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Which is the Most Effective Radiological Parameter for Predicting Early Regression in Acute Lumbar Disc Herniation?

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Research Article

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ABSTRACT

Objective: The aim of this study is to investigate the effectiveness of radiological parameters that can predict early regression in symptomatic lumbar disc herniation by quantitatively measuring the regression.
Method: This cross-sectional study included 39 patients (23 males and 16 females) admitted to neurosurgery outpatient clinics with lumbar and leg pain between 2018-2019 who had been diagnosed with lumbar disc herniation via MRI, and underwent conservative treatment due to the absence of sphinctre urinary-fecal incontinence and foot drop in their neurological examination. The type, density, relationship with posterior longitunidal ligament (PLL), size and degree of migration of disc herniation that could be predictive for regression were recorded.
Results: Sequestration&extrusion cases had significantly higher regression than protrusion cases (p=0.018). Hyperintense cases had significantly higher regression than the others (iso-hipointens) (p=0.042). Cases with migration had significantly higher regression than the non-migration (p=0.017). Among all parameters, migration was the most strongly associated parameter with early regression of lumbar disc herniations.
Conclusions: Our study showed that sequestered-extruded, hyperintense, and highly migrated disc herniations in the early period of symptomatic lumbar disc herniation are more associated with regression and migration is the strongest radiological parameter.

Keywords: Conservative treatment, lumbar disc herniation, mrı, spontaneous regression.

Akut Lomber Disk Hernisinde Erken Dönemdeki Gerilemeyi Öngörmede En Etkili Radyolojik Parametre Hangisidir?

Süreç

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ÖZ

Amaç: Bu çalışmanın amacı semptomatik lomber disk hernilerinde, erken dönemde disk herniasyonundaki küçülmeyi tahmin edebilen radyolojik parametrelerin etkinliğini herniasyondaki küçülmeyi kantitatif olarak ölçerek araştırmaktır.
Yöntem: Kesitsel tipteki bu çalışmaya 2018-2019 yılları arasında beyin ve sinir cerrahisi polikliniğine bel ve bacak ağrısı şikâyeti ile başvuran, MRG ile lomber disk herniasyonu tanısı konulan, nörolojik muayenelerinde üriner-fekal inkontinans ve düşük ayak olmaması nedeniyle konservatif tedavi uygulanan 39 hasta (23 erkek ve 16 kadın) dahil edildi. Disk herniasyonundaki küçülmeyi öngörebilecek parametreler olan disk herniasyonunun tipi, dansitesi, posterior longitunidal ligament (PLL) ile ilişkisi, boyutu ve migrasyon derecesi her hasta için belirlendi.
Bulgular: Sekestre&ekstrüde tipteki disk hernileri, protrüde tipteki herniasyonlara göre anlamlı olarak daha yüksek gerileme göstermiştir (p=0.018). Hiperintens disk hernileri diğerlerine göre (iso-hipointens) anlamlı olarak daha yüksek gerileme gösterdi (p=0.042). Migrasyon gösteren disk hernileri, migrasyon göstermeyenlere göre anlamlı olarak daha yüksek gerileme gösterdi (p=0.017). Tüm parametreler arasında, lomber disk hernilerinin erken dönemde regresyonu ile en güçlü ilişkili parametre migrasyon idi.
Sonuç: Çalışmamız semptomatik lomber disk hernilerinin erken döneminde sekestre-ekstrüde, hiperintens ve yüksek oranda migrasyon gösteren disk hernilerinin küçülme ile daha fazla ilişkili olduğunu ve migrasyonun en güçlü radyolojik parametre olduğunu göstermiştir.

Anahtar sözcükler: Konservatif Tedavi, Lomber Disk Hernisi, MRG, Spontan Gerileme

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Introduction

In a review of asymptomatic patients, radiological imaging of the lumbar region showed bulging in 10-81%, protrusion in 3-63%, and extrusion in 0-24% [1]. However, the presence of symptomatic disc hernia is between 1-3% [2].

While lumbar disc herniation requires an urgent surgical intervention in the presence of sphincter urinary fecal incontinence and foot drop, an elective surgical intervention is recommended in case of persistent pain lasting for 6 weeks after conservative treatments. The aim of lumbar disc herniation surgery is to alleviate compression on nerve roots at the site of herniation. However, in some patients, this situation, which is intended by surgery, is possible with spontaneous regression of the herniation without the need for surgical intervention.

In a review, spontaneous regressions in disc herniation were associated with the following: disc herniation in extruded-sequestered form, migration up or down, rupture of posterior longitudinal ligament (PLL) in transligamentous form, and presence of hyperintense disc herniations on magnetic resonance imaging (MRI) T2 [3].

To the best of our knowledge, the number of studies focusing on early regression of lumbar disc herniation and investigating regression quantitatively is very limited.

While the characteristics of spontaneously regressing disc herniation cases have been evaluated in different studies, to our knowledge, there is still very little information in terms of quantifying the degree at which each of these characteristics are related to regression.

In this study, we aimed to investigate the effectiveness of these radiological parameters by evaluating the radiological parameters that have been shown to be associated with regression in different studies on the same patients and quantitatively measuring the regression in order to predict the regression that may occur in the early period in lumbar disc hernation.

Material and Methods

Study Group

This study is a cross-sectional study that included 39 patients admitted to neurosurgery outpatient clinics with lumbar and leg pain between 2018-2019 who had been diagnosed with lumbar disc herniation via MRI, and underwent conservative treatment due to the absence of sphinctre urinaryfecal incontinence and foot drop in their neurological examination.

In the study the patients, those whose leg pain was compatible with the level and localization of the disc herniation, those whose pain score was between 60 and 100 mm in the first neurological examination according to the Visual Analogue Scale (VAS), those with a leg lift test 45 degrees and below, and those less than 10 days between lumbar MRI with the day of the onset of pain were included. Those who have additional degenerative diseases that may be a source of pain in their lumbar MR, those who have undergone any physical therapy during conservative follow-up, those who have undergone invasive interventions for pain, those who have undergone previous surgical intervention were excluded from the study.

Determination of Herniation and Disc Regression

Patients were evaluated by axial and sagittal 4-mm thickness sections with a 1.5 tesla MRI device. All MRIs were evaluated by two radiologists. The patients were classified radiologically as bulging, protrusion, extrusion and sequestration according to the type of herniation; central, subarticular, foraminal and extraforaminal (in axial plan) according to the localization of the herniation; hypointense, isointense and hyperintense according to intensity on T2-weighted MRI relative to the annular fibrosis at the herniation site; and subligamentous and transligamentous according to their relationship with the posterior longitudinal ligament [4]. Disc herniations occupying 50% or more of the spinal canal in that section were considered “large disc herniation”, and disc herniations other than these were considered “non-large disc herniation”.

The migration rate was found by proportioning the length of the migrated disc hernia to the posterior height of the corresponding vertebral corpus (Figure 1).

The disc herniation volume measured in the sections with disc herniation in the axial plane was proportioned to the canal volume in that section using the OsiriX Lite software program (Figure 2). This proportioning was repeated in all sections with disc herniation. Disc herniation rate was determined by summing these rates. This calculation was repeated in the second MRI and the regression ratio was calculated with the difference between them (Figure 3).

Conservative Treatment

All patients were informed about the natural course of lumbar disc herniation. It was stated that surgical intervention is an option for the immediate relief of pain, but conservative treatment, which include medication and rest, can reduce the pain. Patients were prescribed non-steroidal anti-inflammatory and myorelaxant drugs intramuscularly and corticosteroids for a total of 2-3 times (if there are no contraindications). 3 days of bed rest was recommended. Patients were warned to apply for urgent surgical intervention in case of drop foot and/or urinary/fecal incontinence. Weekly polyclinic control was recommended. In the patients whose pain did not regress at weekly polyclinic controls, either intramuscular treatment (except corticosteroid) was repeated or oral treatment (analgesic-myorelaxant) was continued. During the follow-ups, no invasive intervention was performed for pain in any patient. The diagnosis, treatment and follow-up procedures of the patients were carried out by the same physician.

Written informed consent was obtained from all the participants included in our study.

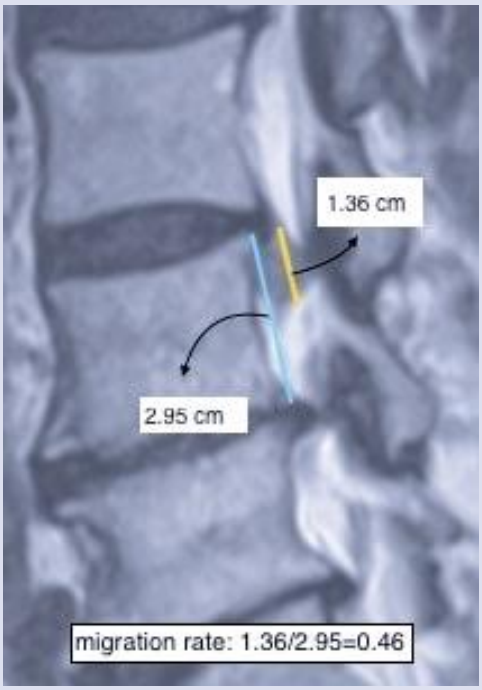

Figure 1. Calculation of migration rate

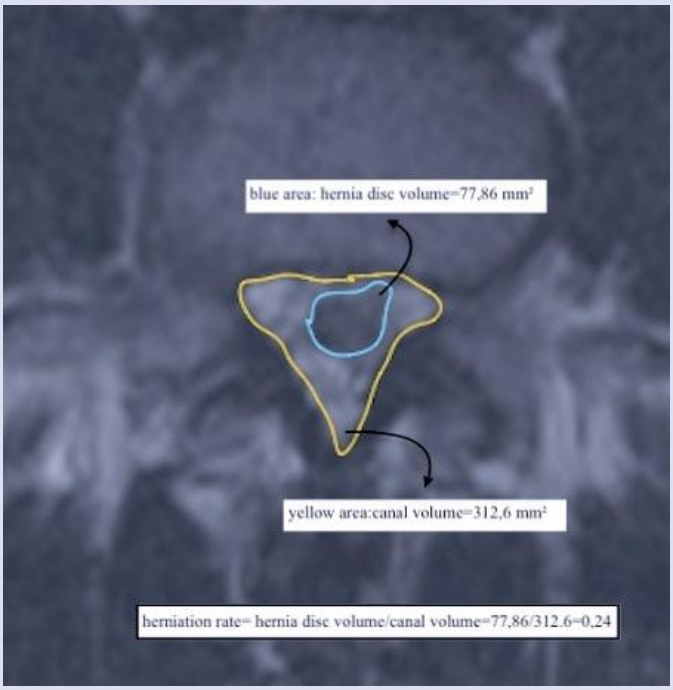

Figure 2. Calculation of herniation rate

(a)

(b)

Figure 3. (a) In the initial Lumbar MRI, disc herniation rate was calculated by determining the sum of the blue area and the yellow area in each section. Disc herniation rate for this patient: 1.25. (b) In the second lumbar MRI (after 65 days), the disc herniation rate was calculated as 1.07 and the regression was calculated as 0.14. It was determined that there was 14% spontaneous volume reduction in herniation of this patient after 65 days of follow-up.

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Statistical Analysis

All analyses were performed on SPSS v21 (SPSS Inc., Chicago, IL, USA). Histogram plots were used to determine whether variables are normally distributed. Amounts of regression were analyzed with the Mann Whitney U test or Kruskal Wallis test depending count of groups. Pairwise comparisons were performed with the Bonferroni correction method. Multiple linear regression analysis (forward selection method) were performed to determine significant factors of the amount of regression. Two-tailed p-values of less than 0.05 were considered statistically significant.

Results

We included 39 patients (23 males and 16 females) into our study, mean age was 43.79 ± 12.70 (range 21 - 74, median 43). Sixteen (41.03%) patients were affected from the right side while 23 (58.97%) patients were affected from the left side. The most common level was L5 - S1 (53.85%). The most common location was central - subarticular (46.15%). Three (7.69%) patients had sequestration, 32 (82.05%) patients had extrusion and 4 (10.26%) patients had protrusion. MRI intensity was hyperintense in the 28 (71.79%) cases. Nine (23.08%) cases were transligamentous and 30 (76.92%) cases were subligamentous. Twenty-one (53.85%) patients had large hernia. Mean regression were found as 0.31 ± 0.32 (range -0.39 - 1.00, median 0.33) and there was no change in one (2.56%) cases and four (10.26%) cases had progression. Mean follow up time was 64.72 ± 12.95 days (Table 1).

Sequestration & extrusion cases had significantly higher regression than protrusion cases (p=0.018). Hyperintense cases had significantly higher regression than the others (p=0.042). Cases with migration had significantly higher regression than the others (p=0.017). In addition, we divided migration into four groups as no migration, 0.01 - 0.33, 0.34 - 0.66 and 0.67 - 1.00. We found 0.67 - 1.00 group had significantly higher regression than in the no migration group. Also, there were no significant differences between age (below 45 and over 45), gender, side, level (L2 - L3 & L3 - L4 and L4 - L5 & L5 - S1), location (central & central - subarticular and subarticular & foraminal), relationship with posterior longitudinal ligament (PLL) (transligamentous and subligamentous), size (non-large and large) groups with regard to regression (Table 2).

We performed multiple linear regression analysis to determine the most significant factors of the amount of regression. We found cases with migration have higher amounts of regression (p=0.006). Other variables included in the model age (p=0.574), gender (p=0.811), side (p=0.743), level (p=0.252), location (p=0.683), type (p=0.301), MRI intensity (p=0.576), relationship with PLL (p=0.700) and size (p=0.186) were found to be non-significant (Table 3).

Table 1. Summary of patients and herniations characteristics

Age	43.79 ± 12.70 (21 - 74)
< 45	21 (53.85%)
> 45	18 (46.15%)
Gender	
Male	23 (58.97%)
Female	16 (41.03%)
Side	
Right	16 (41.03%)
Left	23 (58.97%)
Level	
L2 - L3	1 (2.56%)
L3 - L4	7 (17.95%)
L4 - L5	10 (25.64%)
L5 - S1	21 (53.85%)
Location	
Central	6 (15.38%)
Central - Subarticular	18 (46.15%)
Subarticular	14 (35.90%)
Foraminal	1 (2.56%)
Type	
Sequestration	3 (7.69%)
Extrusion	32 (82.05%)
Protrusion	4 (10.26%)
MRI intensity	
Hyperintense	28 (71.79%)
Isointense	6 (15.38%)
Hypointense	5 (12.82%)
Relationship with PLL	
Transligamentous	9 (23.08%)
Subligamentous	30 (76.92%)
Size	
Non-large	18 (46.15%)
Large	21 (53.85%)
Migration	
None	10 (25.64%)
0.01 - 0.33	5 (12.82%)
0.34 - 0.66	17 (43.59%)
0.67 - 1.00	7 (17.95%)
Regression [(1)]	0.31±0.32(-0.39 - 1.00)
Absent	5 (12.82%)
Present	34 (87.18%)
Follow-up time (days)	64.72 ± 12.95
VAS	
60-80 mm	21(53.84%)
80-100 mm	18(46.15%)
Pain onset to MRG time(days)	
1-3.	12(30.76%)
4-6.	7(17.94%)
7-10.	20(51.28%)

Data are given as mean ± standard deviation (minimum - maximum) for continuous variables and as frequency (percentage) for categorical variables, [1]Negative value represents progression

Table 2. Amount of regression with regard to patients and herniations characteristics

	n	Mean ± Standard Deviation	Median (Minimum - Maximum)	p
Age				
< 45	21	0.28 ± 0.33	0.23 (-0.39 - 1.00)	0.297
> 45	18	0.35 ± 0.30	0.41 (-0.31 - 1.00)	
Gender				
Male	23	0.32 ± 0.33	0.34 (-0.31 - 1.00)	0.710
Female	16	0.30 ± 0.30	0.25 (-0.39 - 1.00)	
Side				
Right	16	0.37 ± 0.32	0.42 (-0.31 - 1.00)	0.304
Left	23	0.27 ± 0.31	0.27 (-0.39 - 1.00)	
Level				
L2 - L3 & L3 - L4	8	0.49 ± 0.26	0.42 (0.21 - 1.00)	0.082
L4 - L5 & L5 - S1	31	0.27 ± 0.31	0.24 (-0.39 - 1.00)	
Location				
Central & Central - Subarticular	24	0.30 ± 0.31	0.37 (-0.39 - 0.86)	0.634
Subarticular & Foraminal	15	0.33 ± 0.33	0.27 (-0.16 - 1.00)	
Type				
Sequestration & Extrusion	35	0.35 ± 0.30	0.40 (-0.31 - 1.00)	0.018
Protrusion	4	-0.04 ± 0.26	0.01 (-0.39 - 0.24)	
MRI intensity				
Hyperintense	28	0.37 ± 0.26	0.40 (-0.31 - 1.00)	0.042
Iso-Hypointense	11	0.16 ± 0.40	0.15 (-0.39 - 1.00)	
Relationship with PLL				
Transligamentous	9	0.39 ± 0.28	0.40 (0.04 - 1.00)	0.571
Subligamentous	30	0.29 ± 0.33	0.30 (-0.39 - 1.00)	
Size				
Non-large	18	0.33 ± 0.38	0.34 (-0.39 - 1.00)	0.673
Large	21	0.29 ± 0.26	0.33 (-0.31 - 0.86)	
Migration				
Absent	10	0.08 ± 0.30	0.12 (-0.39 - 0.48)	0.017
Present	29	0.39 ± 0.28	0.40 (-0.31 - 1.00)	
Migration				
None [a]	10	0.08 ± 0.30	0.12 (-0.39 - 0.48)	0.031
0.01 - 0.33 [ab]	5	0.42 ± 0.16	0.50 (0.15 - 0.57)	
0.34 - 0.66 [ab]	17	0.31 ± 0.28	0.25 (-0.31 - 0.86)	
0.67 - 1.00 [b]	7	0.56 ± 0.32	0.47 (0.19 - 1.00)	

Negative values represent progression, [a, b] Same letters denote the lack of statistically significant difference between groups.

Table 3. Significant factors of the regression, multiple linear regression analysis

	Unstandardized β	Standard Error	Standardized β	p	95.0% Confidence Interval for β	
(Constant)	0.082	0.091		0.374	-0.103	0.267
Migration (Present)	0.309	0.106	0.433	0.006	0.095	0.523

Dependent Variable: Amount of regression; R2=0.187; F=8.531; p=0.006

Discussion

Our study showed that early-stage sequestrated-extruded, hyperintense and highly migrating disc herniations are more associated with regression, and migration is the strongest among these parameters.

In recent studies, the total incidence of spontaneous regression of lumbar disc hernia is reported around 65-70% [5]. But there are a limited number of studies on factors related to the development or possibility of spontaneous regression [6-8]. The studies in the literature generally focus on the effects of herniation type on spontaneous regression. According to the results of current studies, disc extrusion and sequestration tend to demonstrate regression more frequently than cases with disc protrusions or bulging (77% vs. 30%). Sequestrated lumbar disc herniation refers to the complete separation of herniation from the feeding area [4]; so when both macrophage activation and dehydration mechanisms are evaluated according to herniation types, sequestrated disc herniations may have a much higher regression rate than disc extrusion (43% and 15%) (4,8). In our study, 3% of the patients had sequestrated, 82% had extruded disc herniations and 4% had protruded disc herniations. In our study, sequestration & extrusion cases had significantly higher regression than protrusion cases (p=0.018).

The presence of T2 hyperintensity on MRI is another factor associated with regression, possibly due to the relationship with the hydration of the hernia site. That is, T2 hyperintensity may mean that the herniation tissue is contracting due to dehydration [9-11]. In the study conducted by Henmi et al., T2 signal intensity was found to be higher in patients with short disease duration, and T2 signal intensity increased as the disease duration increased. In addition, they found a higher regression rate in discs with herniation with a higher T2 signal intensity compared to discs with a low T2 signal intensity [12]. In our study, 71.79% of the patients had hyperintense herniations, 28.21% had Iso-Hypointense herniations. Hyperintense cases had significantly higher regression than the others (Iso-Hypointense) (p=0.042).

Disc herniations are mostly paramedian because of the weak lateral structure of the posterior longitudinal ligament. Some disc herniations pass into the epidural space by destroying the PLL, and some remain below the PLL, those are called transligamentous and subligamentous, respectively [5]. Although transligamentous disc herniations have been shown to be more associated with regression due to the dense vascular structure in the epidural space, there are limited data on the effects of herniation localization on regression in the literature (6,7) In our study, there were no significant differences between transligamentous and subligamentous groups with regard to regression (Table 2).

Among the studies examining the relationship between herniation size and regression, in their studies evaluating the second MRI results of the patients, Early et al. (after a mean of 18.6 months) and Bozaa et al. (after 6-15 months (mean of 11 months)) showed that the size of the disc herniation correlated with regression [9,13]. When we examined the second MRI results of the cases (after a mean of 64 days), it was found that, there were no significant differences between non-large and large groups with regard to regression (Table 2). We thought that this difference was related to the edematous changes within the herniation caused by the inflammatory mechanism, which is responsible for pain and is thought to be related to regression, and which was more active in the early stages [14]. The migration of disc herniation is defined as a herniation mass, cranially or caudally, reaching more than a quarter of the spine, and migration has been associated with the spontaneous regression of disc herniation [5,15,16]. In the study conducted by Iwabuchi et al., patients with and without lumbar disc herniation regression were compared and herniation migration was found more prominently in patients who showed regression. Lumbar disc herniation tends to be in contact with the epidural tissue during migration, and therefore, resorption of herniation may be facilitated [16]. In our study, similar to the literature, Cases with migration had significantly higher regression than the others (p=0.017). In addition, we divided migration into four groups as no migration, 0.01 - 0.33, 0.34 - 0.66 and 0.67 - 1.00. We found 0.67 - 1.00 group had significantly higher regression than in the no migration group.

Although clinical results do not correlate well with disc regression, some studies have found full regression or significantly higher regression rates with good clinical outcomes [8]. In the study conducted by Bozzao et al. with lumbar disc herniation patients, clinical improvement was observed in all patients showing 70% regression rate [13]. In our study, although there were differences specific to the patient (no regression in five patients), an average of 31% regression was observed at the end of 64 days, no patient was operated, and no patient complained of pain that would affect their daily lives at the end of conservative treatment.

The low number of patients and the low frequency of radiological follow-up were among the limitations of our study. However, the aim in the short follow-up period was to reveal the parameters that could predict regression in the early period. Apart from this, it is a known fact that disc herniations are largely regressed in the long term. Interestingly, some patients' pain resolved completely during the study, even though their herniations had progressed or did not regress at all. Even though this was explained by the knowledge that pain is associated with inflammation that occurs in the early period rather than mechanical compression, we thought it is necessary to investigate the relationship between inflammation and time with new studies and to pave the way for new treatment modalities.

Conclusion

Regardless of the radiological characteristics of lumbar disc herniation, conservative treatment is the first option. However, while directing patients with sequestrated or extruded, hyperintense, and migrated disc herniation to conservative treatment, we think that sharing the possibility of regression with the patient will increase the compliance with conservative treatment.

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Consent to participate: Informed consent was obtained from all individual participants included in the study.

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