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REVIEW ARTICLE

Microendoscopic discectomy versus open discectomy for lumbar disc herniation: a meta-analysis

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Abstract
Purpose To compare the outcomes of microendoscopic discectomy and open discectomy for patients with lumbar disc herniation.
Methods An extensive search of studies was performed in PubMed, Medline, Embase, Cochrane library and Google Scholar. The following outcome measures were extracted: visual analogue scale (VAS), Oswestry disability index (ODI), complication, operation time, blood loss and length of hospital stay. Data analysis was conducted with RevMan 5.0.
Results Five randomized controlled trials involving 501 patients were included in this meta-analysis. The pooled analysis showed that there was no significant difference in the VAS, ODI or complication between the two groups. However, compared with the open discectomy, the microendoscopic discectomy was associated with less blood loss [WMD = −151.01 (−288.22, −13.80), $P = 0.03$], shorter length of hospital stay [WMD = −69.33 (−110.39, −28.28), $P = 0.0009$], and longer operation time [WMD = 18.80 (7.83, 29.76), $P = 0.0008$].
Conclusions Microendoscopic discectomy, which requires a demanding learning curve, may be a safe and effective alternative to conventional open discectomy for patients with lumbar disc herniation.

Keywords Discectomy · Endoscopic · Microendoscopic · Lumbar disc herniation

Introduction

Lumbar disc herniation is a common pathological change of the lumbar spine [1, 2]. Surgical discectomy is indicated for the patients who were nonresponsive to conservative management (at least 6 weeks) or had progressive neurological impairment [1–3]. The surgical approaches include open discectomy, microdiscectomy, microendoscopic discectomy and percutaneous endoscopic discectomy [4].

Conventional open discectomy (OD) has been regarded as a “standard” surgical fashion [4, 5], which was firstly described by Mixter and Barr in 1934 [6]. This technique could relieve patients’ pain and improve their nerve function. However, the greatest problem is the surgical trauma of paravertebral muscles, which is related with the failed back surgery syndrome [7, 8]. Besides, some research noticed that the long-term satisfaction of this surgical approach would obviously deteriorate due to surgical scarring and adhesion [9, 10].

Foley and Smith introduced the microendoscopic discectomy (MED) technique in 1997 [11] and reported satisfactory clinical outcomes of 100 patients who underwent this technique in the following year [12]. This minimally invasive technique was performed by a transmuscular approach with advanced optics. Some reports compared intraoperative electromyography [13] and postoperative MRI [14] in the patients who were treated with the two techniques. These results revealed that the MED approach was superior to the OD approach in muscle and soft tissue damage. In addition, the MED technique markedly reduced postoperative pain of patients and facilitated their recovery [11, 15, 16].

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Most reports indicated the MED approach could reduce the surgical trauma, length of hospital stay and time to return to work/activity [9, 15, 17–21]. However, the safety of this approach has been questioned due to the small working space which might make it difficult to avoid the damage to dural and neural structures. Some studies reported that there were more dural tear, root injury and recurrent herniation in the microendoscopic group compared with the open group [21, 22]. Teli et al. [22] also noticed the length of hospital stay was longer in the microendoscopic group than in the open group. As a result, a meta-analysis of relevant studies is necessary to establish the current state of evidence. This study aims to compare the outcomes of the microendoscopic discectomy and the open discectomy.

Materials and methods

Inclusion criteria

Randomized controlled trials (RCTs) on treatment of lumbar disc herniation were reviewed. The criteria for inclusion of an article were: (1) patients were 18 years old or older; (2) patients were diagnosed with symptomatic lumbar disc herniation; (3) interventions: microendoscopic discectomy and open discectomy; (4) the study reported at least one desirable outcome; (5) all included patients were followed up at least 1 year after surgery; (6) patients were excluded if they were associated with intervertebral instability, spondylolisthesis, underwent intervertebral fusion, infection, malignancy, deformity, rheumatoid arthritis, previous surgery of lumbar spine, cauda equina symptoms, cervical or lumbar spine stenosis of any etiology.

Search strategy

A computerized search of RCT published between 1997 and September 2015 was performed in PubMed, Medline, Embase and Cochrane Central Register of Controlled Trials (CENTRAL) (Wiley Online Library) and Google Scholar. The following key words were used for search: "microendoscopic", "endoscopic", "discectomy", "open", "conventional" and "lumbar disc herniation" with various combinations of the operators "AND", "NOT", and "OR". We restricted the language to English.

Selection of studies

Two reviewers (JLH and SWX) independently reviewed all subjects, abstracts, reference lists and the full text of articles that were potentially eligible based on abstract review. Then the eligible trials were selected according to the inclusion criteria. When consensus could not be reached, a third reviewer (ZCY) was consulted to resolve the disagreement.

Data extraction

Two reviewers (JLH and SWX) extracted data independently. The data extracted included the following categories: patients (selection criteria, age, sex and follow-up time), treatments (intervention details) and clinical outcomes: visual analogue scale (VAS), Oswestry disability index (ODI), complication, operation time, blood loss and length of hospital stay.

Assessment of study quality

Two reviewers (JLH and ZJW) independently assessed the quality of each study using the 12 criteria and instructions recommended by the Cochrane Back Review Group (CBRG) [23], and met to reach consensus. The items were scored with 'yes', 'no', or 'unsure'. As before, if consensus could not be reached, a third reviewer (ZCY) was consulted to resolve the disagreement. Studies were categorized as having a "low risk of bias" when at least six criteria, and the study had no serious methodological flaws. Studies with serious flaws or those in which fewer than six of the criteria were met should be rated as having a "high risk of bias".

Data analysis

Data analysis was performed with RevMan 5.0 (the Cochrane Collaboration). Two reviewers (JLH and SWX)

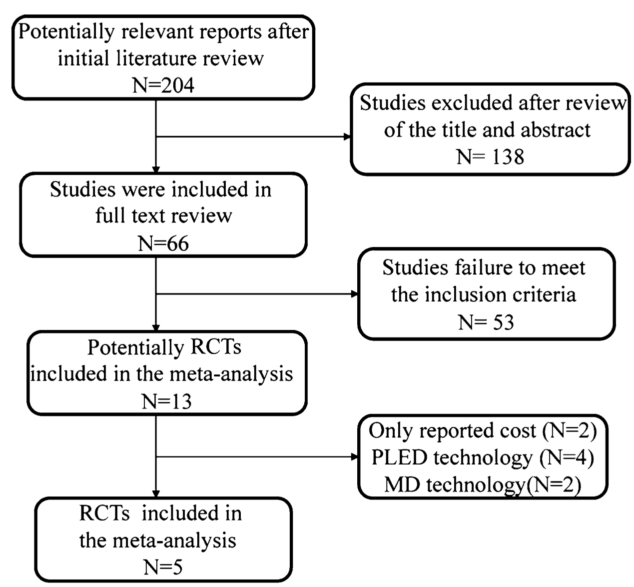

Fig. 1 The procedure of the literature search. *PELD* percutaneous endoscopic lumbar discectomy, *MD* microdiscectomy

Table 1 The baseline characteristics and outcomes of each study

Study	Country	Surgical approach	Patient (male/female)	Age (years)	Level of disc herniation	Follow-up (months)	Outcome
Teli [22]	Italy	MED	70 (45/25)	39 ± 12	L3/4:1, L4/5:29, L5/S1:40	26 ± 2	VAS, ODI, SF-36, surgical incision scar, operation time, hospital stays, recurrence time, complication, cost
		OD	70 (46/24)	39 ± 12	L3/4:1, L4/5:28, L5/S1:41	26 ± 2	
Righesso [21]	Brazil	MED	21 (10/11)	42.0 ± 10.7	L2/3:1, L3/4:1 L4/5:11, L5/S1:8	36.2 (25–56)	VAS, ODI, RTWT, neurological status, incision size, operation time, hospital stays, blood loss, complication
		OD	19 (13/6)	46.0 ± 12.4	L4/5:11, L5/S1:8	36.0 (24–46)	
Garg [19]	India	MED	55 (36/19)	37 ± 8	L4/5:31, L5/S1:24	12–18	ODI, operation time, hospital stays, blood loss, complication, weight of removed disc
		OD	57 (44/13)	38 ± 6	L4/5:41, L5/S1:16	12–18	
Hussein [9]	Egypt	MED	95	30.9 (18–54)	L2/3:1, L3/4:5 L4/5:49, L5/S1:40	104.2	ODI, NRS, operative time, blood loss, postoperative analgesics, hospital stay, RTWT, PSI, MacNab satisfaction, complication, reoperation time
		OD	90	30.9 (18–54)	L2/3:2, L3/4:7 L4/5:43, L5/S1:39	101.3	
Huang [20]	China (Taiwan)	MED	10 (6/4)	39.2 ± 10.8	L3/4:1, L4/5:8, L5/S1:1	18.9	VAS, MacNab satisfaction, operative time, blood loss, hospital stay, IL-6, IL-8, IL-1, CRP, TNF-a
		OD	12 (9/3)	39.8 ± 11.0	L4/5:9, L5/S1:3	18.9	

MED microendoscopic discectomy, *OD* open discectomy, *VAS* visual analogue scores, *ODI* Oswestry disability index, *RTWT* time to return to work/activity, *NASS* North American Spine Society Instrument scores, *NRS* Numerical Rating Scale, *PSI* patient satisfaction index, *RDQ* Roland Disability Questionnaire score

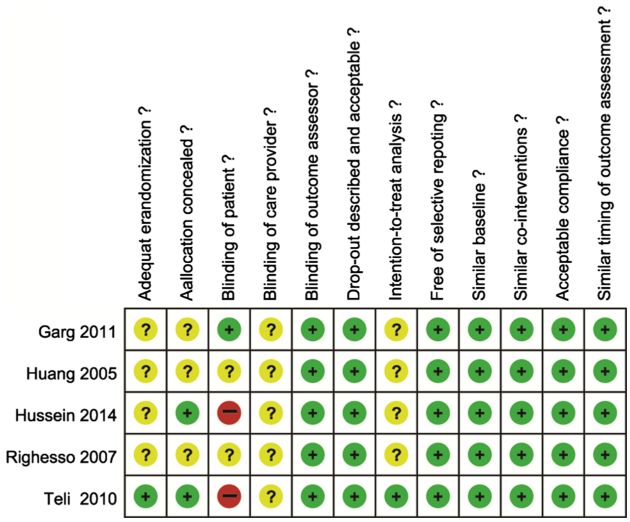

Fig. 2 The risk of bias assessment of each included study

monitored the data input to ensure there were no errors. Risk ratio (RR) or odds ratio (OR) was used as a summary statistic to analyze dichotomous variables, and the standardized mean difference (SMD) was used to analyze continuous variables. Both were reported with 95 % confidence intervals (CIs), and a *P* value of 0.05 was used as the level of statistical significance. Random-effects or fixed-effects models were used depending on the heterogeneity of the studies included. Heterogeneity was tested using I-square test, where $I^2 > 50\,\%$ implied heterogeneity.

Results

Search results

The search strategy yielded 204 relevant articles. There were only thirteen studies taken for a comprehensive evaluation. After evaluating the full article of the remaining articles, eight more studies were excluded due to data record or unsuitable interventions, four of them due to adoption of percutaneous endoscopic lumbar discectomy [15, 24–26]. As a result, a total of five randomized controlled trials (RCTs) [9, 19–22] were identified in this study. The literature search procedure is shown in Fig. 1.

Baseline characteristics and quality assessment

These RCTs included a total of 501 patients, 253 patients were treated with microendoscopic discectomy (microendoscopic group) and 248 patients underwent open discectomy (open group). These studies were performed in various countries. The demographic distribution of both groups was similar and the baseline characteristics of each study are presented in Table 1. All studies had a quality score of 7–11 (low risk of bias). The detailed risk of bias in each study is summarized in Fig. 2.

Effectiveness

Three RCTs [20–22] reported the VAS score at the latest follow-up. However, one study [21] did not provide standard deviation (SD). The pooled result revealed no

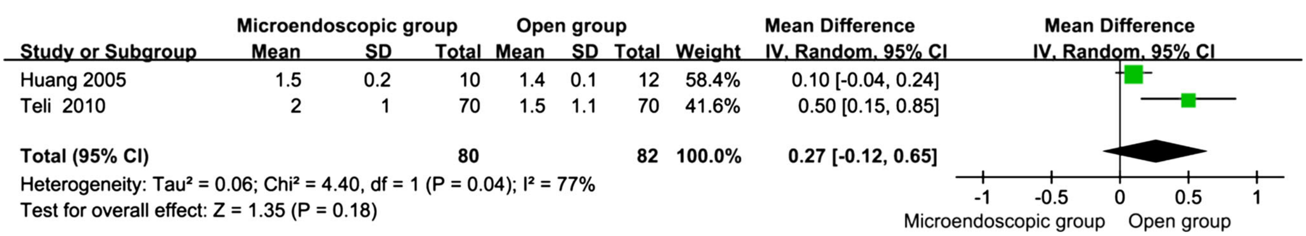

Fig. 3 Standardized mean difference (SMD) estimate for the VAS score

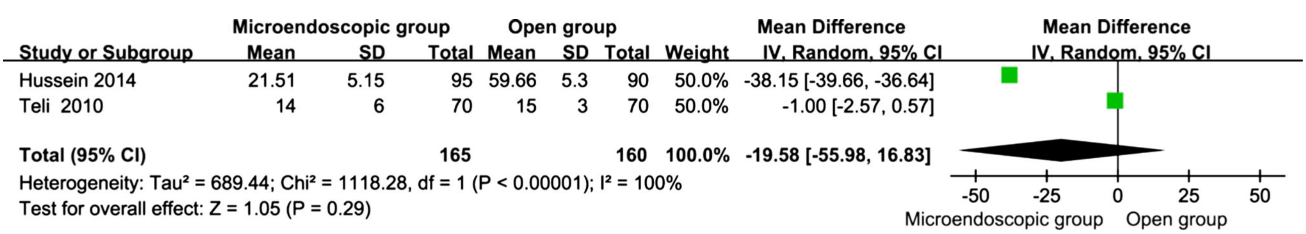

Fig. 4 Standardized mean difference (SMD) estimate for the ODI score

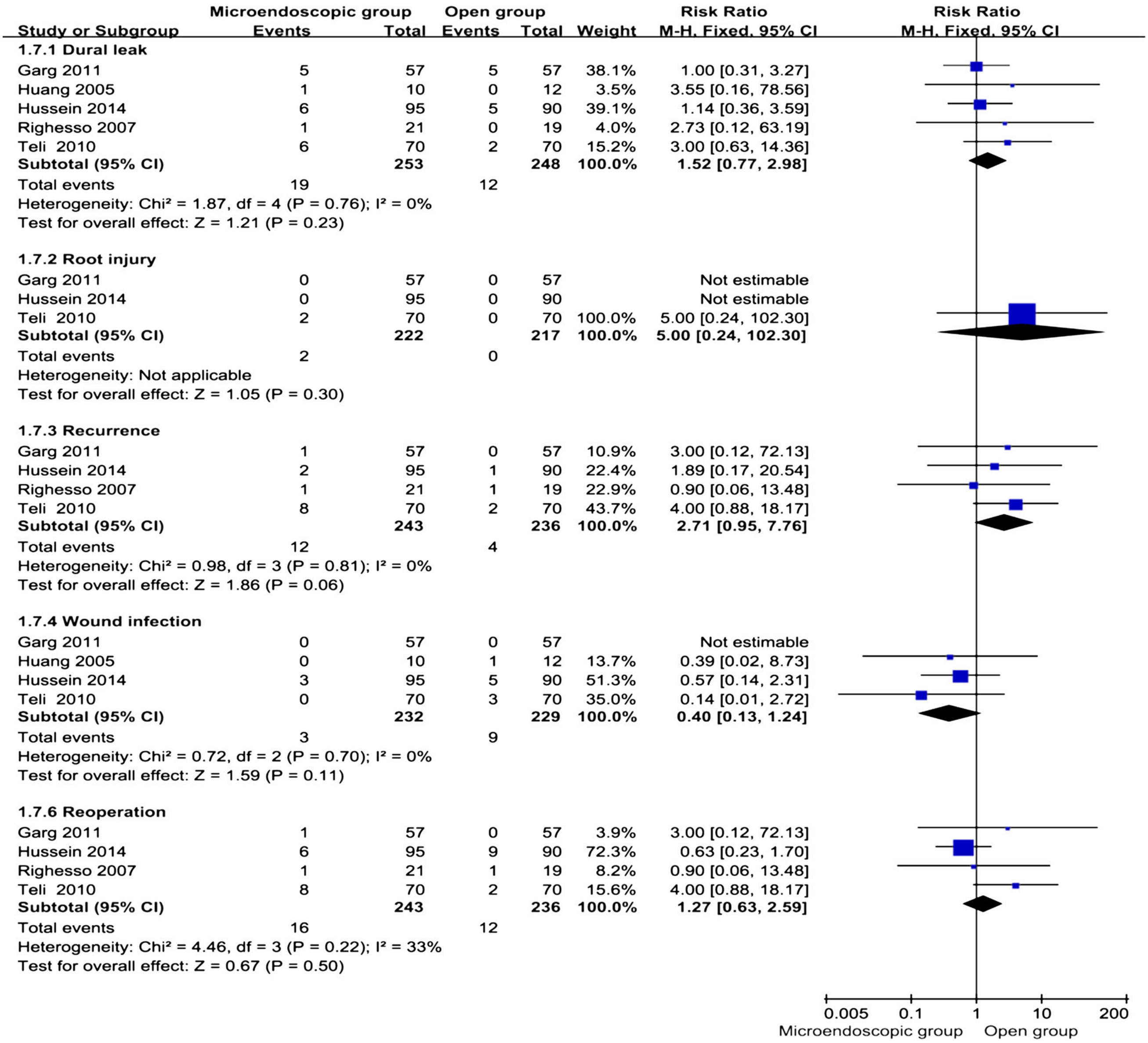

Fig. 5 Risk ratio (RR) estimate for the complications

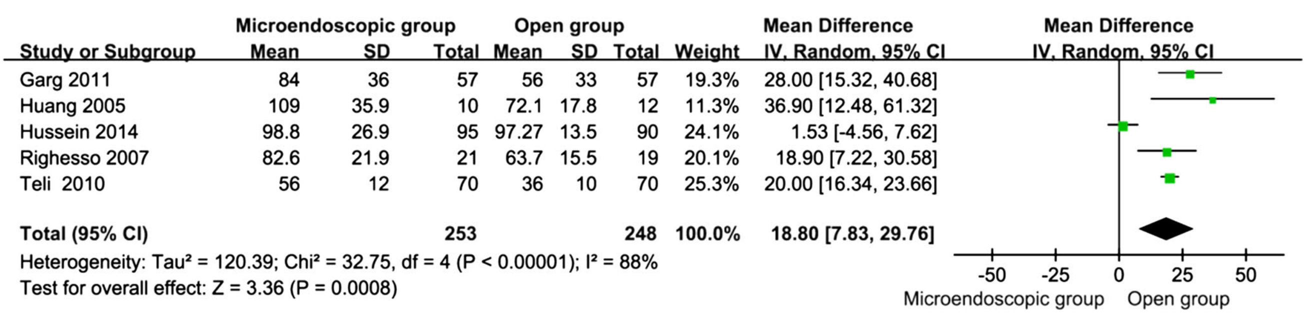

Fig. 6 Standardized mean difference (SMD) estimate for the operation time (minutes)

significant difference between the two groups [WMD = 0.27 (−0.12, 0.65), $P = 0.18$, $I^2 = 77$ %, Fig. 3]. Four studies [9, 19, 21, 22] compared the ODI score at the final follow-up between the two groups, whereas two RCTs [19, 21] did not provide the SD, the pooled analysis also showed the difference was not

Study or Subgroup	Microendoscopic group Mean	SD	Total	Open group Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Garg 2011	41	12	57	306	120	57	34.1%	-265.00 [-296.31, -233.69]
Huang 2005	87.5	69.4	10	190	115	12	31.2%	-102.50 [-180.50, -24.50]
Hussein 2014	41.6	13.1	95	124.22	24.5	90	34.7%	-82.62 [-88.33, -76.91]
Total (95% CI)			**162**			**159**	**100.0%**	**-151.01 [-288.22, -13.80]**

Heterogeneity: Tau² = 14118.50; Chi² = 126.29, df = 2 (P < 0.00001); I² = 98%
Test for overall effect: Z = 2.16 (P = 0.03)

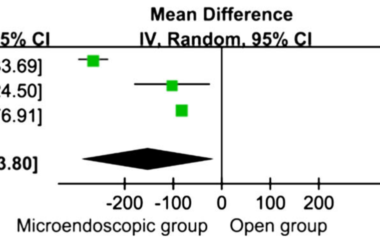

Fig. 7 Standardized mean difference (SMD) estimate for the blood loss (ml)

Study or Subgroup	Microendoscopic group Mean	SD	Total	Open group Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Garg 2011	72	24	57	288	72	57	24.0%	-216.00 [-235.70, -196.30]
Huang 2005	3.57	0.98	10	5.92	2.39	12	25.4%	-2.35 [-3.83, -0.87]
Hussein 2014	10.46	3.5	95	82.38	18.3	90	25.3%	-71.92 [-75.77, -68.07]
Teli 2010	54	12	70	49	10	70	25.3%	5.00 [1.34, 8.66]
Total (95% CI)			**232**			**229**	**100.0%**	**-69.33 [-110.39, -28.28]**

Heterogeneity: Tau² = 1728.91; Chi² = 1582.59, df = 3 (P < 0.00001); I² = 100%
Test for overall effect: Z = 3.31 (P = 0.0009)

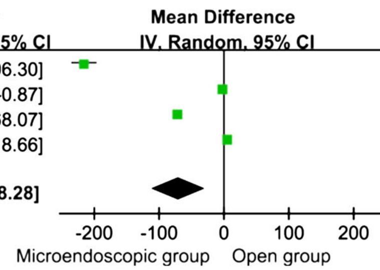

Fig. 8 Standardized mean difference (SMD) estimate for the length of hospital stay (hours)

significant [WMD = −19.58 (−55.98, 16.83), $P = 0.29$, $I^2 = 100$ %, Fig. 4].

Safety

With the inconsistent definition of the complication across all included studies, the meta-analysis of overall complication was inappropriate. Therefore, only the major adverse events including dural tear, root injury, recurrence, reoperation and wound infection were analyzed in the present study. All RCTs [9, 19–22] reported the complication. The qualitative analysis revealed no significant difference in the complication of dural tear, root injury, recurrence, reoperation or wound infection between the two groups (all $P > 0.05$, Fig. 5).

All studies [9, 19–22] reported the operation time of the two groups. The result demonstrated the microendoscopic approach resulted in significantly longer operation time compared with the open approach [WMD = 18.80 (7.83, 29.76), $P = 0.0008$, $I^2 = 88$ %, Fig. 6]. Four RCTs [9, 19–21] compared the intraoperative blood loss between the two groups, while one of them did not provide the SD [21]. The pooled analysis showed that the blood loss of the microendoscopic group was significantly less than that of the open group [WMD = −151.01 (−288.22, −13.80), $P = 0.03$, $I^2 = 98$ %, Fig. 7]. All RCTs [9, 19–22] assessed the length of hospital stay, whereas one study [21] did not provide the SD. The result also indicated the microendoscopic discectomy was correlated with significantly shorter length of hospital stay compared with the open discectomy [WMD = −69.33 (−110.39, −28.28), $P = 0.009$, $I^2 = 100$ %, Fig. 8].

Discussion

This meta-analysis compared microendoscopic discectomy with open discectomy for symptomatic lumbar disc herniation (LDH). The pooled analysis showed that there was similar improvement of clinical symptoms (VAS and ODI) of patients in the two groups. The differences of dural tear, root injury, recurrence and reoperation between the two treatment groups were not statistically significant. However, compared with the open group, the microendoscopic group resulted in less blood loss, shorter length of hospital stay, and longer operation time. The results indicated the more time-consuming technique of microendoscopic discectomy had an advantage in less surgical trauma.

The VAS and ODI scores were used for clinical effectiveness assessment in this study. The pooled analysis showed that there was no significant difference in these parameters between the two groups, indicating the ability of both approaches to decompress the nerve root was similar. However, the evaluation of the VAS and ODI is more dependent on the subjective feeling of patients and the scores might be acquired variably by different investigators [27]. Therefore, the reliability of these results was investigated and the conclusions were consistent following sensitivity analysis. Besides, these heterogeneities are large ($I^2 = 77$ %, 100 %, respectively).

Complication is a very important factor for assessing surgical safety. Some previous studies reported that dural tear, root injury and recurrence in the microendoscopic group were more than those in the open group [21, 22]. A possible explanation is the poor perception of depth with microendoscopic operation [16, 21, 22] and the restricting confines of tubular retractor, which limit surgeon to orientate surgical instruments [21, 28]. Iatrogenic dural tear and root injury are common complications [29–31], which might result in clinical sequelae [32–35]. However, such complications in this study were similar in the two groups ($P = 0.23$, 0.30, respectively). The finding indicated that the microendoscopic technique, with advanced surgical instruments, could provide sufficient space to avoid and control damage to dural and neural structures.

The recurrence of herniation at the same level of lumbar is a major problem [36, 37], which ranges from 0.5 to 10.7 % [38, 39] and has been the major cause of long-term pain and reoperation [17, 40, 41]. The limited field of tubular retractor might restrict the ability of surgeon to identify and extract the free fragments within the disc space, which ultimately leads to more recurrence in the microendoscopic group than in the open group [22]. In the present study, the recurrence rate was 4.94 % (12/243) in the microendoscopic group and 1.69 % (4/236) in the open group. There seemed to be more recurrence of LDH in the microendoscopic group than in the open group. However, the difference was not statistically significant (RR = 2.71, $P = 0.06$). It is important to note that the P value (0.06) was not considerably large, which meant that the result might be different if the study number and sample were to increase.

Blood loss was taken for evaluating surgical trauma in this study. The result indicated the surgical trauma of the microendoscopic discectomy was smaller than that of the open discectomy, which was comparable with the previous studies [9, 19, 20]. Furthermore, the minimally invasive technique could facilitate early recovery of the patients and shorten their time to return to work or normal activities [21, 42]. The length of hospital stay in this study was also significantly shorter in the microendoscopic group compared with the open group. Operation time was taken to assess the surgical difficulty, and the pooled analysis revealed the microendoscopic group was associated with longer time to remove the compressive pathological tissue, which was similar with the previous literature [17, 19, 20]. However, it is important to note that the surgical time would reduce gradually with the improvement of operative proficiency [9, 32]. Perez-Cruet et al. [32] reported that the mean operation time was 110 min in the first 30 cases, whereas it was only 75 min in the last 30 cases.

The microendoscopic discectomy may be a reliable technique. However, this approach also has defects. First, there is a certain difficulty to suture the dural tear properly in the limited room [43]. Secondly, there is a demanding learning curve to adapt the difference between hand and eye coupling with the three-dimensional view in the open surgical field and hand and eye spatial separation with the two-dimensional view in the microendoscopic approach [32]. Thirdly, it is a cost-consuming surgical technique when compared with the conventional open discectomy [22, 44].

This study has some limitations. It is clear that we did not comment on the subject of cost-effectiveness, which is a pity that it is a complex system. Besides, clinical heterogeneity may be caused by the various surgical instruments and operative proficiency in different treatment centers. Furthermore, only small size sample could be enrolled in these studies and the follow-up periods were various (1–8 years). Finally, all of the documents were in English, there may be language bias.

Conclusions

This study only concentrated on the difference between clinical outcomes of the two surgical approaches. As compared with open discectomy, microendoscopic discectomy was associated with similar improvement of symptoms and smaller surgical trauma. Microendoscopic discectomy, which requires a demanding learning curve, maybe a safe and effective alternative to open discectomy for the patients with symptomatic lumbar disc herniation. As there are limitations in this study, high-quality RCTs should be performed to assess this conclusion.

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Compliance with ethical standards

Conflict of interest None.

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