THE PREDICTIVE FACTORS FOR RESORPTION OF LUMBAR DISC HERNIATION

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Objective. To determine the timing and to identify predictive factors of resorption of lumbar disc herniation.
Material and Methods. This study is retrospective cohort and is devoted to the study of two groups of patients: Group 1 with herniated disc resorption and Group 2 with no resorption. All patients underwent MRI of the lumbar spine at the onset of initial symptoms, and the second study was conducted during the second visit. Based on the MRI results, the following parameters were assessed: the degree of intervertebral disc degeneration according to the Pfirrmann classification, the degree of facet joint degeneration according to the Grogan classification, the type of hernia, the degree of migration of the hernial fragment according to the Komori classification, Modic changes, the state of the endplates according to the Rajasekaran classification, the presence of retrolisthesis and the presence of resorption of the hernial fragment in dynamics. The Syngo.via workstation was used to measure the volume of the hernial fragment. Resorption of a disc herniation was considered to be a decrease in its volume by more than 50 % of the initial value with mandatory relief of radicular pain syndrome. The identification of resorption predictors was performed by building logistic regression models. Single-factor models were used to identify individual predictors associated with the target event. For continuous indicators, the ROC analysis identified the maximum cut-point values according to the Youden's index.
Results. Group 1 included 141 patients, and Group 2 (comparison) — 93. Statistically significant differences between groups were found in several parameters. The average age of patients was 6 years younger; the interval between MRI studies was on average 2 months longer; and the protrusive type hernias were more in Group 2 than in Group 1. Gender, body mass index, the presence of retrolisthesis and smoking habit did not differ significantly between the groups. In Group 2, there were more cases of hernia at the L5—S1 level, which is associated with a higher incidence of hernia at this level. Using logistic regression models, it was revealed that hernia volume, hernia type according to the Komori classification, body mass index and Modic changes are significant factors for hernia resorption. A hernia volume of more than 1.1 cm^3, no Modic change, hernia types II and III according to Komori, and body mass index of less than 30.24 increase the chances of disc herniation resorption.
Conclusion. The average time to resorption of herniated lumbar disc is 5.5 months. Factors that predict the resorption include types II and III of hernia according to the Komori classification (correspond to sequestered herniation), the absence of Modic changes, hernial fragment volume larger than 1.1 cm^3, and body mass index less than 30.24.
Key words: lumbar disc herniation; resorption of the hernial fragment.
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Intervertebral disc herniation remains one of the most common diseases in the structure of spine pathology and is annually diagnosed in 5 to 20 people out of 1,000; these are mostly individuals aged 30 to 50 years [1].

According to studies [2–4], 20 to 30 % of patients with lumbar disc herniations with radicular symptoms require surgery.

The authors converge on a position that the long-term outcomes of surgery and conservative treatment are similar [5]. If the patient suffers from neurological deficit or requires an immediate clinical effect, however, surgery is preferred. Guinto et al. in 1984 described the first case of resorption of a herniation based on CT scanning [6]. As MRI technology has developed, it has been revealed that disc herniations of the spine tend to become smaller over time. Yet it does not occur in all patients, and there is currently no method of predicting the resorption of a disc herniation. The incidence of this phenomenon varies significantly in the scientific literature: 20 to 90 %.

In light of this, the study of the incidence, mechanisms, and predictors of spontaneous resorption of lumbar disc herniations is an essential aspect to improve patient treatment strategies [3, 4].

The objective is to determine the timing and to identify predictive factors of resorption of lumbar disc herniations.

Material and Methods

This study is retrospective cohort trial and is focused on identifying predictors of resorption of lumbar disc herniation. In addition, comparison of two groups of patients was performed. The first group included those who had resorption of disc herniation; the second group included those who did not have this process and had surgery. The comparison was done to find statistically significant dif-

ferences between the criteria, which were then tested by building logistic regressions to see what roles they played in the resoprtion process.

The patients received conservative treatment under the supervision of a neurologist at the place of residence. The treatment included non-steroidal anti-inflammatory medication, myorelaxants, physical therapy, and nerve blocks. The conservative treatment did not differ between the groups.

All patients underwent MRI of the lumbar spine at the onset of the first symptoms. The second imaging was performed at the second appointment.

The following parameters were evaluated according to the MRI findings: the degree of disc degeneration according to the Pfirrmann classification; the degree of degeneration of the facet joints according to the Grogan classification; the type of herniation, the degree of migration of the hernial fragment according to the Komori classification; Modic changes; the state of the endplates according to the Rajasekaran (TEPS) classification; the presence of retrolisthesis; and the presence of resorption of the hernial fragment in time. Herniations were classified according to Komori using MRI in the sagittal plane; three types were distinguished: type I – hernial fragment edges are visualized, no migration (corresponds to protrusion type); type II – no clear boundaries of hernial protrusion (extrusion type); type III – sequestered hernias with hernial fragment migration. The VAS was used to evaluate pain syndrome, and the Oswestry Questionnaire was used to determine physical activity.

The volume of the hernial fragment was measured using the Syngo.via workstation. The herniation was circled in the sagittal plane on each slice where it was visible. Then, the Syngo.via software identified the herniation and calculated the volume. A disc herniation resorption was considered to be a reduction in its volume by more than 50 % of the initial value with mandatory relief of radicular pain syndrome.

Statistical methods. The continuous variables were checked for normality by the Shapiro – Wilk Test and described as medians with interquartile range (MED [Q1; Q2]), standardized mean difference ± standard deviations (M ± SD), and minimum and maximum values (MIN–MAX). The binary and categorical variables were represented by the number of events and frequency, n (%).

The continuous variables were compared between groups by the Mann–Whitney U test, and by the Wilcoxon signed-rank test at the pre- and post-resorption points. To assess the shift of distributions, the pseudo-median (pMED) for paired differences was calculated; the relative magnitude of the difference was defined through the standardized mean difference. The binary and categorical variables were compared between groups by Fisher's exact test, and by McNemar's test before and after resorption.

The predictors of resorption were identified by building logistic regression models. Using univariate models, individual predictors associated with the target event were determined. For continuous variables, maximum thresholds were identified by ROC analysis according to the Youden's index. From the set of covariates with the achieved significance value of $p < 0.3$ in univariate models, multivariate logistic regression models optimal by the Akaike information criterion were constructed using forward and backward steps. The forward and backward step models matched. For the multivariate logistic regression model, ROC analysis was used to identify the classification threshold with the maximum Youden's index, to build a table of correspondence (contingency), and to calculate prognostic indicators: sensitivity and specificity. Using the Hosmer–Lemeshov test, we examined the consistent frequency predictions of the calibrated model with the actual frequency of adverse events.

All used tests were two-sided. Achieved values of $p < 0.05$ were considered significant. Calculations were performed in the RStudio IDE (version 2023.09.1 Build 494 © 2009-2023 Posit Software, PBC, USA).

Results

The first group with spontaneous resorption of disc herniation included 141 patients, and the comparison group (without resorption) included 93 patients. The mean age of patients in the first group was 46 years, and 40 years in the second group. The main features of patients in both groups and their comparison are shown in Table 1.

Statistically significant differences were found in several parameters: age (the mean age of patients was 6 years less in the second group); interval between MR screenings (this period was longer on mean by 2 months in the second group); protrusion type of hernia (the number of herniation was higher in the second group). Gender, body mass index (BMI), presence of retrolisthesis, and smoking were not significantly different between groups. As for the level of herniation, there were more cases at the L5–S1 level in the second group, which we believe is associated with a higher incidence of herniation at this level.

A comparison of MRI findings revealed that the second group mainly comprised patients with Grogan stages I and II degeneration. This difference was obvious only at the first appointment. The first group had more patients with no Modic changes. The other parameters were similar for both groups (Table 2).

A comparison of the intensity of pain syndrome in the lower extremities according to VAS in the first group showed a statistically significant decrease in pain after herniation resorption; in the lumbar spine the intensity of pain syndrome did not differ from initial values. In the second group, the intensity of pain in the lower extremities was identical between appointments. Logistic regression models revealed that herniation volume, age, herniation type according to Komori classification, BMI, and Modic change are significant factors for herniation resorption. Herniation volume more than 1.1 cm , no Modic change, Komori type II and III herniation, and BMI less than 30.24 increase the chances of resorption of disc herniation (Table 3).

Discussion

We have not found original domestic articles focused on resorption of lumbar disc herniations. Yet, there are review papers on this issue. In foreign literature, the number of academic studies in this direction is increasing every year.

In the meta-analysis conducted by Zou et al. [7], 31 studies examining 1,043 herniations were reviewed. The results showed that the overall incidence of spontaneous herniation resorption was 70.39 %. The researchers found that the regression rate depends on the type of herniation: sequestered – 87.77 %, extrusion – 66.91 %, protrusion – 37.53 %. In 40.19% of patients, there was a reduction of herniation from 25 to 50 %; in 43.62 % of patients – more than 50 %; and in 36.89 % of patients – complete resolution of herniation. The rate of resorption by country is as follows: 66.98 % in Japan, 61.66 % in the USA, 83.52 % in the South Korea (95 % CI: 0.70; 0.97), 60.68 % in China, 78.30 % in the UK, 56.70 % in Italy, 83.68 % in Turkey. Depending on the period of follow-up, three groups were identified in the study: group A – up to 6 months, group B – 6 to 12 months, and group C – more than 12 months. The rate of resorption in these groups did not differ and amounted to 64.6, 72.0, and 69.3%, respectively.

In a systematic review, Chiu et al. [8] found that the resorption rate of extrusion and sequestered herniations was 76.9 %. They identified several factors to predict herniation regression: the presence of extrusion or sequestration, fragment migration, and high T2 signal on MRI. Our study confirmed that extrusion and sequestered herniation have a greater tendency to spontaneous regression.

Hong et al. [9] studied 28 cases; the period of resorption of disc herniation ranged from 3 to 21 months. In 67 % of cases, the herniations resolved within a year. In general, disc herniations regressed in 59.06 % of patients for up to one year. In our study, the mean time of resorption of disc herniation was 5.5 months that corresponds to the literature data [10].

Shan et al. [11] studied the incidence of disc herniation resorption in patients with Modic changes. 85 patients participated retrospectively: 50 without Modic changes and 35 with changes (mostly

Table 1

Main features of patients in the study groups and their comparison

Parameter	First group (n = 141)	Second group (n = 93)	Comparison (p value)
Gender, n (%)			
Male	75 (53)	49 (53)	0.424
Female	66 (47)	44 (47)	
Age, years	46.0 [39.0; 57.0] 47.6 ± 12.2 (20.0–76.0)	40.0 [33.0; 48.0] 40.6 ± 10.5 (20.0–69.0)	<0.001*
Body mass index	27.3 [25.4; 30.0] 28.5 ± 4.8 (19.8–49.4)	28.1 [24.6; 32.0] 28.5 ± 6.5 (16.6–49.4)	0.882
Period between MRI scanning, months	5.5 [4.0; 8.0] 5.9 ± 2.8 (1.0–14.0)	7.5 [5.0; 10.0] 8.5 ± 4.8 (4.0–27.0)	<0.001*
Herniation level, n (%)			
L1–L2	3 (2)	0 (0)	0.278
L2–L3	4 (3)	1 (1)	0.651
L3–L4	15 (11)	4 (4)	0.092
L4–L5	69 (49)	39 (42)	0.348
L5–S1	50 (35)	49 (53)	0.010*
Herniation type, n (%)			
Protrusion	23 (16)	28 (30)	0.015*
Extrusion	40 (28)	21 (23)	0.363
Sequestered	78 (55)	44 (47)	0.285
Retrolisthesis, n (%)			
Presence of Retrolisthesis	30 (21)	23 (25)	0.432
None	111 (79)	70 (75)	0.632
Smoking (+), n (%)	55 (39) [31 %; 47 %]	38 (41) [31 %; 51 %]	0.786

*p < 0.05.

type II). The authors revealed that herniation resorption occurs less frequently in patients with Modic changes because the hernial bulging in this category of patients contains fragments of hyaline cartilage. The hyaline cartilage content in the structure of the hernial bulging results in loss of proteoglycans and less edema, making the tendency to resorption also decreased [11, 12].

In our study, there were more patients with Modic I in the second group ($p < 0.05$). In logistic regression, one of the resorption criteria was the absence of Modic changes.

Ding et al. [13] concluded that the low incidence of herniatoin resorption in patients with Modic changes might be associated with the following factors: cartilage content, decreased neovascularization and macrophage infiltration, decreased expression of matrix metalloproteinases-3 (stromelysins).

Autio et al. [14] found that the age group of 41 to 50 years old has a higher incidence of resorption of herniations. Probably, this is associated with the fact that intervertebral herniation in elderly patients are more solid: they contain little water and a lot of fibrous tissue. In our study, the mean age of patients in the first group was 6 years more. However, according to Seo et al. [15], the incidence and extent of lumbar disc herniation resorption do not correlate with age.

Some authors suggest performing contrast-enhanced MRI of the lumbar spine to predict herniation resorption. Signal enhancement around the herni-

Table 2
Main MRI findings of patients in the study groups and their comparison, n (%)

Parameter	First group (n = 141)	Second group (n = 93)	Comparison (p value)
Intervertebral disc degeneration according to Pfirmann	0 – 4 (3) 1 – 1 (1) 2 – 25 (18) 3 – 79 (56) 4 – 30 (21) 5 – 2 (1)	0 – 0 (0) 1 – 0 (0) 2 – 24 (26) 3 – 58 (62) 4 – 10 (11) 5 – 1 (1)	General comparison: 0.070 Category: p; correction p 0: 0.154; 0.307 1: >0.999; >0.999 2: 0.143; 0.307 3: 0.346; 0.520 4: 0.050; 0.300 5: >0.999; >0.999
Facet joint degeneration according to Grogan	1 – 19 (13) 2 – 78 (55) 3 – 43 (30) 4 – 1 (1)	1 – 28 (30) 2 – 48 (52) 3 – 15 (16) 4 – 2 (2)	General comparison: 0.003* Category: p; correction p 1: 0.003*; 0.010* 2: 0.594; 0.594 3: 0.014*; 0.027* 4: 0.565; 0.594
Modic change	No changes – 93 (66) Type I– 13 (9) Type II – 34 (24) Type III – 1 (1)	No changes – 51 (55) Type I – 22 (24) Type II – 19 (20) Type III – 1 (1)	General comparison: 0.016* Category: p; correction p No changes: 0.100; 0.200 Type I: 0.004*; 0.018* Type II: 0.528; 0.705 Type III: > 0.999; > 0.999
Endplate changes according to Rajasekaran	0 – 0 (0) 1 – 18 (13) 2 – 33 (23) 3 – 36 (26) 4 – 37 (26) 5 – 12 (9) 6 – 5 (4)	0 – 1 (1) 1 – 13 (14) 2 – 29 (31) 3 – 16 (17) 4 – 21 (23) 5 – 12 (13) 6 – 1 (1)	General comparison: 0.287 Category: p; correction p 0: 0.397; 0.569 1: 0.845; 0.845 2: 0.226; 0.569 3: 0.150; 0.569 4: 0.541; 0.631 5: 0.282; 0.569 6: 0.407; 0.569
Herniation type according to Komori	1 – 23 (16) 2 – 40 (28) 3 – 78 (55)	1 – 28 (30) 2 – 21 (23) 3 – 44 (47)	General comparison: 0.047* Category: p; correction p 1: 0.015*; 0.046* 2: 0.363; 0.363 3: 0.285; 0.363

*$p < 0.05$.

Table 3
Logistic regression models to identify predictors of resorption of lumbar disc herniations

Covariates	Univariate models		Initial multivariate model		Automated multivariate optimal model		Desired multivariate optimal model	
	OR [95 % CI]	p	OR [95 % CI]	p	OR [95% CI]	p	OR [95 % CI]	p
Herniation volume more than 1.1 cm^3	9.91 [5.22; 19.71]	<0.001*	10.41 [5.15; 22.26]	<0.001*	11.02 [5.52; 23.28]	<0.001*	11.02 [5.52; 23.28]	<0.001*
Komori classification (Types II and III)	0.45 [0.24; 0.85]	0.013*	0.75 [0.35; 1.62]	0.461	–	–	–	–
Body mass index less than 30.24	0.53 [0.3; 0.93]	0.027*	0.39 [0.19; 0.78]	0.009*	0.37 [0.18; 0.74]	0.005*	0.37 [0.18; 0.74]	0.005*
No Modic changes	1.6 [0.93; 2.73]	0.088	1.93 [1.01; 3.73]	0.047*	1.93 [1.02; 3.72]	0.046*	1.93 [1.02; 3.72]	0.046*

*p < 0.05.

al fragment is considered a predictor of spontaneous resorption. This is a neovascularized area with macrophage infiltration. It is important for phagocytosis and hernia regression [14, 16, 17].

The resorption of disc herniation does not always contribute to the resolution of the pain syndrome. Sometimes patients continue to experience lumbar pain associated with spondylarthrosis. There may also be residual leg pain because of residual radiculopathy [18, 19]. According to other data, if the herniation volume is reduced by more than 25 %, it improves the clinical symptoms [10]. The mean herniation reduction in our study in the first group was found to be more than 50 % of the initial volume.

Rashed et al. [20] conducted a systematic review and metanalysis of 16 papers on the resorption of disc herniations. The study included 360 patients with a mean age of 42.8 years. The period between MR screenings was 11.5 months. The resorption rate was 69.2 % for protrusion herniations, 70.6 % for extrusion herniations, and 90.0% for sequestered herniations. Initially large herniation size [19, 10, 21], absence of Modic changes [9, 22, 23], type III herniation according to the Komori classification [21, 24], and transligamentous herniations [21, 25] have been identified as predictors of resorption.

There are also studies that have examined the influence of the duration of symptoms on the degree of resorption. Their results show that the probability of resorption reduces with increasing duration of clinical symptoms [16, 23].

Hornung et al. [26] performed a prospective study involving 93 patients with discs herniations. The objective of the study was to identify predictors of early resorption (up to 3 months). According to the results, the rate of early resorption was 24.7 %. The predictors of early resorption were the size of the hernial fragment, posterior L4 body height, and sacral slope. The greater the values of these factors, the greater the resorption probability. In our study, the rate of disc herniation resorption within three months was 21.9 % (31 patients), the mean age of these patients was 48.2 years, and the mean herniation volume was 1.33 cm^3. Sequestered herniations were diagnosed in 20 (64.5 %) patients.

Conclusion

The mean period of resorption of lumbar disc herniations is 5.5 months. The predictors of resorption are types II and III according to Komori classification (corresponding to sequestered herniations), absence of Modic changes, hernial fragment volume more than 1.1 cm^3 and BMI less than 30.24.

The study had no sponsors. The authors declare that they have no conflict of interest.
The study was approved by the local ethics committee of the institution. All authors contributed significantly to the research and preparation of the article, read and approved the final version before publication.

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