REPEAT DISCECTOMY AND SPINAL FUSION IN THE TREATMENT OF RECURRENT LUMBAR DISC HERNIATION: SYSTEMATIC REVIEW OF THE LITERATURE

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Objective. To conduct a literature review of studies comparing the treatment of recurrent lumbar disc herniation using discectomy and spinal fusion.
Material and Methods. A comprehensive search across four electronic databases (PubMed, Google Scholar, Science Direct, and Cochrane) was conducted. Studies comparing the outcomes of discectomy and spinal fusion for recurrent lumbar disc herniation were analyzed. Postoperative complications, cost and duration of surgery, length of hospital stay, pain score, and recurrence rate were compared.
Results. Ten studies comprising data of 1066 patients met the inclusion criteria. Discectomy was performed in 620 of them, while 446 patients underwent spinal fusion surgery. Discectomy yielded good results in VAS scores for leg and back pain, but after 3–6 months, there was no significant difference compared to spinal fusion. The recurrence rate for discectomy varied from 7.27 % to 22.91 %, while fusion had 0 % same-level recurrence. Fusion surgery had fewer complications: 1.72–28.00 % (average 11.6 %) vs 5.25–32.73 % (average 15.7 %) for discectomy. However, spinal fusion had longer operation time, greater blood loss and longer hospital stay compared to discectomy.
Conclusion. Discectomy and spinal fusion are effective treatment options for recurrent lumbar disc herniation. At the same time, discectomy demonstrates a high level of initial relief of symptoms and is more cost-effective. However, the risk of recurrence is significant, and the progression of degeneration and instability may result in pain recurrence within a year. Fusion surgery provides stability and eliminates the risk of recurrence, but the main challenge is the cost of surgery. The choice of technique should be based on individual patient factors, and the advantages and disadvantages of each approach should be carefully considered.

Key Words: recurrent herniation, degenerative disc disease, posterior lumbar interbody fusion, discectomy, spinal instability
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Degenerative disc disease and diseases of the lumbar facet joints are widespread among the ageing population and are one of the most common causes of disability. It has been determined that these abnormalities occur in 40 % of adults over the age of 40 and in 80 % of those over the age of 80. Nevertheless, the onset of degeneration is not limited only to middle-aged and elderly people. General clinical signs of the disease include mechanical back pain, radicular signs, symptoms of neurogenic intermittent claudication, limited mobility and poor quality of life.

One of the most common manifestations of degenerative disc disease is a herniated intervertebral disc. It is usually removed by discectomy. There are various types of this procedure: traditional open discectomy, microdiscectomy, endoscopic discectomy and other options [3–5]. Nevertheless, the recurrence of intervertebral disc herniation after discectomy is 10–30 %, and the progression of instability is about 25 % [6, 7]. Factors associated with recurrent intervertebral disc herniation include smoking, young age, overweight, retaining the disc height, etc. [8, 9].

There is consensus on the treatment of a new onset of a herniation of an intervertebral disc using discectomy. Nevertheless, the treatment techniques for recurrent herniation are still controversial. Some authors [10, 11] recommend repeated discectomy due to its low morbidity, shorter hospital stay, low cost and high efficiency. However, this technique is still associated with the risk of recurrent herniation and the instability progression that may lead to deterioration [6–8].

Spinal fusion techniques eliminate the risk of recurrence at the same level and instability of the lumbar spinal motion segment [12, 13]. The arguments against spinal fusion are based on the cost of grafts, long hospital stays, surgery duration and intraoperative blood loss. Despite the potential drawbacks, some

authors stand for the use of spinal fusion techniques in recurrent hernia.

The objective is to conduct an analysis of studies comparing the treatment of recurrent lumbar disc herniation using discectomy and spinal fusion.

Material and Methods

Search strategy. Following the guidelines for writing systematic reviews and meta-analyses (PRISMA), we searched for papers in the databases PubMed/Medline, Cochrane, Google Scholar and Science Direct. We used the PICO search engine. The search was conducted according to the following characteristics:

– patients treated for recurrent herniated intervertebral disc of the same level;
– procedure: discectomy;
– comparison: spinal fusion;
– outcome: any.

After that, the search terminology was enhanced with the use of medical terms (MeSH) to expand keywords. The data search was conducted until 2022.

Inclusion and exclusion criteria. The papers had to meet the following criteria to be included in the study: (1) the study population included patients with recurrent lumbar disc herniation; (2) the study discussed techniques of discectomy or spinal fusion for the treatment of recurrent lumbar disc herniation; (3) the sample size was at least 10 patients; (4) the articles had to be published in English or translated into English.

Papers were excluded from the study if they met any of the following criteria: (1) the study population included only pediatric cases; (2) case reports or technical reports; (3) they were published in a language other than English or without translation into English.

Research selection and data extraction. Two authors independently checked the titles and abstracts of the selected papers to define whether they met inclusion criteria of the review. Then we reviewed the full texts of potentially relevant papers to confirm compliance with the requirements. The data was extracted from each appropriate article using a standard form. The extracted data included the following: (1) demographic profiles of the study population; (2) clinical profiles of the study population; (3) surgical peculiarities, including complications, cost and surgery duration; (4) duration of hospital stay; (5) pain indicators; (6) frequency of recurrence. Any inconsistencies in data extraction were eliminated by consensus.

Results

Initially, 810 papers associated with the research issue were found in the databases. Then we deleted 110 duplicates, and 700 articles remained. Then we analyzed the headings and abstracts and selected 111 articles. Then 50 papers were excluded, as they were not comparative studies, and 61 articles remained. As a result of complete analysis of the papers 51 studies were excluded due to unclear data, lack of comparison with the control group and impossibility to access the full text of the study. The remaining 10 papers (9 retrospective studies and 1 randomized controlled study) met the inclusion and exclusion criteria (Fig.).

Then it was revealed that patients underwent repeated discectomy for recurrent herniated lumbar disc in 620 cases out of those described in the selected studies, and spinal fusion in 446 cases. No other demographic data was provided for analysis.

Clinical outcomes. In the early stages after discectomy, good outcomes were obtained according to the VAS data for leg and back pain. Nevertheless, after 3–6 months, there was no difference between the two techniques. The difference was insignificant (Table 1).

The rate of complications and recurrences. Discectomy was associated with a significantly higher recurrence rate of 7.27–22.91 % (mean 12.80 %), while spinal fusion had no recurrence ($p < 0.05$). Spinal fusion also had fewer complications: 1.72–28.00 % (mean 11.60 %) compared to discectomy: 5.25–32.73 % (mean 15.70 %). Nevertheless, the difference was insignificant with $p = 0.15$. The most frequent complications were ruptures of the dura mater and neurological defects; they were more common during repeated discectomy (Table 2).

Blood loss. Intraoperative blood loss was higher during spinal fusion compared to repeated discectomy: 478 ± 83 ml and 202 ± 33 ml, respectively. However, this difference was significant with $p = 0.048$ (Table 2).

Duration of surgery and length of hospital stay. Spinal fusion was associated with a longer surgery duration compared to repeated discectomy; the mean values were 174 ± 28 min and 93 ± 17 min, respectively ($p < 0.05$). The surgery duration was not specified in one of the studied. The hospital stay was significantly longer with spinal fusion than with discectomy; the mean values were 8 ± 4 and 5 ± 3 days, respectively, $p < 0.05$ (Table 3).

Discussion

The debates over whether discectomy or spinal fusion is preferred have been taking place for a long time. There is no definitive research evidence in favor of one technique over another [14, 15]. Considering the morbid physiology of disc degeneration and herniation, stenosis and instability are resultantly almost unavoidable that indicates the need for stabilization of the lumbar spinal motion segment. Ye.A. Loparev et al. [7] showed that 83.3 % of patients have progressive degeneration after microdiscectomy. Some surgeons believe that discectomy and spinal fusion should be the main options for treating degenerative disc disease [16], since signs of instability may be the most atypical and subject to interpretation. Additionally, discectomy with spinal fusion eliminates the risk of recurrence at the same level. Nevertheless, the risk of herniation at the adjacent level is still a concern. On the contrary, many authors argue that the cost of surgical grafts and potentially longer rehabilitation make spinal fusion a less fitting option [3].

Recurrence. There were no recurrences at the same level after discectomy and spinal fusion in all the studies reviewed [4, 12, 17–23]. It is related to the fact that the techniques of spinal fusion provide

a wide surgical area and the possibility of performing a more complete discectomy. Stabilization of the spinal motion segment eliminates abnormal micromovements that accelerate degeneration and recurrence. On the contrary, the recurrence rate at the same level reaches 22.9% after discectomy without spinal fusion. Many patients who underwent a repeat discectomy will ultimately need a spinal fusion within 4 years. A herniated intervertebral disc is a late sign of degenerative disc disease and a sign of instability. In this regard, discectomy without spinal fusion will probably result in a progressive worsening of instability and symptoms in patients.

Postoperative pain. Postoperative pain is a challenge, especially when performing posterior lumbar interbody fusion due to a herniated intervertebral disc. Nevertheless, many studies have demonstrated that there is no difference in the pain outcome after repeated discectomy or spinal fusion. Postoperative pain in degenerative disease occurs due to disc degeneration, instability, osteoporosis, facet degeneration, paraspinal muscle degeneration and injured end plates. While discectomy and spinal fusion produce comparable satisfaction in the early period, long-term follow-ups show reduced satisfaction in patients after discectomy due to recurrent back pain [4, 12, 25]. Discectomy eliminates discogenic pain to some extent. Nevertheless, other causes of pain (for example, instability) are still neglected. As a result, postoperative pain usually remains with the progression of degeneration and ultimately requires spinal fusion [25, 26]. On the contrary, spinal fusion eliminates the factors of instability in the vertebrae and facets. The issues of muscle degeneration and osteoporosis are not solved properly, so it may cause persistent pain both with and without spinal fusion.

The cost of surgery. This is an essential factor in the management of patients. In addition to the cost of grafts, spinal fusion techniques are associated with longer hospital stays and surgery duration, resulting in a higher total cost. El Shazly et al. [18] conducted a direct cost comparison of discectomy with and without spinal fusion. According to the findings, TLIF costs $1,256.7 more than discectomy alone, while PLIF costs $666.7 more than discectomy alone [4, 18, 24, 27]. Heindel et al. [11] concluded that the high financial expenditures associated with spinal fusion promote the use of repeated discectomy as the main technique for recurrent symptoms after single-level discectomy. All studies analyzed only the cost of surgery, without considering the costs of treating recurrences. The aggregate costs may be insignificant or even reversed in 25–40 % of cases of recurrences during the transition to spinal fusion after microdiscectomy [4, 7].

Blood loss. When performing spinal fusion, blood loss is usually greater than during discectomy, especially when using MIS. Our literature review confirms this. This is because spinal fusion requires more procedures with soft tissues. In addition, it is essential to note that blood loss, although it is almost always greater during spinal fusion, also depends on the experience of a surgeon.

Postoperative hospital stay. A postoperative stay is an essential factor for the patient. Longer hospital stays usually entail higher costs for both patients and hospitals. Psychological stress associated with the hospital atmosphere may depress many patients. Several authors report significantly longer hospital stays with spinal fusion than with discectomy [12, 13].

Limitations of the study. Our study is a brief overview. Although the number of patients in this case is large, the number of studies conducted is insufficient. It is impossible to verify that the groups being compared are similar in age, gender, abnormality level, number of previous surgeries and other risk factors. This information is not available. A randomized controlled study would give more informative results.

Conclusion

Recurrent herniation of intervertebral disc is a difficult complication of discectomy. A repeated discectomy and its options are sometimes vital. They are associated with shorter surgery duration, less blood loss, lower cost

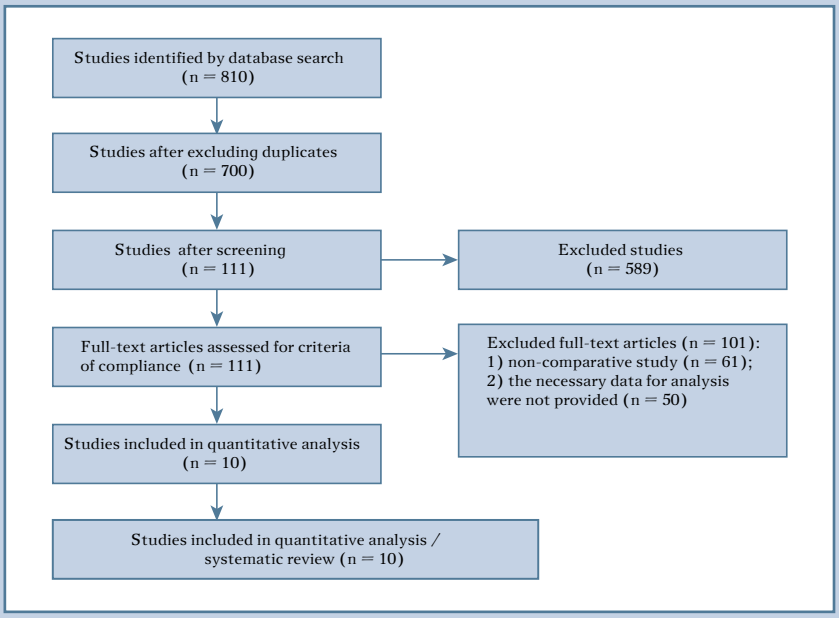

Fig.
Strategy of search and selection of literature data for inclusion in the systematic review

Table 1

Analysis of papers based on indicators "back pain" and "leg pain" according to the VAS after surgery

Sources	Patients, n		Back pain according to VAS, points		Leg pain according to VAS, points	
	Discectomy	Spinal fusion	Discectomy	Spinal fusion	Discectomy	Spinal fusion
Yao et al. [4]	48	26	3.74 ± 1.44	3.77 ± 1.58	5.36 ± 1.41	4.58 ± 1.32
Yao et al. [12]	47	58	1.70 ± 0.72	1.95 ± 0.80	1.64 ± 0.82	1.86 ± 0.67
Ahsan et al. [17]	110	25	2.47 ± 1.93	1.06 ± 1.01	1. 95 ± 1.65	1.50 ± 0.50
Liu et al. [23]	209	192	3.10 ± 1.20	1.40 ± 0.80	1.10 ± 0.08	1.20 ± 0.70
Guan et al. [20]	25	12	1.40 ± 0.80	4.20 ± 3.20	2.60 ± 2.30	2.80 ± 2.60
Zaater et al. [21]	24	15	NA	NA	NA	NA
Kravtsov et al. [13]	94	30	NA	NA	NA	NA
Zhuo et al. [22]	25	40	NA	NA	NA	NA
Fu et al. [19]	23	18	NA	NA	NA	NA
El Shazly et al. [18]	15	30	NA	NA	NA	NA
Total	620	446	–	–	–	–

NA – not available.

Table 2

Recurrences, complications and blood loss during discectomy or spinal fusion (according to the literature)

Sources	Recurrence, %		Complication, %		Blood loss, ml	
	Discectomy	Spinal fusion	Discectomy	Spinal fusion	Discectomy	Spinal fusion
Yao et al. [4]	22.90	0.00	12.50	3.85	NA	148.46 ± 5.36
Yao et al. [12]	10.70	0.00	8.51	1.72	NA	111.38 ± 56.43
Ahsan et al. [17]	7.27	0.00	32.73	28.00	120.00 (85–250)	550.00 (480–650)
Liu et al. [23]	12.00	0.00	5.25	6.25	NA	NA
Guan et al. [20]	12.00	0.00	8.00	17.00	NA	NA
Zaater et al. [21]	12.98	0.00	20.00	26.00	170.80 ± 104.80	546.70 ± 211.60
Kravtsov et al. [13]	7.40	0.00	17.40	2.50	NA	NA
Zhuo et al. [22]	12.00	0.00	13.00	10.00	300.00 ± 45.40	600.00 ± 125.70
Fu et al. [19]	4.30	0.00	13.00	11.10	162.70 ± 106.80	546.70 ± 206.10
El Shazly et al. [18]	13.30	0.00	26.70	10.00	256.70 ± 67.13	660.00 ± 164.97

NA – not available.

and good early patient satisfaction. Nonetheless, the risk of recurrence is still significant. The advantages of spinal fusion are stabilization of the spinal motion segment and the elimination of the risk of recurrence. The main issue is the cost of surgery. Although the discectomy demonstrates good early outcomes, the pain returns within a year due to the progression of degeneration and instability that requires additional stabilization. These factors should be considered before deciding on the preference of one surgical technique over another.

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

Table 3

Duration of surgery and length of hospital stay for discectomy or spinal fusion (according to the literature)

Sources	Surgery duration		Length of hospital stay	
	Discectomy	Spinal fusion	Discectomy	Spinal fusion
Yao et al. [4]	80.00 ± 36.58	146.54 ± 38.07	8.80 ± 2.78	14.96 ± 5.36
Yao et al. [12]	63.38 ± 20.25	140.09 ± 57.07	8.13 ± 2.91	12.74 ± 4.04
Ahsan et al. [17]	95.00 ± 9.00	188.00 ± 16.80	5.00 (4.00–8.00)	8.00 (7.00–14.00)
Liu et al. [23]	NA	NA	NA	NA
Guan et al. [20]	82.70 ± 29.10	229.60 ± 42.10	1.00 ± 0.30	3.70 ± 0.90
Zaater et al. [21]	103.40 ± 24.40	187.50 ± 31.50	2.30 ± 1.30	4.80 ± 1.20
Kravtsov et al. [13]	60.00–130.00	107.00–240.00	4.00–14.00	10.00–21.00
Zhuo et al. [22]	95.00 ± 25.00	150.00 ± 33.00	8.00 ± 2.10	10.00 ± 3.00
Fu et al. [19]	100.90 ± 22.80	166.30 ± 26.70	4.70 ± 1.40	6.20 ± 1.10
El Shazly et al. [18]	125.30 ± 25.32	194.00 ± 25.58	3.40 ± 0.74	3.50 ± 1.13

NA – not available.

References

1. **Park HY, Kim YH, Ha KY, Kim SI, Min HK, Oh IS, Seo JY, Chang DG, Park JT.** Minimally invasive lateral lumbar interbody fusion for clinical adjacent segment pathology: a comparative study with conventional posterior lumbar interbody fusion. Clin Spine Surg. 2019;32:E426–E433. DOI: 10.1097/BSD.0000000000000787.
2. **Niosi CA, Oxland TR.** Degenerative mechanics of the lumbar spine. Spine J. 2004;4 (6 Suppl):202S–208S. DOI: 10.1016/j.spinee.2004.07.013.
3. **Kim CH, Chung CK, Park CS, Choi B, Kim, MJ Park BJ.** Reoperation rate after surgery for lumbar herniated intervertebral disc disease: nationwide cohort study. Spine. 2013;38:581–590. DOI: 10.1097/BRS.0b013e318274f9a7.
4. **Yao Y, Zhang H, Wu J, Liu H, Zhang Z, Tang Y, Zhou Y.** Comparison of three minimally invasive spine surgery methods for revision surgery for recurrent herniation after percutaneous endoscopic lumbar discectomy. World Neurosurg. 2017;100: 641–647.e1. DOI: 10.1016/j.wneu.2017.01.089.
5. **Lutsik AA, Gavrilov IV, Bondarenko GYu, Epifantsev AG, Peganov AI.** New approaches to surgical treatment of recurrent lumbar intervertebral disc herniation. Khirurgiya Pozvonochnika (Russian Journal of Spine Surgery). 2015;12(1):36–45. DOI: 10.14531/ss2015.1.36-45.
6. **Dreval ON, Kuznetsov AV, Chekhonatsky VA, Baskov AV, Chekhonatsky AA, Gorozhanin AV.** Pathogenetic aspects and risk factors for recurrent lumbar disc herniation: literature review. Khirurgiya Pozvonochnika (Russian Journal of Spine Surgery). 2021;18(1):47–52. DOI: 10.14531/ss2021.1.47-52.
7. **Loparev EA, Klimov VS, Evsyukov AV.** Reoperation after herniated disc removal in patients with lumbar degenerative disc disease. Khirurgiya Pozvonochnika (Russian Journal of Spine Surgery). 2017;14(1):51–59. DOI: 10.14531/ss2017.1.51-59.
8. **Konovalov NA, Nazarenko AG, Brinyuk ES, Kaprovoy SV, Beloborodov VA, Stepanov IA.** Risk factors for recurrent lumbar disk herniation. Coluna/Columna, 2022;21:04. DOI: 10.1590/S1808-185120222104263325.
9. **Belykh E, Krutko AV, Baykov ES, Giers MB, Preul MC, Byvaltsev VA.** Preoperative estimation of disc herniation recurrence after microdiscectomy: predictive value of a multivariate model based on radiographic parameters. Spine J. 2017;17:390–400. DOI: 10.1016/j.spinee.2016.10.011.
10. **Benzakour A, Benzakour T.** Lumbar disc herniation: long-term outcomes after mini-open discectomy. Int Orthop. 2019;43:869–874. DOI: 10.1007/s00264-019-04312-2.
11. **Heindel P, Tuchman A, Hsieh PC, Pham MH, D'Oro A, Patel NN, Jakoi AM, Hah R, Liu JC, Buser Z, Wang JC.** Reoperation rates after single-level lumbar discectomy. Spine. 2017;42:E496–E501. DOI: 10.1097/BRS.0000000000001855.
12. **Yao Y, Zhang H, Wu J, Liu H, Zhang Z, Tang Y, Zhou Y.** Minimally invasive transforaminal lumbar interbody fusion versus percutaneous endoscopic lumbar discectomy: revision surgery for recurrent herniation after microendoscopic discectomy. World Neurosurg. 2017;99:89–95. DOI: 10.1016/j.wneu.2016.11.120.
13. **Kravtsov MN, Kruglov IA, Mirzametov SD, Seleznev AS, Alekseyeva NP, Manukovskiy VA, Gaidar BV, Svistov DV.** Evaluation of the effectiveness of surgical methods for the treatment of recurrent lumbar disc herniation: a cohort retrospective study. Khirurgiya Pozvonochnika (Russian Journal of Spine Surgery). 2021;18(2):34–43]. DOI: 10.14531/ss2021.2.34-43.
14. **Guigui P, Ferrero E.** Surgical treatment of degenerative spondylolisthesis. Orthop Traumatol Surg Res. 2017;103(1S):S11–S20. DOI: 10.1016/j.otsr.2016.06.022.
15. **Shepard N, Cho W.** Recurrent lumbar disc herniation: a review. Global Spine J. 2019;9:202–209. DOI: 10.1177/2192568217745063.
16. **Kerezoudis P, Goncalves S, Cesare JD, Alvi MA, Kurian DP, Sebastian AS, Nassr A, Bydon M.** Comparing outcomes of fusion versus repeat discectomy for recurrent lumbar disc herniation: A systematic review and meta-analysis. Clin Neurol Neurosurg. 2018;171:70–78. DOI: 10.1016/j.clineuro.2018.05.023.
17. **Ahsan MK, Hossain MR, Khan MSI, Zaman N, Ahmed N, Montemurro N, Chaurasia B.** Lumbar revision microdiscectomy in patients with recurrent lumbar disc herniation: A single-center prospective series. Surg Neurol Int. 2020;11:404. DOI: 10.25259/SNI_540_2020.
18. **El Shazly A, El Wardany M, Morsi A.** Recurrent lumbar disc herniation: A prospective comparative study of three surgical management procedures. Asian J Neurosurg, 2013;8:139–146. DOI: 10.4103/1793-5482.121685.
19. **Fu TS, Lai PL, Tsai TT, Niu CC, Chen LH, Chen WJ.** Long-term results of disc excision for recurrent lumbar disc herniation with or without posterolateral fusion. Spine. 2005;30:2830–2834. DOI: 10.1097/01.brs.0000190393.15369.94.
20. **Guan J, Ravindra VM, Schmidt MH, Dailey AT, Hood RS, Bisson EF.** Comparing clinical outcomes of repeat discectomy versus fusion for recurrent disc herniation utilizing the N2QOD. J Neurosurg Spine. 2017;26:39–44. DOI: 10.3171/2016.5.SPINE1616.
21. **Zaater A, Azzazi A, Sakr S, Elsayed A.** Recurrent lumbar disk herniation with or without posterolateral fusion. Neurosurg Quart. 2016;26:42–46. DOI: 10.1097/WNQ.0000000000000126.
22. **Zhuo X, Hu J, Li B, Sun H, Chen Y, Hu Z.** [Comparative study of treating recurrent lumbar disc protrusion by three different surgical procedures]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2009;23:1422–1426. In Chinese.
23. **Liu C, Zhou Y.** Percutaneous endoscopic lumbar diskectomy and minimally invasive transforaminal lumbar interbody fusion for recurrent lumbar disk herniation. World Neurosurg. 2017;98:14–20. DOI: 10.1016/j.wneu.2016.10.056.
24. **Wang H, Wang T, Wang Q, Ding W.** Incidence and risk factors of persistent low back pain following posterior decompression and instrumented fusion for lumbar disk herniation. J Pain Res. 2017;10:1019–1025. DOI: 10.2147/JPR.S132862.
25. **Cao P, Chen Z, Zheng Y, Wang Y, Jiang L, Yang Y, Zhuang C, Liang Y, Zheng T, Gong Y, Zhang X, Wu W, Qiu S.** Comparison of simple discectomy and instrumented posterior lumbar interbody fusion for treatment of lumbar disc herniation combined with Modic endplate changes. Chin Med J (Engl). 2014;127:2789–2794. DOI: 10.3760/cma.j.issn.0366-6999.20132087.
26. **Parker SL, Mendenhall SK, Godil SS, Sivasubramanian P, Cahill K, Ziewacz J, McGirt MJ.** Incidence of low back pain after lumbar discectomy for herniated disc and its effect on patient-reported outcomes. Clin Orthop Relat Res. 2015;473:1988–1999. DOI: 10.1007/s11999-015-4193-1.
27. **Selva-Sevilla C, Ferrara P, Geronimo-Pardo M.** Cost-utility analysis for recurrent lumbar disc herniation: conservative treatment versus discectomy versus discectomy with fusion. Clin Spine Surg. 2019;32:E228–E234. DOI: 10.1097/BSD.0000000000000797.

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