RESORPTION OF LUMBAR DISC HERNIATIONS: A NON-SYSTEMATIC LITERATURE REVIEW

A.J. Sanginov, I.D. Isakov, Sh.A. Akhmetyanov, A.V. Peleganchuk
Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan, Novosibirsk, Russia

Objective. To analyze the information on spontaneous resorption of lumbar disc herniation.
Material and Methods. A non-systematic review of 37 publications on resorption of disc herniation was conducted. The data on the timing, mechanisms and predictors of regression of lumbar disc herniation were summarized. A clinical case is presented illustrating the resorption of a herniated L4—L5 intervertebral disc over 8 months.
Results. The frequency and timing of resorption of lumbar disc herniation vary depending on the number of patients, follow-up period, the type and nature of the hernial bulging, and other characteristics of patients. The results of meta-analyses indicate that the average period of spontaneous resorption of lumbar disc herniation is more than 6 months. The main theories of spontaneous resorption of lumbar disc herniation are the dehydration theory, the mechanical theory, and mechanisms associated with inflammatory processes and neovascularization. Currently, predictors of disc herniation resorption include the type and size of the hernia, follow-up period, Modic changes, etc. Existing data on the timing, mechanisms and predictors of resorption of lumbar disc herniation are insufficient to improve treatment tactics for this category of patients.
Conclusion. Herniated lumbar intervertebral discs tend to undergo spontaneous regression which, however, is not observed in all patients. The mechanisms of resorption can be different, and the fact of resorption itself can occur in different types of hernia with different frequencies. An analysis of large data sets is necessary to more accurately determine the timing and predictors of resorption of lumbar disc hernias.
Key Words: lumbar disc herniation, resorption of the hernial fragment.
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Lumbar disc herniations remain an acute challenge in modern vertebrology, as they are mainly found in working-age individuals and tend to increase the detection rate annually. The importance of surgery in the treatment of this pathology is high. Nowadays, the main attention is paid to minimally invasive surgeries [1]. Surgical treatment techniques are effective and fast ways to relieve radicular pain, prevent the development of neurological abnormalities, and allow an early return to work. According to the clinical guidelines of the Association of Neurosurgeons of Russia (2014), the indication for surgical treatment is the duration of radicular pain syndrome or pain in the lumbar spine for at least 4 weeks (in the absence of symptoms of loss of nerve function requiring immediate decompression). There is no defined duration of conservative therapy, including in foreign articles, and it ranges from 6 weeks to 6 months, depending on the pain intensity and a treatment option [2–4].

With the development of new technologies in the fields of physiotherapy and neurology, non-surgical treatment options for patients with lumbar disc herniations are widely disseminated. This has led to an increase in the number of articles dedicated to this issue. Because of the development and prevalence of MRI, articles have appeared describing the spontaneous reduction or even disappearance of disc herniations over time. This phenomenon was called "resorption of disc herniation" that can be either partial or complete [5]. The first case of spontaneous regression of lumbar disc herniation was described in 1984 by Guinto et al. [6]. A systematic review of 37 studies showed that the incidence of this phenomenon ranged from 62 % to 66 % over a period of 6 to 12 months [7, 8]. Nevertheless, there are still unstudied issues regarding the predictors and timing of regression of herniation.

Material and Methods

The analysis of PubMed and eLibrary databases was performed; 37 articles were selected in accordance with the keywords "lumbar disc herniation," "resorption of herniation" and "regression of herniation." This review provides the main issues discussed in the articles that are illustrated by our own clinical observation of the resorption of disc herniation at the L4–L5 level during 8 months.

Results and their Discussion

The timing and frequency of resorption of the herniated fragment. According to the articles, the period of resorption of disc

herniation ranges from 1.5 to 48 months, and the frequency of resorption ranges from 4.3 to 93.3 % (Table).

According to the retrospective analysis of 37 cases performed by Martinez-Quinones et al. [9], it was found that the timing of herniation regression is at least 1 year. After the review of the data of 53 patients with sequestered disc herniations, Macki et al. [45] reported that resorption of the herniated fragment occurs after an average of 9.3 ± 13.3 months (according to MRI findings). According to other authors [45, 46], the mean time between MRI scans, which state the fact of spontaneous regression of a herniated fragment, ranges from 5.54 to 9.27 months.

The incidence of resorption varies depending on the type of herniation and the duration of follow-up. After the review of 42 patients, Takada et al. [38] concluded that the period of regression depends on the type of hernial bulging. According to their data, sequestered herniations usually regress after 9 months, extrusion herniations – after 12 months. Protrusion herniations regress very slowly, because this type is often detected in young patients whose nucleus pulposus is enriched with collagen fibers and chondrocytes. According to the retrospective analysis of 48 patients with lumbar disc herniation performed by Kurilina et al. [21], regression was recorded after 12 months in patients with extrusion and sequestered hernias in all cases, whereas it was in 25.0 % in patients with protrusion-type herniations. Ahn et al. [26], based on an MRI examination, found that 25 (69.4 %) out of 36 patients had resorption; meanwhile, the rate of resorption in sequestered herniations was 100 %. Seo et al. [20] analysed the data from 43 patients with lumbar disc herniation using MRI to estimate the volume of the herniation. They found that there was a decrease in the volume in 62.5 % of cases, with a mean reduction of 310.73 ± 743.60 mm^3. Yu et al. [32] followed up on 102 patients with lumbar disc herniation over a two-year period. Out of them, 83 (81.4 %) showed a partial or complete response to treatment. Surgery was recommended for the remaining 19 patients (18.5 %). The volume of the herniated disc during conservative treatment decreased from 1,433.89 ± 525.49 mm^3 to 1,002.01 ± 592.95 mm^3 ($p < 0.01$). In 20 patients (24.1%), the volume of resorption exceeded 50 %; no decrease in the herniation was found in 63 patients during the MRI scan. Nevertheless, there has been a clinical improvement. According to the results of a meta-analysis performed by Zhong et al. [47], the incidence of disc herniation resorption was 66.66 % (95 % CI 55.12–78.21 %).

Wang et al. [48] found that the mean incidence of lumbar disc herniation is 63 %. Meanwhile, the highest rate of resorption (96 %) was recorded by Lee et al. [13], with a mean follow-up period of 12 months. Three articles report the lack of resorption with a follow-up period of 45 days [49], 20 days [50], and a median of 5 days (3–7 days) [51], which suggests that disc herniation resorption should not be expected for 1.5 months. According to Ahn et al. [26], the rate of disc herniation resorption was 69 % after 8.5 months, Delauche-Cavallier et al. [24]: 67 % after 12.5 months, Bozzao et al. [22]: 63 % after 12.5 months, Matsubara et al. [19]: 62 % after 11 months, Komori et al. [8]: 64 % after 8.7 months, Bush [23]: 64 % after 12 months, and Iwabuchi [18]: 62 % after 4.1 months. The timing of resorption in the other six articles, with a resorption rate of approximately 63 %, ranged from 8.5 to 12.9 months, mean 10.5 months. Four studies reported long-term follow-up data with a mean duration of more than 24 months. Fagerlund et al. [27] reported resorption of 73 % of the hernias after a 24-month follow-up, Yukawa et al. [15]: 57 % after a mean follow-up of 30 months, Shin et al. [16]: 58 % after follow-up of 3 years, Ilkko et al. [34]: 83 % after a mean follow-up of 5.2 years.

One of the latest is a meta-analysis performed by Zou et al. [52], which included 31 studies involving 2,233 patients with lumbar disc herniations who received conservative treatment. According to this study, the cumulative incidence of disc herniation resorption was 70.39 %: 87.77 % for sequestered hernias; 66.91 % for extruded hernias and 37.53 % for protruded ones. It is interesting that the rate of resorption varies in different countries: 66.98 % in Japan, 61.66 % in the USA, 83.52 % in Korea, 60.68 % in China, 78.30 % in the UK, 56.70 % in Italy, and 83.68 % in Turkey. The analysis showed that there was no statistically significant difference in the rate of resorption between prospective, retrospective and randomized controlled studies ($p = 0.77$). Similarly, there was no difference between qualitative and quantitative methods for estimating the volume of disc herniations ($p = 0.05$). The mean period of regression was more than 6 months.

As shown in the table, the number of patients in 31 of the 37 articles was less than 100; the follow-up period exceeded 12 months in 16 papers; and the incidence of resorption was more than 70 % in 18 papers. The incidence and time of lumbar disc herniation resorption differ depending on the number of patients, follow-up duration, the type and nature of the hernia bulging, and other features of the patients. In compliance with the results of the conducted meta-analyses, the mean period of spontaneous resorption of lumbar disc herniation is more than 6 months.

Mechanisms of resorption of lumbar disc herniation. Various theories of the mechanisms of spontaneous resorption of disc herniation have been offered, including those confirmed by in vitro and in vivo animal studies [53–55]:

– according to the theory of dehydration, a herniated nucleus pulposus can compress back into a fibrous ring as a result of gradual dehydration;

– if disc herniation bulges through the ring without damaging it, it can pull back (the so-called protrusion types of herniation);

– lumbar disc herniation triggers sterile inflammation and neovascularization in the epidural space with gradual cartilage resorption through enzymatic degradation and phagocytosis.

Lama et al. [56] proposed that fragments of hyaline cartilage present in the disc herniation tissue have a slight swelling or loss of proteoglycan and can be

Table
Follow-up periods and incidence of resorption of lumbar disc herniation (according to literature data)

Authors	Patients, n	Follow-up period, months	Incidence of resorption, %
Komori et al. [8]	77	8.7	64.00
Martinez-Quinones et al. [9]	37	1.5	4.30
Kamanli et al. [10]	26	1.5	19.20
Teplick, Haskin [11]	55	5.0–36.0	20.00
Modic et al. [12]	16	6.0	25.00
Lee et al. [13]	505	12.0	43.50
Jensen et al. [14]	139	14.0	46.70
Yukawa et al. [15]	30	30.0	56.60
Shin et al. [16]	128	36.0	58.00
Ma et al. [17]	409	12.0	59.06
Iwabuchi et al. [18]	34	6.0	62.00
Matsubara et al. [19]	31	9.7	62.00
Seo et al. [20]	43	6.3	62.50
Kurilina et al. [21]	48	12.0	62.50
Bozzao et al. [22]	65	12.5	63.00
Bush et al. [23]	165	12.0	64.00
Delauche-Cavallier et al. [24]	21	12.5	67.00
Ahn et al. [25]	36	6.9	69.40
Ahn et al. [26]	36	8.5	69.40
Fagerlund et al. [27]	30	24.0	73.00
Galucci et al. [28]	15	4.0	73.30
Ellenberg et al. [29]	14	30.0	78.50
Shan et al. [30]	30	6.0	80.00
Maigne et al. [31]	48	48.0	81.20
Yu et al. [32]	102	24.0	81.37
Saal et al. [33]	11	25.0	81.80
Ilkko et al. [34]	18	62.4	83.00
Hong et al. [35]	28	8.8	85.70
Benson et al. [37]	32	23.2	87.50
Takada et al. [38]	42	3.0–12.0	88.00 (>50 % reduction in herniation size)
Buttermann [39]	58	36.0	89.60
Demirel et al. [40]	20	3.0	90.00
Kesikburun et al. [41]	40	17.0	90.00
El Barzouhi et al. [42]	95	12.0	92.60
Autio et al. [43]	55	12.0	92.70
Cribb et al. [44]	15	24.0	93.30
Komori et al. [59]	22	6.0	86.30

slowly resorbed, which accumulates the risk of persistent sciatic nerve pain.

Predictors of spontaneous regression of a herniated fragment. The following criteria for spontaneous regression of disc herniation are described in the literature: the type and size of the herniated fragment, MRI parameters, and a transient enlargement in the size of hernia bulging [18, 48]. Ahn et al. [26] believe the integrity of the posterior longitudinal ligament to be the main predictor of herniation regression: the regression rate of subligamentous, transligamentous, and sequestered herniations is 17 %, 48 % and 82 %, respectively. The high incidence of resorption of extruded and sequestered herniations is explained by the fact that when a fragment of the nucleus pulposus penetrates through the fibrous ring and posterior longitudinal ligament into the epidural space and is exposed to the systemic circulation [7, 45]. This causes an autoimmune response, including the infiltration of inflammatory cells and neovascularization. According to Chiu et al. [7], the incidence of regression of protrusion-type herniations is 30.0 %, and that of extrusion and sequestration-type herniations is 76.9 %.

In order to study the predictors of lumbar disc herniation resorption, Rashed et al. [58] performed a system-

atic review and meta-analysis, which included 16 articles describing 360 cases. The mean time period between MRI scans was 11.5 months. The probability of spontaneous regression in protruded, extruded and sequestered disc herniations was 52.5 %, 70.4 % and 93.0 %, respectively ($\chi^2 = 126.01$; $p < 0.001$). Extruded and sequestered herniations also had a considerably higher probability of complete resorption. Other predictors of resorption were a larger initial herniation volume (1,260.16 versus 1,006.71 mm^3; $p < 0.002$), a transligamentous herniation ($\chi^2 = 13.321$; $p < 0.001$), and the third type of disc herniation according to the Komori classification (sequestered herniation with disc fragment migration; $\chi^2 = 14.5132$; $p < 0.001$). The authors also detected similar patterns in qualitative data and confirmed that the improvement in symptoms is associated with the resorption of disc herniation.

The composition of hernial bulging is of great significance in its resorption [61–63]. The presence of parts of the endplate and changes in the Modic classification prevent the infiltration of macrophages and the initiation of neovascularization processes, thereby preventing the onset of spontaneous resorption of disc herniation. Yu et al. [32] highlighted the decisive influence of autoimmune responses in spontaneous resorption of herniation, including inflammatory responses mediated by infiltration of macrophages interacting with the disc, enzymatic degradation reactions, and angiogenesis.

Shan et al. [30] performed a retrospective analysis of 85 cases of disc herniations to study the effect of Modic changes on herniation resorption in two treatment groups: conservative and surgical. In the conservative treatment group, patients with no Modic type changes at the endplate were more likely to experience the disc herniation resorption, as shown by MRI findings. The authors found a reduced herniation volume in 67 % (10 out of 15) of patients in the group with Modic changes compared with 93 % (14 out of 15) in the group without Modic changes (criterion x'; $p = 0.169$). In the surgical treatment group, a histological examination of the disc tissue was conducted, and different proportions of the pulpous nucleus, fibrous ring and hyaline cartilage in the hernial mass were detected in patients with and without Modic changes ($p < 0.05$). The disc herniation tissues in the Modic changes group had more hyaline cartilage and less nucleus pulposus than in the Modic unchanged group, although the content of the fibrous ring was similar. More capillaries were revealed in herniation samples from patients without Modic changes. Macrophages were more widespread in samples from patients without changes in the Modic classification. In this regard, Modic changes in patients with lumbar disc herniations are associated with a cartilaginous herniation, which resolves worse than a more typical hernia. Conservative treatment is less likely to be efficient in patients with lumbar disc herniation with Modic changes. Summarizing the above data, it can be concluded that currently the type and size of herniation, follow-up period, Modic changes, etc. are considered predictors of the resorption of a herniated disc. In our opinion, the existing data on the time, mechanisms and predictors of resorption of lumbar disc herniation are insufficient to improve the treatment strategy for this category of patients. Given that the duration of conservative treatment for herniations varies from 6 weeks to 6 months in patients without neurological deficits, and the duration of herniation resorption is often more than 6 months, it is important to determine which patients should be referred for surgery after 6–8 weeks and which patients can be treated conservatively with the expectation of herniated fragment resorption.

For exemplificatory purposes, here is an example from our practice.

Patient K., 48 years old, applied to the Consulting Unit of the Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Y.L. Tsivyan with complaints of lumbar spine pain (3 points according to VAS) and in the left leg along the posterior surface of the thigh and lower leg (6 points according to VAS) and temporary numbness in the left foot along the outer surface. Motor status: no paresis. According to the medical history, the pain appeared 3 months ago on the background of physical activity. Conservative treatment was almost ineffective. The patient was diagnosed with degenerative spine disease of the lumbar spine, L4–L5 disc herniation, grade 1 polysegmental spondyloarthrosis, compression L5 root syndrome on the left, and low back pain. According to the MRI of the lumbar spine, sequestered herniation of the L4–L5 intervertebral disc with caudal migration of the fragment was detected (Fig. 1). There was no instability in the spinal motion segment, according to the results of functional radiography. The patient was referred for elective surgical treatment. Nevertheless, he consulted a neurosurgeon again only after 8 months to resolve the issue of the appropriateness of surgical treatment. During this period, on his own initiative, he was followed on an outpatient basis and received two courses of conservative treatment, including drug therapy, therapeutic blockades, and physiotherapy procedures. At the time of admission to the hospital, he presented with lumbar spine pain (3 points according to VAS), intermittent moderate pain in his left leg up to the knee (2 points according to VAS), and complete regression of numbness in his left foot. According to the MRI scan of the lumbar spine, complete resorption of the hernial fragment was found (Fig. 2).

Resorption of L4–L5 disc herniation, grade 1 polysegmental spondyloarthrosis, left-sided residual compression L5 root syndrome, and low back pain were established. Intermittent pain in the left leg up to the knee was regarded as a left-sided residual compression L5 root syndrome. Considering the relief of radicular symptoms with resorption of the herniated fragment (according to MRI findings), we decided to refuse surgical treatment of the patient, and he was discharged for

Fig. 1
MRI scan of the lumbar spine of patient K. at initial visit

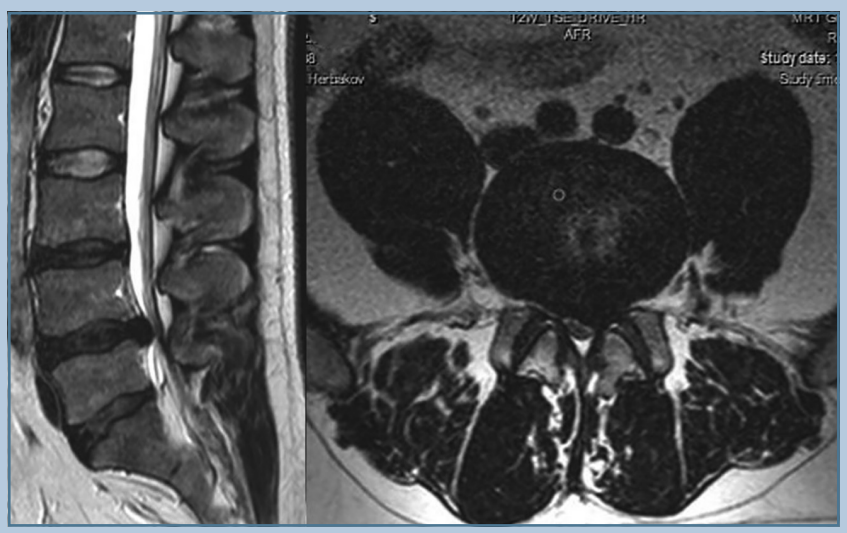

Fig. 2
MRI scan of the lumbar spine of patient K. 9 months after initial visit

outpatient supervision by a neurologist at his place of residence.

Conclusion

Lumbar disc herniations often undergo spontaneous regression, although this is not always the case for all patients. The mechanisms behind this resorption process can vary, and the frequency of resorption may differ depending on the type of herniation. To more accurately determine the timing and predictors of resorption of lumbar disc herniations, analysis of large data sets is required.

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.

References

1. **Gushcha AO, Yusupova AR.** Minimally invasive surgery and modern view on the treatment of degenerative spine diseases. Zhurnal Voprosy Neirokhirurgii Imeni N.N. Burdenko. 2021;85(1):5–9. DOI: 10.17116/neiro2021850115.
2. **Liu C, Ferreira GE, Abdel Shaheed C, Chen Q, Harris IA, Bailey CS, Peul WC, Koes B, Lin CC.** Surgical versus non-surgical treatment for sciatica: systematic review and meta-analysis of randomised controlled trials. BMJ. 2023;381:e070730. DOI: 10.1136/bmj-2022-070730.
3. **Awad JN, Moskovich R.** Lumbar disc herniations: surgical versus non-surgical treatment. Clin Orthop Relat Res. 2006;443:183–197. DOI: 10.1097/01.blo.0000198724.54891.3a.
4. **Kreiner DS, Hwang SW, Easa JE, Resnick DK, Baisden JL, Bess S, Cho CH, DePalma MJ, Dougherty 2nd P, Fernand R, Ghiselli G, Hanna AS, Lamer T, Lisi AJ, Mazanec DJ, Meagher RJ, Nucci RC, Patel RD, Sembrano JN, Sharma AK, Summers JT, Taleghani CK, Tontz WL Jr, Toton JF.** An evidence-based clinical guideline for the diagnosis and treatment of lumbar disc herniation with radiculopathy. Spine J. 2014;14:180–191. DOI: 10.1016/j.spinee.2013.08.003.
5. **Tkachev AM, Epifanov AV, Akarachkova ES, Smirnova AV, Iliushin AV, Archakov DS.** Pathophysiologic aspects of resorption of intervertebral disk hernia. Consilium Medicum. 2019;21(2):59–63. DOI: 10.26442/20751753.2019.2.180147.
6. **Guinto FC Jr, Hashim H, Stumer M.** CT demonstration of disk regression after conservative therapy. AJNR Am J Neuroradiol. 1984;5:632–633.
7. **Chiu CC, Chuang TY, Chang KH, Wu CH, Lin PW, Hsu WY.** The probability of spontaneous regression of lumbar herniated disc: a systematic review. Clin Rehabil. 2015;29:184–195. DOI: 10.1177/0269215514540919.
8. **Komori H, Shinomiya K, Nakai O, Yamaura I, Takeda S, Furuya K.** The natural history of herniated nucleus pulposus with radiculopathy. Spine. 1996;21:225–229. DOI: 10.1097/00007632-199601150-00013.
9. **Martinez-Quinones JV, Aso-Escario J, Consolini F, Arregui-Calvo R.** [Spontaneous regression from intervertebral disc herniation. Propos of a series of 37 cases]. Neurocirugia (Astur). 2010;21:108–117. In Spanish.
10. **Kamanli A, Karaca-Acet G, Kaya A, Koc M, Yildirim H.** Conventional physical therapy with lumbar traction; clinical evaluation and magnetic resonance imaging for lumbar disc herniation. Bratisl Lek Listy. 2010;111:541–544.
11. **Teplick JG, Haskin ME.** Spontaneous regression of herniated nucleus pulposus. AJR Am J Roentgenol. 1985;145:371–375. DOI: 10.2214/ajr.145.2.371.
12. **Modic MT, Ross JS, Obuchowski NA, Browning KH, Cianflocco AJ, Mazanec DJ.** Contrast-enhanced MR imaging in acute lumbar radiculopathy: a pilot study of the natural history. Radiology. 1995;195:429–435. DOI: 10.1148/radiology.195.2.7724762.
13. **Lee J, Kim J, Shin JS, Lee YJ, Kim MR, Koh W, Shin BC, Lee MS, Ha IH.** Long-term course and predictive factors associated with disc resorption in lumbar disc herniation patients. J Neurol Sci. 2017;381:278. DOI: 10.1016/j.jns.2017.08.792.
14. **Jensen TS, Albert HB, Soerensen JS, Manniche C, Leboeuf-Yde C.** Natural course of disc morphology in patients with sciatica: an MRI study using a standardized qualitative classification system. Spine. 2006;31:1605–1612. DOI: 10.1097/01.brs.0000221992.77779.37.
15. **Yukawa Y, Kato F, Matsubara Y, Kajino G, Nakamura S, Nitta H.** Serial magnetic resonance imaging follow-up study of lumbar disc herniation conservatively treated for average 30 months: relation between reduction of herniation and degeneration of disc. J Spinal Disord. 1996;9:251–256.
16. **Shin JS, Lee J, Kim MR, Shin BC, Lee MS, Ha IH.** The long-term course of patients undergoing alternative and integrative therapy for lumbar disc herniation: 3-year results of a prospective observational study. BMJ Open. 2014;4:e005801. DOI: 10.1136/bmjopen-2014-005801.
17. **Ma Z, Yu P, Jiang H, Li X, Qian X, Yu Z, Zhu Y, Liu J.** Conservative treatment for giant lumbar disc herniation: clinical study in 409 cases. Pain Physician. 2021;24:E639–E648.
18. **Iwabuchi M, Murakami K, Ara F, Otani K, Kikuchi SI.** The predictive factors for the resorption of a lumbar disc herniation on plain MRI. Fukushima J Med Sci. 2010;56:91–97. DOI: 10.5387/fms.56.91.
19. **Matsubara Y, Kato F, Mimatsu K, Kajino G, Nakamura S, Nitta H.** Serial changes on MRI in lumbar disc herniations treated conservatively. Neuroradiology. 1995;37:378–383. DOI: 10.1007/BF00588017.
20. **Seo JY, Roh YH, Kim YH, Ha KY.** Three-dimensional analysis of volumetric changes in herniated discs of the lumbar spine: does spontaneous resorption of herniated discs always occur? Eur Spine J. 2016;25:1393–1402. DOI: 10.1007/s00586-014-3587-1.
21. **Kurilina LR, Velichko MN, Sokolova EV, Vorob'yova SS, Len'shina FL.** The spontaneous resorption of hernias of intervertebral disks of lumbar spine. Meditsinskiy al'manakh. 2013;6(30):198–201.
22. **Bozzao A, Gallucci M, Masciocchi C, Aprile I, Barile A, Passariello R.** Lumbar disk herniation: MR imaging assessment of natural history in patients treated without surgery. Radiology. 1992;185:135–141. DOI: 10.1148/radiology.185.1.1523297.
23. **Bush K, Cowan N, Katz DE, Gishen P.** The natural history of sciatica associated with disc pathology. A prospective study with clinical and independent radiologic follow-up. Spine. 1992;17:1205–1212. DOI: 10.1097/00007632-199210000-00013.
24. **Delauche-Cavallier MC, Budet C, Laredo JD, Debie B, Wybier M, Dorfmann H, Ballner I.** Lumbar disc herniation: computed tomography scan changes after conservative treatment of nerve root compression. Spine. 1992;17:927–933. DOI: 10.1097/00007632-199208000-00010.
25. **Ahn SH, Park HW, Byun WM, Ahn MW, Bae JH, Jang SH, Kim YK.** Comparison of clinical outcomes and natural morphologic changes between sequestered and large central extruded disc herniations. Yonsei Med J. 2002;43:283–290. DOI: 10.3349/ymj.2002.43.3.283.
26. **Ahn SH, Ahn MW, Byun WM.** Effect of the transligamentous extension of lumbar disc herniations on their regression and the clinical outcome of sciatica. Spine. 2000;25:475–480. DOI: 10.1097/00007632-200002150-00014.
27. **Fagerlund MK, Thelander U, Friberg S.** Size of lumbar disc hernias measured using computed tomography and related to sciatic symptoms. Acta Radiol. 1990;31:555–558. DOI: 10.1177/0284185190031006.
28. **Gallucci M, Bozzao A, Orlandi B, Manetta R, Brughitta G, Lupattelli L.** Does postcontrast MR enhancement in lumbar disk herniation have prognostic value? J Comput Assist Tomogr. 1995;19:34–38. DOI: 10.1097/00004728-199501000-00006.
29. **Ellenberg MR, Ross ML, Honet JC, Schwartz M, Chodoroff G, Enochs S.** Prospective evaluation of the course of disc herniations in patients with proven radiculopathy. Arch Phys Med Rehabil. 1993;74:3–8. DOI: 10.5555/uri:pii:0003999393903743.
30. **Shan Z, Fan S, Xie Q, Suyou L, Liu J, Wang C, Zhao F.** Spontaneous resorption of lumbar disc herniation is less likely when modic changes are present. Spine. 2014;39:736–744. DOI: 10.1097/BRS.0000000000000259.
31. **Maigne JY, Rime B, Deligne B.** Computed tomographic follow-up study of forty-eight cases of nonoperatively treated lumbar intervertebral disc herniation. Spine. 1992;17:1071–1074. DOI: 10.1097/00007632-199209000-00010.
32. **Yu P, Mao F, Chen J, Ma X, Dai Y, Liu G, Dai F, Liu J.** Characteristics and mechanisms of resorption in lumbar disc herniation. Arthritis Res Ther. 2022;24:205. DOI: 10.1186/s13075-022-02894-8.

33. **Saal JA, Saal JS, Herzog RJ.** The natural history of lumbar intervertebral disc extrusions treated nonoperatively. Spine. 1990;15:683–686. DOI: 10.1097/00007632-199007000-00013.
34. **Ilkko E, Lahde S, Heikkinen ER.** Late CT-findings in non-surgically treated lumbar disc herniations. Eur J Radiol. 1993;16:186–189. DOI: 10.1016/0720-048x(93)90068-x.
35. **Hong SJ, Kim DY, Kim H, Kim S, Shin KM, Kang SS.** Resorption of massive lumbar disc herniation on MRI treated with epidural steroid injection: a retrospective study of 28 cases. Pain Physician. 2016;19:381–388. DOI: 10.36076/ppj/2016.19.381.
36. **Komori H, Okawa A, Haro H, Shinomiya Ki K.** Factors predicting the prognosis of lumbar radiculopathy due to disc herniation. J Orthop Sci. 2002;7:56–61. DOI: 10.1007/s776-002-8416-0.
37. **Benson RT, Tavares SP, Robertson SC, Sharp R, Marshall RW.** Conservatively treated massive prolapsed discs: a 7-year follow-up. Ann R Coll Surg Engl. 2010;92:147–153. DOI: 10.1308/003588410X12518836438840.
38. **Takada E, Takahashi M, Shimada K.** Natural history of lumbar disc hernia with radicular leg pain: Spontaneous MRI changes of the herniated mass and correlation with clinical outcome. J Orthop Surg (Hong Kong) 2001;9:1–7. DOI: 10.1177/230949900100900102.
39. **Buttermann GR.** Lumbar disc herniation regression after successful epidural steroid injection. J Spinal Disord Tech. 2002;15:469–476. DOI: 10.1097/00024720-200212000-00007.
40. **Demirel A, Yorubulut M, Ergun N.** Regression of lumbar disc herniation by physiotherapy. Does non-surgical spinal decompression therapy make difference? Double-blind randomized controlled trial. J Back Musculoskelet Rehabil. 2017;30:1015–1022. DOI: 10.3233/BMR-169581.
41. **Kesikburun B, Eksioglu E, Turan A, Adiguzel E, Kesikburun S, Cakci A.** Spontaneous regression of extruded lumbar disc herniation: correlation with clinical outcome. Pak J Med Sci. 2019;35:974–980. DOI: 10.12669/pjms.35.4.346.
42. **El Barzouhi A, Vleggeert-Lankamp CL, Lycklama a Nijeholt GJ, Van Der Kallen BF, Van Den Hout WB, Jacobs WC, Koes BW, Peul WC.** Magnetic resonance imaging in follow-up assessment of sciatica. N Engl J Med. 2013;368:999–1007. DOI: 10.1056/NEJMoa1209250.
43. **Autio RA, Karppinen J, Niinimaki J, Ojala R, Kurunlahti M, Haapea M, Vanharanta H, Tervonen O.** Determinants of spontaneous resorption of intervertebral disc herniations. Spine. 2006;31:1247–1252. DOI: 10.1097/01.brs.0000217681.83524.4a.
44. **Cribb GL, Jaffray DC, Cassar-Pullicino VN.** Observations on the natural history of massive lumbar disc herniation. J Bone Joint Surg Br. 2007;89:782–784. DOI: 10.1302/0301-620X.89B6.18712.
45. **Macki M, Hernandez-Hermann M, Bydon M, Gokaslan A, McGovern K, Bydon A.** Spontaneous regression of sequestrated lumbar disc herniations: Literature review. Clin Neurol Neurosurg. 2014;120:136–141. DOI: 10.1016/j.clineuro.2014.02.013.
46. **Yang X, Zhang Q, Hao X, Guo X, Wang L.** Spontaneous regression of herniated lumbar discs: Report of one illustrative case and review of the literature. Clin Neurol Neurosurg. 2016;143:86–89. DOI: 10.1016/j.clineuro.2016.02.020.
47. **Zhong M, Liu JT, Jiang H, Mo W, Yu PF, Li XC, Xue RR.** Incidence of spontaneous resorption of lumbar disc herniation: a meta-analysis. Pain Physician. 2017;20:E45–E52. DOI: 10.36076/ppj.2017.1.e45.
48. **Wang Y, Dai G, Jiang L, Liao S.** The incidence of regression after the non-surgical treatment of symptomatic lumbar disc herniation: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2020;21:530. DOI: 10.1186/s12891-020-03548-z.
49. **Santilli V, Beghi E, Finucci S.** Chiropractic manipulation in the treatment of acute back pain and sciatica with disc protrusion: a randomized double-blind clinical trial of active and simulated spinal manipulations. Spine J. 2006;6:131–137. DOI: 10.1016/j.spinee.2005.08.001.
50. **Fan Y, Zhao P.** A randomized, placebo-controlled trial of vertebral mobilization treatment on patients with acute radiculopathy caused by lumbar disc herniation. Physiotherapy (united kingdom). 2015;101(Suppl 1):e1714–e1715. DOI: 10.1016/j.physio.2015.03.129.
51. **Broetz D, Hahn U, Maschke E, Wick W, Kueker W, Weller M.** Lumbar disk prolapse: response to mechanical physiotherapy in the absence of changes in magnetic resonance imaging. Report of 11 cases. NeuroRehabilitation. 2008;23:289–294. DOI: 10.5167/uzh-3870.
52. **Zou T, Liu XY, Wang PC, Chen H, Wu PG, Feng XM, Sun HH.** Incidence of spontaneous resorption of lumbar disc herniation: a meta-analysis. Clin Spine Surg. 2023 Jul 31. Epub ahead of print. DOI: 10.1097/BSD.0000000000001490.
53. **Haro H, Komori H, Kato T, Hara Y, Tagawa M, Shinomiya K, Spengler DM.** Experimental studies on the effects of recombinant human matrix metalloproteinases on herniated disc tissues – how to facilitate the natural resorption process of herniated discs. J Orthop Res. 2005;23:412–419. DOI: 10.1016/j.orthres.2004.08.020.
54. **Kato T, Haro H, Komori H, Shinomiya K.** Sequential dynamics of inflammatory cytokine, angiogenesis inducing factor and matrix degrading enzymes during spontaneous resorption of the herniated disc. J Orthop Res. 2004;22:895–900. DOI: 10.1016/j.orthres.2003.11.008.
55. **Doita M, Kanatani T, Ozaki T, Matsui N, Kurosaka M, Yoshiya S.** Influence of macrophage infiltration of herniated disc tissue on the production of matrix metalloproteinases leading to disc resorption. Spine. 2001;26:1522–1527. DOI: 10.1097/00007632-200107150-00004.
56. **Lama P, Zehra U, Balkovec C, Claireaux HA, Flower L, Harding IJ, Dolan P, Adams MA.** Significance of cartilage endplate within herniated disc tissue. Eur Spine J. 2014;23:1869–1877. DOI: 10.1007/s00586-014-3399-3.
57. **Tkachev AM, Epifanov AV, Akarachkova ES., Smirnova AV, Ilyushin AV, Gordeeva IE.** Resorption of herniated intervertebral disc. Phenomenon of transient increase in size. RMJ. 2022;(4):7–10.
58. **Rashed S, Vassiliou A, Starup-Hansen J, Tsang K.** Systematic review and meta-analysis of predictive factors for spontaneous regression in lumbar disc herniation. J Neurosurg Spine. 2023;39:471–478. DOI: 10.3171/2023.6.SPINE23367.
59. **Komori H, Okawa A, Haro H, Muneta T, Yamamoto H, Shinomiya K.** Contrast-enhanced magnetic resonance imaging in conservative management of lumbar disc herniation. Spine. 1998;23:67–73. DOI: 10.1097/00007632-199801010-00015.
60. **Tkachev AM, Epifanov AV, Akarachkova ES, Smirnova AV, Iljushin AV, Archakov DS.** Inflammation contributes to the spontaneous regression of spinal disc herniation. RMJ. Medical Review. 2019;(7):30–33.
61. **Kuleshov AA, Krupatkin AI, Murav'yova NV.** Spontaneous resorption of intervertebral disc herniations. N.N.Priorov Journal of Traumatology and Orthopedics. 2026;(3):81–89. DOI: 10.32414/0869-8678-2016-3-81-89.
62. **Ozturk B, Gunduz OH, Ozoran K, Bostanoglu S.** Effect of continuous lumbar traction on the size of herniated disc material in lumbar disc herniation. Rheumatol Int. 2006;26:622–626. DOI: 10.1007/s00296-005-0035-x.
63. **Henmi T, Sairyo K, Nakano S, Kanematsu Y, Kajikawa T, Katoh S, Goel VK.** Natural history of extruded lumbar intervertebral disc herniation. J Med Invest. 2002;49:40–43.

Address correspondence to:
Sanginov Abdugafur Jabborovich
Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan,
17 Frunze str., Novosibirsk, 630091, Russia,
Dr.sanginov@gmail.com

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Abdugafur Jabborovich Sanginov, MD, PhD, researcher, Research Department of Neurovertebrology, Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan, 17 Frunze str., Novosibirsk, 630091, Russia, ORCID: 0000-0002-4744-4077, Dr.sanginov@gmail.com;
Ilya Dmitrievich Isakov, junior researcher, Research Department of Neurovertebrology, Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan, 17 Frunze str., Novosibirsk, 630091, Russia, ORCID: 0000-0002-9228-3241, doctorisakov@mail.ru;
Shamil Alfirovich Akhmetyanov, MD, PhD, researcher, Research Department of Neurovertebrology, Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan, 17 Frunze str., Novosibirsk, 630091, Russia, ORCID: 0000-0003-0505-8319, sh.ahmetyanov@yandex.ru;
Aleksey Vladimirovich Peleganchuk, MD, PhD, researcher, Research Department of Neurovertebrology, Head of the Department of Neurosurgery No. 2, Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan, 17 Frunze str., Novosibirsk, 630091, Russia, ORCID: 0000-0002-4588-428X, apeleganchuk@mail.ru.