Int J Clin Exp Med 2015;8(5):7261-7269
www.ijcem.com /ISSN:1940-5901/IJCEM0004641

Original Article

Sequestrectomy versus microdiscectomy in the treatment of lumbar disc herniation: a meta-analysis

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Received December 9, 2014, Accepted February 6, 2015; Epub May 15, 2015; Published May 30, 2015

Abstract: Background: It remains unknown whether sequestrectomy provides better outcomes than microdiscectomy for lumbar herniated discs (LHD). Therefore, we conducted a meta-analysis to compare the effects of sequestrectomy and microdiscectomy in the treatment of patients with LHD. Methods: Clinical trials published in PubMed, Embase, and Web of Science were systematically reviewed to compare the effects of sequestrectomy and microdiscectomy for LHD. Outcomes included reherniation rate, duration of surgery, length of hospital stay, and postoperative Visual Analog Scale (VAS) scales for leg and back pains. A fixed-effects or random-effects were used to pool the estimates, depending on the heterogeneity among the studies. Results: Five cohorts and two randomized controlled trials (RCTs) with a total of 929 patients met the inclusion criteria and were included in this meta-analysis. All patients underwent sequestrectomy or microdiscectomy. Pooled estimates showed that patients treated with sequestrectomy had comparable effects in reherniation rate (RR = 1.36, 95% CI: 0.81, 2.27; P = 0.240), length of hospital stay (WMD = -0.22 days, 95% CI: -0.45, 0.01; P = 0.060), and postoperative VAS scales for leg pain (WMD = 0.53, 95% CI: -1.54, 2.60; P = 0.617) or back pain (WMD = 0.18, 95% CI: -1.64, 2.00; P = 0.846), but had a shorter duration of surgery (WMD = -6.97 minutes, 95% CI: -12.15, -1.78; P = 0.008), when compared with those treated with microdiscectomy. Conclusion: Based on the current evidence, sequestrectomy significantly reduced the operational time, but had similar effects on reherniation rate, length of hospital stay, and postoperative VAS scales for leg and back pains, when compared with microdiscectomy. Further well-designed randomized controlled studies are needed to identify our findings.

Keywords: Sequestrectomy, microdiscectomy, lumbar herniated discs, meta-analysis

Introduction

Lumbar disc herniation (LDH) is the main cause of discogenic low back pain (LBP) in patients between 24 and 45 years of age. Previous studies indicated that about 60%-80% of patients would suffer back pain during their lifetime [1], and 2%-10% of them need the surgical treatment for sciatica [2].

There are two main methods for intervertebral disc surgery. One is the lumbar discectomy which involved an extensive removal of lamina and the offending ruptured disc, which was first introduced by Mixter and Barr in 1934 [3]. The other is microdiscectomy which involved partial resection of bony structure, the facet joints, and the ligamentum flavum, followed by the removal of intervertebral disc material, which was first reported by Yasargil and Caspar in 1977 [4]. This surgical technique became the gold standard procedure for patients with symptomatic LDP whose radiculopathy has not been improved with a conservative measure [5].

There is evidence suggesting that the degenerative disc material left in the intervertebral space would result in a high risk of reherniation, therefore causing the nerve root compression and recurrence of symptoms. In 1978, Williams reported a conservative surgical approach to the virgin herniated lumbar disc. He recommended making only blunt perforation in the fibrous ring without incision and without curettage of the disc space [6]. Since the introduction of this approach, several clinical trials have indicated promising results without an increased risk of reherniations [7, 8].

There were numerous studies that compared the effects of sequestrectomy and microdiscectomy in the treatment of LDH patients; however, their results remained inconsistency. In a prospective cohort, Fakouri B, et al. [9] reported that the reheniation rate in the sequestrectomy group was slightly lower than that in the microdiscectomy group (4.17% *VS* 5.56, *P* = 1.00). However, their results contradicted with the findings from the study conducted by Kotil K, et al. [10], in which the reherniation rate was three times likely in sequestrectomy group (4.1%) than in microdiscectomy group (1.5%). In order to identify whether sequestrectomy provides better outcomes than microdiscectomy for LDH, we conducted this meta-analysis of relative studies to compare the effects of sequestrectomy versus microdiscectomy on reherniation rate and other important clinical outcomes in patients with LDH.

Materials and methods

Literature search to identify related studies

A comprehensive literature search in multiple electronic databases, including PubMed, Embase and Web of Science, from their inception through October 11, 2014 was performed. The search algorithm was generated as following: ("lumbosacral region" [MeSH Terms] OR ("lumbosacral" [All Fields] AND "region" [All Fields]) OR "lumbosacral region" [All Fields] OR "lumbar" [All Fields]) AND disc [All Fields] AND ("hernia" [MeSH Terms] OR "hernia" [All Fields] OR "herniation" [All Fields]) AND microdiscectomy [All Fields] AND sequestrectomy [All Fields]. No language limitation was imposed in the literature search. The reference lists of included studies were also manually checked until no potentially eligible studies could be found. Unpublished data and conference proceedings were not included. When a trial appeared on several publications, we only included the one with most information or longest follow-ups.

Study selection and inclusion criteria

Endnote bibliographic software was used to create an electronic library of citations which indentified in the database searches. PubMed, Embase and Web of Science were conducted using the Endnote, and duplicate publications were deleted. Two independent reviewers (Teng Huang and Zhi Tian) first screened titles/abstracts, and then reviewed the full-texts. Studies met the following inclusive criteria were included for this meta-analysis: (1) studies with design of randomized controlled trials (RCTs), or cohorts; (2) adult patients with magnetic resonance imaging (MRI) confirmed disc herniation, corresponding to clinical signs and symptoms; (3) patients undergoing sequestrectomy, or microdiscetomy; (4) patients with unilateral single-level disc herniation between L2 and S1; (5) patients had no previous operations on the spine and no emergency operations; (6) the study presented the data of clinical outcomes, including reherniation rate, length of hospital stay, duration of surgery, the postoperative visual analog scales (VAS) for leg pain and back pains.

Data extraction

Two investigators (Teng Huang and Zhi Tian) independently performed the data extraction according to the Preferred Reporting Items for systematic Reviews and Meta-analysis (PRISMA) statement [11]. For eligible studies, the following data were collected: first author, year of publication, trial design, number of patients (sequestrectomy/microdiscetomy), and median age of patients, gender, the reherniation rate, and other important clinical outcome data. A standardized Excel file was established to collate the data. Disagreements between reviewers were resolved by consensus.

Quality assessment

For randomized controlled trials, the methodological quality was assessed using the Jadad scale [12]. The scale consists of three items, including randomization (0-2 points), blinding (0-2 points), and dropouts and withdrawals (0-1 point) in report of a randomized controlled study. The scale ranges from 0 to 5 points. Studies with a score ≥ 3 points are said to be of high quality [13].

For nonrandomized studies, the methodological quality was assessed with a modified Newcastle-Ottawa scale [14]. The scale evaluates three criteria, which include patient selection, comparability of the sequestrectomy and microdiscectomy, and outcome assessment. The quality scale ranges from 0 to 9 points.

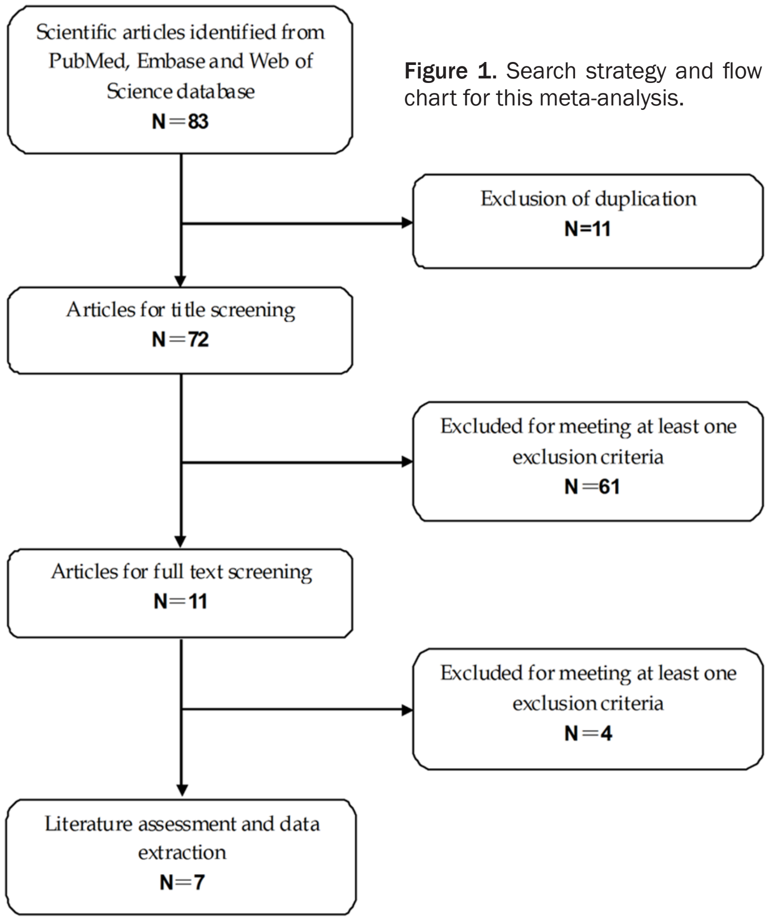

Figure 1. Search strategy and flow chart for this meta-analysis.

Articles with a score ≥ 6 points are considered as high quality.

Statistical analyses

We compared the effects of sequestrectomy and microdiscectomy based on data from the included studies. The reherniation rate is treated as dichotomous variable, and it is expressed as risk ratio (RR) with 95% confidence intervals (CIs); Duration of surgery, length of hospital stay, and VAS scale of pains, are treated as continuous variables, thus they are expressed as weighted mean difference (WMD) with 95% CIs. I^2 statistics was used to assess the heterogeneity between included studies, in which 25-50%, 50-75%, or > 75% were interpreted as low, moderate, or high heterogeneity, respectively [15]. Pooled estimates were calculated using a fixed-effects model (Mantel-Haenszel method) [16] or random-effects model (DerSimonian-Laird method) [17], according to the heterogeneity among the studies. Since the number of included studies was less than 10, the assessment of publication bias was not performed. A *P* value < 0.05 was judged as statistically significant, except where otherwise specified. All analyses were performed with STATA, version 12.0 (Stata Corporation, College Station, TX, USA).

Results

Literature search and selection of studies

The initial literature search yielded 83 potentially relevant articles. After excluding the 11 duplicate publications, 65 were excluded for various reasons (review articles, case reports, abstracts, or not relevant with our topics). Eventually, five prospective/retrospective cohorts and two RCTs with 929 patients met the inclusion criteria and were included in this meta-analysis (**Figure 1**).

Study characteristics and quality assessment

The baseline characteristics of seven included studies in the meta-analysis are given in **Table 1**. These studies were published from 2005 to 2014. All the selected trials presented 929 patients, with 402 undergoing sequestrectomy and 527 undergoing microdiscectomy. These trials were carried out in Canada, the UK, Germany, and Turkey. All the trials included comparable characteristics of patients between the sequestrectomy group and microdiscectomy group, except two trials, one of which included a higher proportion of smokers in the microdiscectomy group [18]. And the other one enrolled older patients in the sequestrectomy group than that in the microdiscectomy group [19]. The most frequent levels of operation were L4-5 and L5-S1 accounting for 77.5% of patients in the sequestrectomy group and 81.0% of patients in the microdiscectomy group. The median NOS score of five cohort studies was 8 points, and median Jadad score of two RCTs was 4 points.

Table 1. Baseline Characteristics of the included studies

Author	Treatment regimen	No. of patients	Median age (range)	Male/ female	Follow-up (months)	Study design	Level of evidence
Fakouri B [9]	Sequestrectomy/free fragmentectomy	24	37.2 (SD: 12.9)	15/9	33.4 (SD: 7.1)	Retrospective cohort	8 (NOS scale)
	Conventional microdiscectomy	72	38.4 (SD: 8.4)	46/26	32.4 (SD: 5.7)		
Kotil K [10]	Sequestrectomy	40	39.9 (22-69)	19/21	49-68	Prospective cohort	8 (NOS scale)
	Microdiscectomy	85	41.1 (18-74)	37/48	49-68		
Shamji MF [18]	Sequestrectomy	74	44.4 ± 1.4	47/27	72 (48-132)	Retrospective cohort	8 (NOS scale)
	Microdiscectomy	98	44.1 ± 1.7	62/36	72 (48-132)		
Kast E [19]	Sequestrectomy	80	45.4 (24-65)	47/33	42	Prospective non-randomized controlled study	8 (NOS scale)
	Microdiscectomy	88	41.9 (29-63)	51/37	42		
Thomé C [20]	Sequestrectomy	42	42 ± 9	24/18	18	Randomized prospective study	4 (Jadad scale)
	Microdiscectomy	42	40 ± 10	23/19	18		
Schick U [21]	Sequestrectomy	100	51.76 ± 13.9	64/36	34.1	Prospective comparative study	8 (NOS scale)
	Microdiscectomy	100	49.52 ± 13.7	50/50	35.4		
Barth M [22]	Sequestrectomy	42	40.8 ± 8.7	22/20	18-29	Randomized prospective study	4 (Jadad scale)
	Microdiscectomy	42	41.3 ± 9.9	23/19	18-29		

M indicates microdiscectomy; S, sequestrectomy; SD, standard deviation.

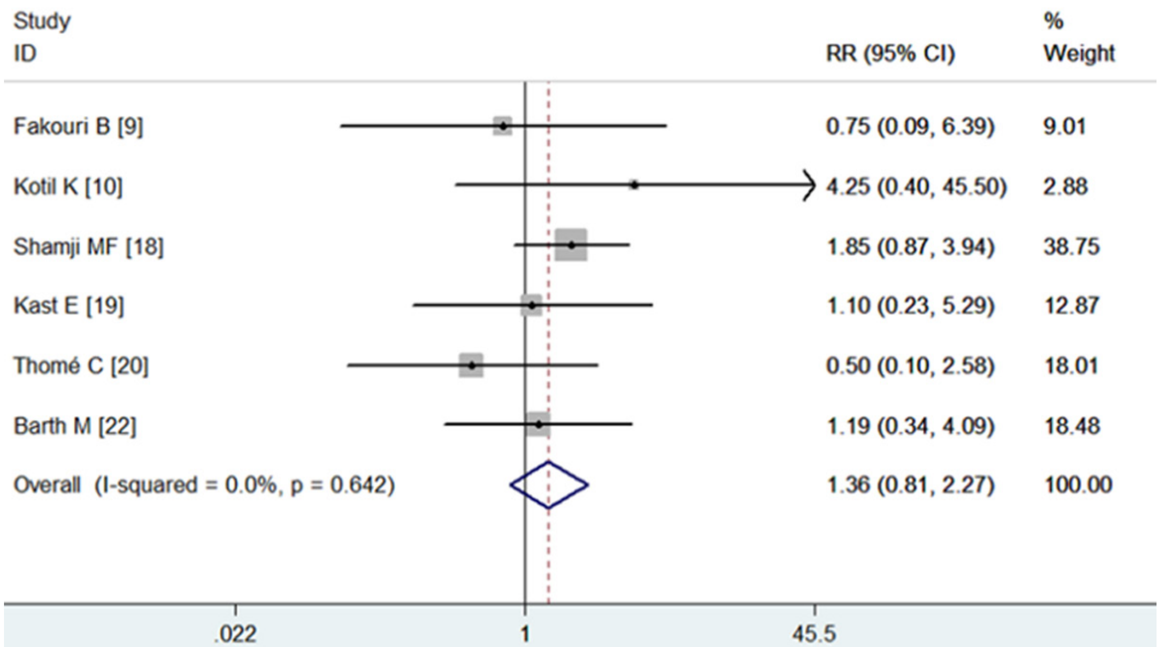

Figure 2. Comparison of rehenernation rate between sequestrectomy and microdiscectomy for patients with LDH.

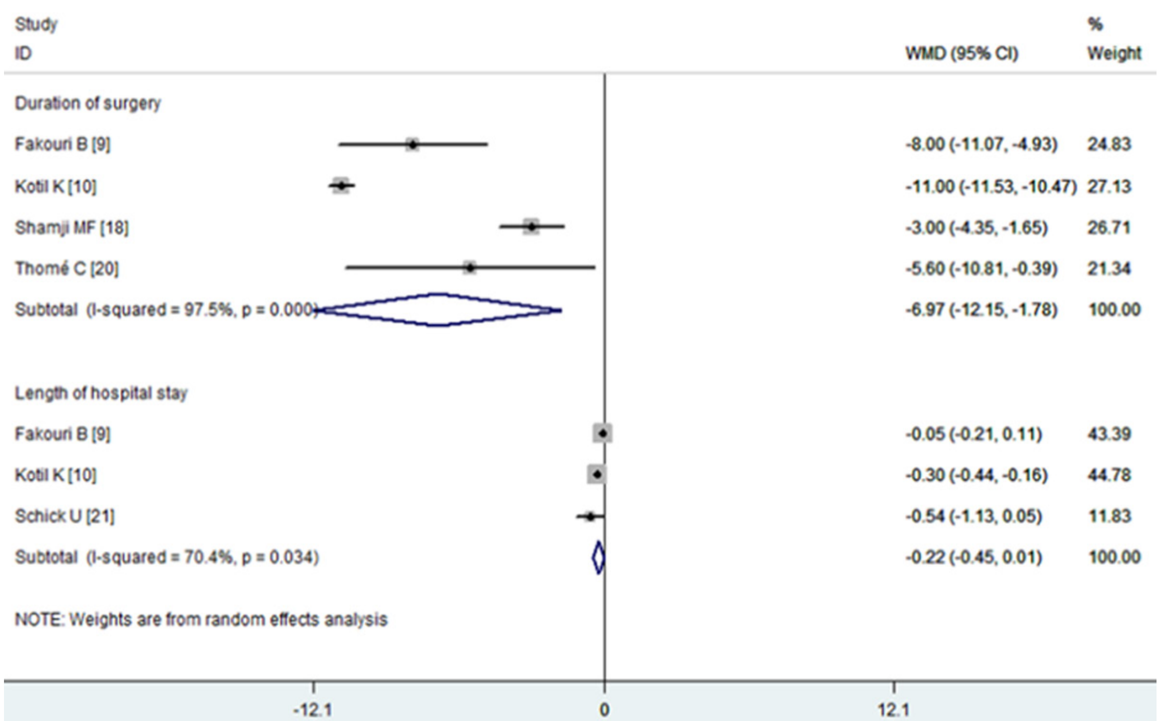

Figure 3. Comparison of duration of surgery and length of hospital stay between sequestrectomy and microdiscectomy for patients with LDH.

Reherniation rate

Reherniation rate ranged from 4.2% to 12.5% in the sequestrectomy group, and 1.2% to 10.5% in the microdiscectomy group. The aggregated results of these included studies showed that the reherniation rate between the patients treated with sequestrectomy and

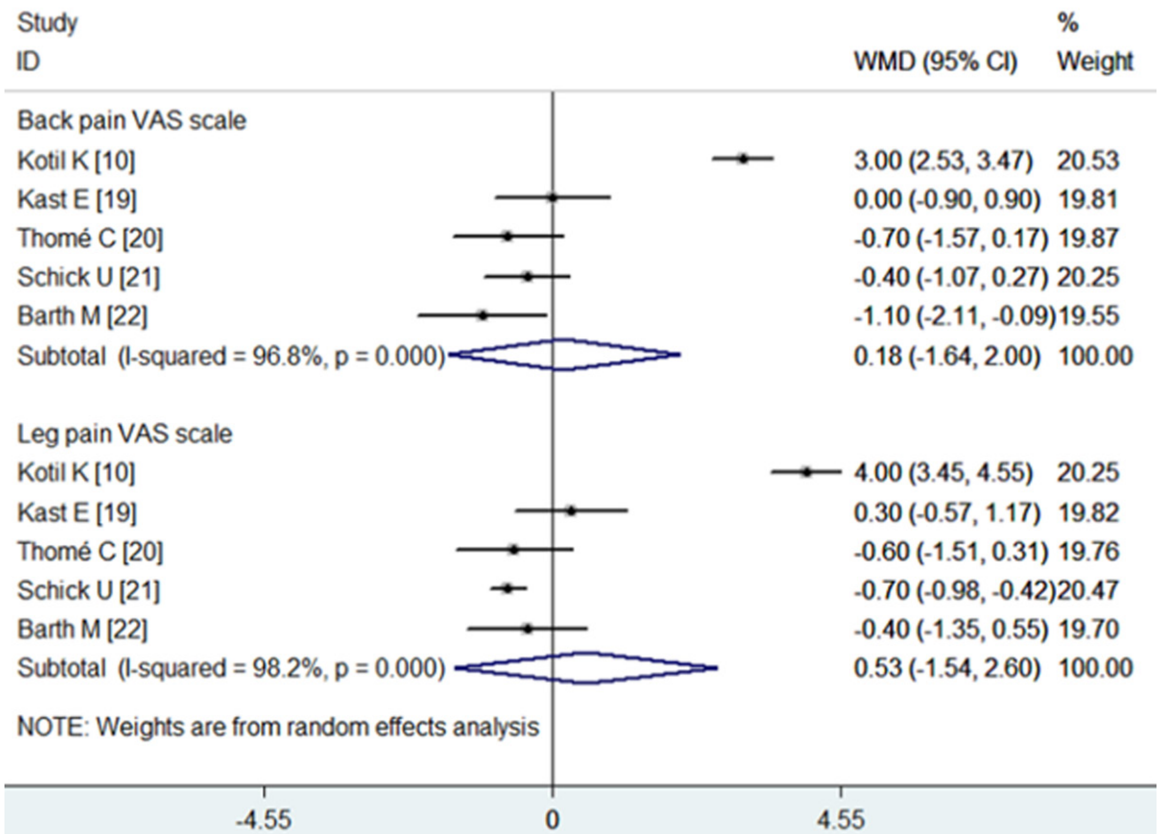

Figure 4. Comparison of postoperative VAS values for leg and back pains between sequestrectomy and microdiscectomy for patients with LDH.

those with microdiscectomy was not significantly difference (RR = 1.36, 95% CI: 0.81, 2.27; P = 0.240) (**Figure 2**). The test for heterogeneity was not statistically significant (I^2 = 0.0%, P = 0.642).

Duration of surgery and length of hospital stay

Four studies reported the data of duration of surgery [9, 10, 18, 20]. All of them showed a shorter duration of surgery in the patients treated with sequestrectomy. Pooled the data using a random-effect model suggest that sequestrectomy had better effect on duration of surgery when compared with microdiscectomy (WMD = -6.97 minutes, 95% CI: -12.15, -1.78; P = 0.008) (**Figure 3**). There was significant heterogeneity between the included studies (I^2 = 97.5%, P = 0.000).

Three studies presented the data of length of hospital stay [9, 10, 21]. All the studies showed that patients treated with sequestrectomy had a shorter length of hospital stay compared with those treated with microdiscectomy. When the data were aggregated, sequestrectomy had similar effect on length of hospital stay compared with microdiscectomy (WMD = -0.22 days, 95% CI: -0.45, 0.01; P = 0.060) (**Figure 3**). There was significant heterogeneity between the included studies (I^2 = 70.4%, P = 0.034).

Leg pain VAS scale and back pain VAS scale

Five studies reported the data of postoperative VAS scales for leg pain and back pain [10, 19-22]. The pooled estimates indicated that there was no significantly difference in postoperative VAS scales for leg pain (WMD = 0.53, 95% CI: -1.54, 2.60; P = 0.617) or back pain (WMD = 0.18, 95% CI: -1.64, 2.00; P = 0.846) between patients in sequestrectomy group and in microdiscectomy group. There was evidence of significant heterogeneity for these outcomes (For leg pain VAS scale: I^2 = 98.2%, P = 0.000; for leg pain VAS scale: I^2 = 96.8%, P = 0.000) (**Figure 4**).

Discussion

The major purpose of this meta-analysis was to compare the effects of sequestrectomy versus microdiscectomy in LDH patients. This meta-analysis based on seven trials showed that there was no statistically significant difference in reherniation rate between sequestrectomy group and microdiscectomy group. However, sequestrectomy had a shorter surgical time, as compared with microdiscectomy. Additionally, the postoperative VAS scales for leg pain and back pain were not significant difference between these two groups. This study indicated the beneficial effects of sequestrectomy in the shorter operating time compared with microdiscectomy. Whereas, with regard to the reherniation rate, these two surgical techniques were comparable.

Reherniation is the most important complication of lumbar disc surgery. The commonly accepted reasons for it include disc degeneration, stress on the facet capsule, and incomplete removal of the degenerated disc material. Among these reasons, degenerated material left in the intervertebral space are said to result in the nerve root compression, clinical deterioration, and reherniation. Therefore, the disc material is often substantially excised from the intervertebral space when performing the microdiscectomy procedure. However, so far there is no solid scientific evidence to support these statements mentioned above, thus further studies are needed to identify these assumes.

According to our meta-analysis, we found that the reherniation rates did not differ significantly between the sequestrectomy group and microdiscectomy group. However, Kotil K, et al [10] in their prospective trial reported an opposite result. In that study, the reherniation rate after 5 years follow-up was higher in the sequestrectomy group (4.1%) than in the microdiscectomy group (1.5%), and this difference was statistically significant ($P < 0.05$). Similarly, Barth M, et al. [22] found the highest reported reherniation rate among the included studies, with 12.5% in the sequestrectomy group and 10.5% in the microdiscectomy group. However, this difference was not statistically significant ($P = 1.0$).

On the contrary, Fakouri B, et al. [9] reported a slightly lower reherniation rate in the sequestrectomy group (4.17%) than in the microdiscectomy group (5.56%), even the difference was not significant ($P = 1.00$). The authors contributed the low rate of reherniation in sequestrectomy group to the strict inclusion criteria, in which only patients with annular defect less than 5mm and without significant bulging of the disc were eligible for the sequestrectomy [9]. Despite the true effect of these two surgical techniques remains controversial in the reherniation rate, we suggest that patients for sequestrectomy treatment should be strictly selected according to the competence of the annulus/posterior longitudinal ligament, then we would obtained a decreased reherniation rate.

The VAS scales for both sequestrectomy and microdiscectomy groups had significantly been improved postoperatively in these included studies. However, our pooled results suggest that there was no significant difference in the postoperative VAS scales between the two groups.

The duration of surgery among these studies varied greatly, which ranged from 24 to 117 minutes in the sequestrectomy group, and 32 to 120 minutes in the microdiscectomy group. Notably, all of these studies showed a shorter operating time in the sequestrectomy group than in the microdiscectomy group. And our results indicated a shorter duration of 6.97 minutes would be achieved when patients chose the treatment of sequestrectomy rather than microdiscectomy. The length of hospital stay in these included studies ranged from 0.9 to 6.4 days in the sequestrectomy group, and 1.17 to 6.94 days in the microdiscectomy group. Despite all of these trials demonstrated that patients treated with sequestrectomy had a shorter hospital stay than microdiscectomy, this difference was not significant.

There were several limitations in our meta-analysis that should be considered when interpreting our results. First, our meta-analysis was conducted based on only seven studies, and some of them had relative small sample size. Compared with large sample trials, smaller trials is more likely to result in an overestimation of the treatment effect. Second, there were several differences between the included trials, including the inclusion criteria, study design, follow-up periods. All these factors would result in heterogeneity, and have a potential impact on the final results. Third, due to the limited number of included trials, the assessment of publication bias was not performed. Thus, we could not exclude the possibility that the missing or unpublished data would lead to bias in effect size. Finally, this meta-analysis was conducted based on data extracted from publications rather than individual patients, which may lead to an overestimation of the treatment effects [23].

In conclusion, this study indicated that sequestrectomy had comparable reherniation rate and other clinical outcomes, including length of hospital stay, and VAS scales for leg and back pains compared with microdiscectomy. However, patients treated with sequestrectomy had a shorter operating time than those treated with microdiscectomy. Considering the limitations in this study, more prospective well-designed, randomized-controlled trials are needed to indentify our findings.

Disclosure of conflict of interest

None.

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