegue grade decreases)

	<30	30–45	45–70	>70
L3-4	10.67 ± 2.10 ($n = 10$)	10.35 ± 2.16 ($n = 11$)	10.37 ± 1.70 ($n = 6$)	9.01 ± 1.91 ($n = 14$)
L4-5	7.94 ± 1.46 ($n = 62$)	7.06 ± 1.65 ($n = 78$)	6.31 ± 1.55 ($n = 162$)	6.04 ± 1.44 ($n = 136$)
L5-S1	7.82 ± 2.05 ($n = 46$)	7.51 ± 3.28 ($n = 61$)	6.34 ± 1.84 ($n = 198$)	5.53 ± 2.23 ($n = 81$)

Note: Compared with Table 4, it is understood that apical length is more effective than base length for the sensitivity of the Lasegue test.

TABLE 6 Relationship between Lasegue degree and hypotenusal length according to L4-5 and L5-S1 disc herniations (recorded regardless of disc orientation)

	<30	30–45	45–70	>70
L4-5	9.21 ± 1.22 ($n = 62$)	9.13 ± 1.42 ($n = 78$)	9.09 ± 1.08 ($n = 162$)	8.98 ± 1.17 ($n = 136$)
L5-S1	9.60 ± 1.44 ($n = 46$)	9.36 ± 1.21 ($n = 61$)	9.32 ± 1.28 ($n = 198$)	9.10 ± 1.32 ($n = 81$)

Note: In L4-5 disc herniations, the hypotenuse (radix) length results in lesser Lasegue test positive results.

level in 438 patients, and the L3-4 level in 41 cases. When the herniated disc location and apical direction were examined, a median disc herniation was found in 285 patients, a paramedian disc herniation in 405 patients, and a lateral disc herniation in 175 cases. The demographic data of the cases according to the location of disc herniation are shown in Table 1.

The apical (a), basal (b), and hypotenusal (c) lengths of the herniated disc were recorded at the levels studied. The formula $a^2 + b^2 = c^2$ is used to determine the hypotenuse length in a right triangle. The hypotenuse lengths were determined by automating this formula by applying it to each cell of an Excel file. (Table 2).

According to the grades of the Lasegue test, the average length of apical disc herniations, hypotenuse lengths, and base lengths were recorded (Tables 3–5). With increasing apical, base, and hypotenuse lengths, the Lasegue test was positive at lower degrees (Tables 4–6).

Because of the low sensitivity of the Lasegue test in L3-4 herniated discs, the relationship between the Lasegue test and hypotenuse length in L4-5 and L5-S1 herniated discs is shown in Table 6. In the case of disc herniation at the L4-5 level, the hypotenuse length was smaller and led to positivity in the Lasegue test (Table 6). Depending on the size of the hypotenuse (radix) of the herniated disc, it was more sensitive to the Lasegue test at the L4-5 level.

The lateral disc herniations were more sensitive to the Lasegue test at the L4-5 level, where the apical length is the smallest (Table 7).

In the groups with disc herniations at all levels, the Lasegue test was less positive as apical length increased (Tables 3 and 7). Similarly, the Lasegue test was positive to a lesser extent when the calculated hypotenuse length increased. For disc herniation at the L3-4 level, herniated disc's apical, base, and hypotenuse lengths were significantly higher for the Lasegue test to be positive. (Tables 4, 5 and 7).

The Lasegue test was very sensitive in lateral disc herniations with foraminal extension.

4 | DISCUSSION

The Lasegue test is one of the essential findings showing the presence of a herniated disc when examining cases with a prediagnosis of low-level lumbar disc herniation.(Asan, 2018; Berthelot et al., 2021; Miller, 2007; Spangfort, 1972; Vroomen et al., 1999) This test, also known as the Straight Leg Raise Test (SLRT), involves traction of the sciatic nerve.(Deville et al., 2000; Majlesi et al., 2008; Poiraudeau et al., 2001; Rebain et al., 2002) As a rule of geometry, it can be explained that the longest side of a right triangle is always the hypotenuse.

In the case of a herniated disc, an inverted right triangle is formed in the region where it is located when it protrudes from the PLL (Figure 1). The herniated part of the disc is the height of the right triangle (a), the part of the herniated disc on the PLL side is the base of the triangle (b), and the hypotenuse is the direction together with the radix (c). According to this rule, in the case of disc herniation, the longest side of the inverted right triangle is on the radix side (c). Therefore, the radix and the hypotenuse lengths can be considered equal.

TABLE 7 Disc orientation; comparison of Lasegue test grade with disc herniation level and apical lengths

	Lateral				Median				Paramedian			
	<30	45	60	70	<30	45	60	70	<30	45	60	70
L3-4	6.92 ± 0.35	6.56 ± 0.28	6.49 ± 0.02	6.07 ± 0.30	6.31 ± 0.25	6.00 ± 0.37	5.66 ± 0.00	6.08 ± 0.42	6.74 ± 0.24	6.24 ± 0.14	5.85 ± 0.57	4.95 ± 0.84
L4-5	6.68 ± 0.37	6.24 ± 0.46	6.08 ± 0.35	5,35 ± 1.15	7.02 ± 0.10	6.72 ± 0.12	6.37 ± 0.19	4.94 ± 1.17	7.00 ± 0.11	6.65 ± 0.14	5.95 ± 0.30	4.19 ± 1.15
L5-S1	6.93 ± 0.14	6.50 ± 0.06	6.03 ± 0.25	4,84 ± 1.13	7.02 ± 0.09	6.89 ± 0.14	6.24 ± 0.39	4.07 ± 1.09	7.03 ± 0.10	6.71 ± 0.15	6.11 ± 0.21	5.44 ± 0.62

Note: As the apical length decreases, the degree of Lasegue increases. The apical size mostly leads to lower Lasegue test positivity in vertical herniations at the L4-5 level in lateral disc herniations.

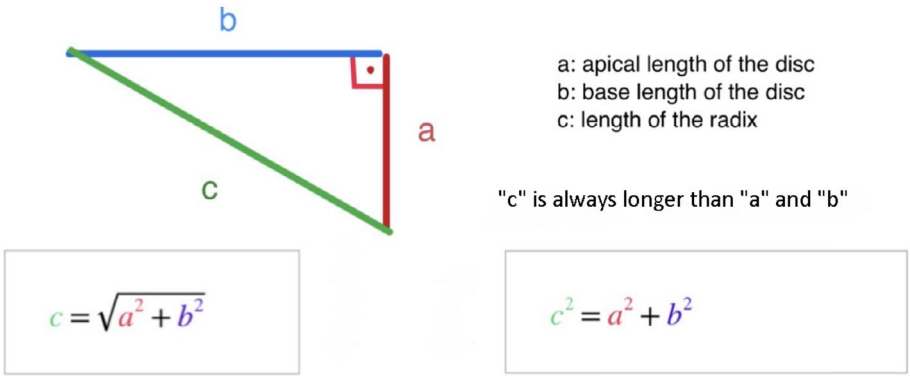

FIGURE 3 Geometric formulation of side measurements in a right triangle.

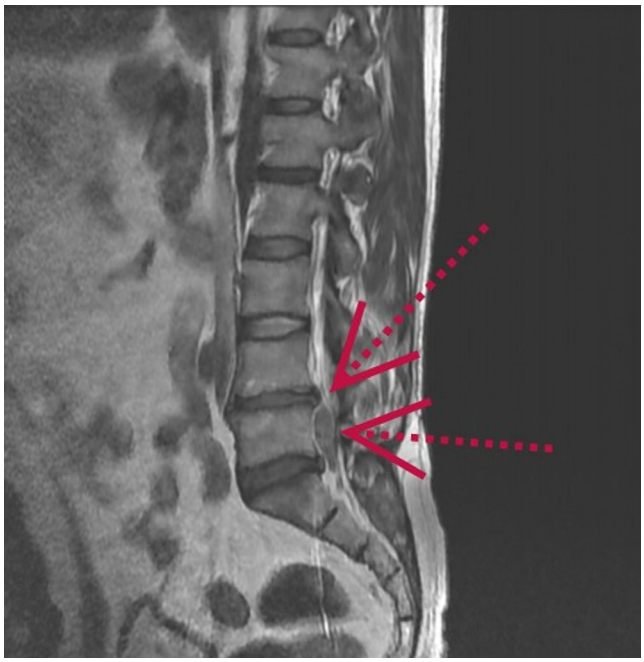

FIGURE 4 In a migrated disc herniation, the most extended apical length of the herniated disc is at a different location from the intervertebral disc distance and radix.

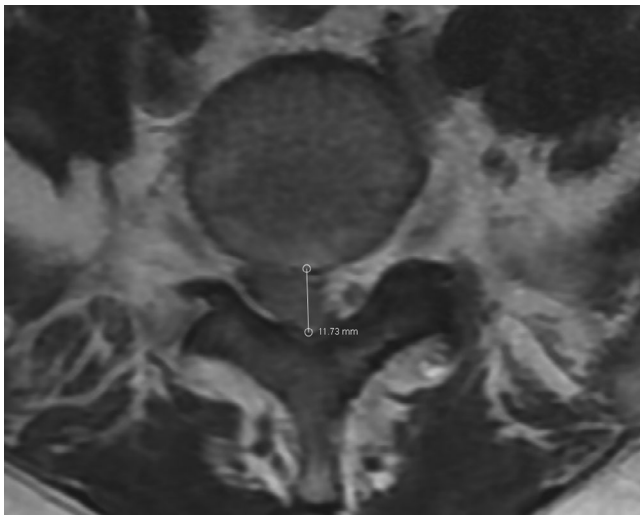

FIGURE 5 Apical length of the same disc herniation away from the radix.

In a right triangle, the hypotenuse length is always proportional to the measurements of the base and the height. An increase in the base or the height increases the radix length, that is, the radicular traction (Figure 3). Therefore, the radicular length must increase when the base length (b) or apical length (a) increases in a herniated disc. This leads to increased traction at the radix.

According to this geometric rule, the Lasegue test aims to increase the radicular length, that is, the traction at the radix. In the absence of disc herniation, the length of the radix is approximately equal to the base length of the right triangle. In the Lasegue test, the base length of the right triangle (b) is subjected to traction until it reaches the length of the hypotenuse. According to the right triangle rule, side c is always longer than sides a and b. When the radix reaches the side length of the hypotenuse, this results in traction. In a case without a herniated disc, it is assumed that it can form a hypotenuse edge of up to 70 degrees. In the presence of a herniated disc, the radix is subject to traction below 70 degrees.

In the presence of a migrated and sequestered disc herniation, the apical portion of the herniated disc material is further from the radix (Figures 4–5). For this reason, the sensitivity of the Lasegue test is lower in migrated disc herniations. In these cases, the apical length of the disc herniation corresponds to its size at the intervertebral disc distance (Figure 6). For this reason, the sensitivity of the Lasegue test is much lower in this group of cases, where surgical intervention is most often considered.

Although the herniated disc's apical length and base length were lowest in lateral disc herniations, the sensitivity was higher with the Lasegue test. Therefore, the Lasegue test has the highest specificity and sensitivity in lateral disc herniations. This is because the potential for radix compression in the foramen is much higher in lateral disc herniations than in median and paramedian herniated discs. The sensitivity of Lasegue in these cases is related to the traction of the radix and its compression.

Although the Lasegue test is a commonly used examination method in LDH, it has high specificity and pseudo-high sensitivity in foraminal herniated discs. Pseudonegativity may also occur in migrated and sequestered disc herniations. For this reason, the specificity and sensitivity of migrated disc herniations are low. Specificity

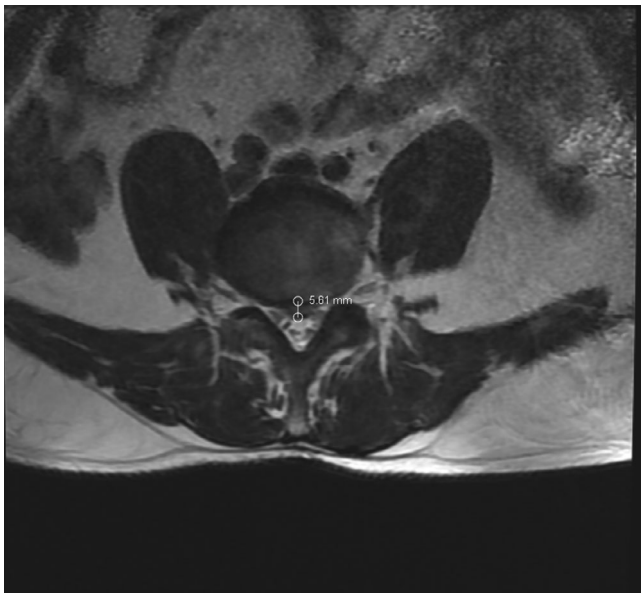

FIGURE 6 Apical length of the disc at the level of intervertebral disc distance.

and sensitivity are higher in paramedian and median disc herniations than in other herniated discs, and specificity and sensitivity at the L4-5 level are higher than in L5-S1 herniated discs.

5 | CONCLUSIONS

The Lasegue test that can be explained by the rules of geometry and aims at traction of the radix. It is frequently used in the prediagnostic phase in LDH cases. It has high specificity and sensitivity in L4-5 herniations. It has low specificity and sensitivity in L3-4 level disc herniations and migrated and sequestered disc herniations. The apical length of the herniated disc is the most critical factor affecting the positivity of the test. Conditions that cause nerve root compression decrease the accuracy of the test.

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