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Original Article

Percutaneous endoscopic lumbar discectomy as the new standard surgery in disc herniation: a meta-analysis

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Abstract: Background: Lumbar disc hernia removal techniques have greatly evolved in terms of instrumentation over the last 30 years. Percutaneous endoscopic lumbar discectomy (PELD) and microendoscopic discectomy (MED) were both commonly used today, whereas which one is more efficient are still controversial. As we know, there is no Meta-analysis in this field. Methods: The data bases, including PubMed, Web of Science, Embase, Cochrane Library, Wanfang, and CNKI were used for a literature search. The references of each selected articles were also manual checked. The outcomes we were interested in were divided into primary ones and secondary ones. High quality articles were separated from selected articles for sensitivity analysis and the funnel plots were used to evaluate the publication bias. Results: Ten studies including 1524 patients were brought into this Meta-analysisultimately. In the aspects of complication, recurrence, long-term ODI score and excellent or good result, there were no statistically significant difference in two groups. As for long-term and postoperative VAS score, the outcomes in the PELD group were better. The heterogeneity was generally low in primary outcomes. The operative time of PELD was longer, whereas it can reduce blood loss, hospital stay and time in bed. The outcomes of sensitivity analysis was similar to the original ones. Except for the long-term VAS score, there were no significant difference in two groups. Conclusion: PELD is a safe and efficient operative method in treating lumbar disc herniation. In the near future, it must be widely used by spinal surgeons and may become the new gold standard for discectomy.

Keywords: Meta-analysis, minimally invasive discectomy, lumbar disc herniation, percutaneous endoscopic lumbar discectomy, microendoscopic discectomy

Introduction

Lumbar disc herniation (LDH), characterized by pain and numbness in lower extremity (e.g., radicular unilateral or bilateral leg pain), [1] is one of the most common causes of nerve root pain and severely affects life quality of working adults [2, 3]. Since operative treatment of lumbar disc herniation was first described by Dandy and Mixter in the early 1900s, it has become the most common disease of the spine requiring surgical treatment methods [4-6]. Over the last 30 years, variant techniques, including standard discectomy; microdiscectomy; MED; and PELD, have been described to reduce blemish and muscle trauma and improve vision [7].

Recently, minimally invasive surgery has been widely applied to treat lumbar disc herniation, especially MED and PELD [8]. Many reviews and Meta-analysis had demonstrated that MED leaded to minimal muscle and soft tissue damage with excellent visualization. It combined the benefits of Microdiscectomy and Open discectomy, so as to provide patients with a faster postoperative recovery and better functional outcomes [9-11]. After Yeung et al. introduced standard transforaminal endoscopic surgery in 2002, another minimally invasive technique, PELD, have increasingly been used to treat lumbar disc herniation [12, 13]. More and more comparative analysis had been produced to compare the outcomes between PELD and

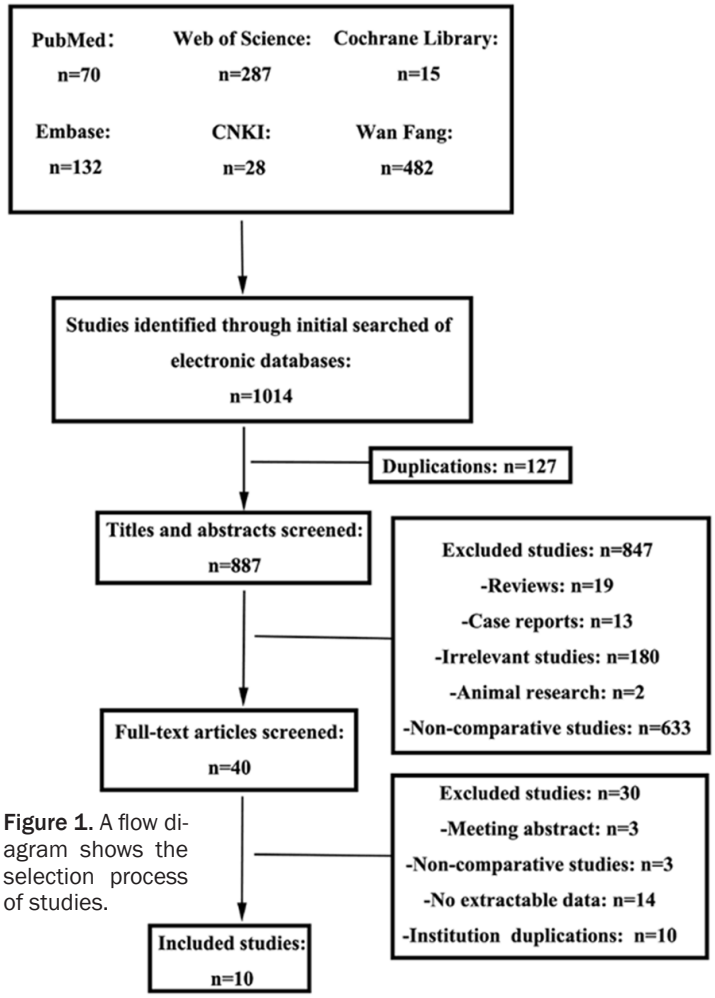

Figure 1. A flow diagram shows the selection process of studies.

standard discectomy. Sanusi et al. discovered that the patient benefit and low risk of complications with endoscopic discectomy using the far lateral approach make it a sustainable option for the treatment of symptomatic LDH, when comparing with microdiscectomy [14]. However, few articles compared clinical outcomes between MED and PELD. As far as we knew, which surgical method is more efficient is the most controversial topic in the field of spine, and there were no Meta-analysis compared these two techniques after we searched the databases.

Therefore, we did this study to compare the primary and secondary outcomes between MED and PELD. The purpose of this Meta-analysis is to provide clinicians with more evidences to choose a more practical technique when operated on LDH.

Methods

Search strategy

A literature search using PubMed; Embase; Web of science; Cochrane library; Wan Fang and CNKI was performed in January 2016 without restriction to time; publication types, or languages. The search terms consisted of the following medical subject headings: "disc herniation" OR "intervertebral disk displacement" OR "disk prolapse" OR "disk slipped" AND "microendoscopic Discectomy" OR "METRx" OR "MED" AND "percutaneous endoscopic discectomy" OR "full-endoscopic technique" OR "tessys" OR "yess" OR "between". We also manual checked the references of selected articles to find more relevant articles.

Inclusion/exclusion criteria

The articles met the following criteria were used: 1). A comparative study (cohort or case-control studies) or randomized controlled trail (RCT) that compared the outcomes of surgical methods, including PELD and MED, which were performed on lumbar disc herniation. 2). Included articles must contain extractable data which would be mentioned below. Exclusion criteria included the following: 1). the types of articles are animal researches; case reports; meeting abstract and reviews. 2). the articles were submitted by the same author or the same institution which may cause the duplication of patients.

Data management

Data from these selected articles were independently extracted by two of the authors and crosschecked for accuracy. Two authors were both blinded to the writers, the institutions and the journals of each article. Each disagreement had been solved by the senior author.

The data we were interested in contained primary outcomes and secondary outcomes. Excellent or good results; long-term and post-

Table 1. Characteristics of selected studies are showed below

Study	Level of evidence	Patients' no PTED/ MED		Follow up	Age (y) PELD/ MED	PELD approach	Matching	Position of the herniation	Quality score
Chen et al. [2015]	4	76	58	6 months	41.5/40.6	Trans*	1, 2, 3, 4, 5, 6	Post*/Fora*	★★★★★★
Li etal. [2015]	2b	35	30	1 year	37.5/37.8	Trans*/inter*	1, 2, 3, 4, 5	NA	★★★★★★★★
Sinkemani et al. [2015]	2b	50	36	14 months	44.2/41.5	Trans*	1, 2, 4, 5	NA	★★★★★★★
Yang et al. [2015]	2b	82	57	3 months	48.4/48.0	Trans*	1, 2, 3, 5	NA	★★★★★★★
Zhang et al. [2015]	2b	21	21	1 year	37.5/35.8	Trans*	1, 2, 4, 5	NA	★★★★★★★
Li et al. [2013]	4	212	208	NA	38.3/43.3	Tran*	1	NA	★★★★★
Zhao et al. [2012]	2b	245	261	NA	39.4/43.2	Tran*	1, 2, 3, 5	NA	★★★★★★★
Yoon et al. [2012]	2b	37	35	6 months	45.9/56.5	Trans*/inter*	1, 2, 3, 4, 5	NA	★★★★★★★
Zhou et al. [2012]	4	25	13	13.5 months	NA	Trans*	NA	Fora*/Extra*	★★★★★
Wu et al. [2009]	1b	30	30	6 months	43.5/45.8	Tran*	1, 5, 6	Post*/Extra*	RCT

PELD=Percutaneous endoscopic lumbar discectomy; MED=Microendoscopic discectomy. Trans=Transforaminal; Inter=interlaminar; Post=posterolateral; Extra=extraforaminal; Fora=foraminal. N=unmatched; Mor=more than; Less=ess than; Mea=mean; Mix: the numbers of level are unclear; NA=data not available. Matching: 1=Age; 2=Duration; 3=Preoperative VAS; 4=Preoperative ODI; 5=Lesion Segment; 6=Position of the herniation.

Table 2. Qualities of including articles are evaluated by modified Newcastle-Ottawa scale

Study	Selection				Comparability		Outcome		Quality score
	Case definition	Represen--tativeness	Selection of Controls	Definition of Controls	Comparable for 1, 2, 3	Comparable for 4, 5, 6	Assessment of outcome	Integrity of follow-up	
Chen et al. [2015]	Yes	No	Yes	No	1, 2, 3	4, 5, 6	No	Yes	★★★★★★
Li et al. [2015]	Yes	No	Yes	Yes	1, 2, 3	4, 5	Yes	Yes	★★★★★★★★
Sinkemani et al. [2015]	Yes	No	Yes	Yes	1, 2	4, 5	Yes	Yes	★★★★★★★
Yang et al. [2015]	Yes	No	Yes	Yes	1, 2, 3	5	Yes	Yes	★★★★★★★
Zhang et al. [2015]	Yes	No	Yes	Yes	1, 2	4, 5	Yes	Yes	★★★★★★★
Li et al. [2013]	Yes	No	Yes	Yes	1	No	Yes	Yes	★★★★★
Zhao et al. [2012]	Yes	No	Yes	Yes	1, 2, 3	5	Yes	Yes	★★★★★★★
Yoon et al. [2012]	Yes	No	Yes	Yes	1, 2, 3	4, 5	Yes	No	★★★★★★★
Zhou et al. [2012]	Yes	No	Yes	Yes	No	No	Yes	No	★★★★★
Wu et al. [2009]									RCT

Matcing: 1=Age; 2=Duration; 3=Preoperative VAS; 4=Preoperative ODI; 5=Lesion Segment; 6=Position of the herniation.

operative VAS scores, long-term ODI scores; complication and recurrence were primary outcomes. Excellent or good results were estimated by the modified MacNab criteria which divided patients' feeling into four degrees. We compared both long-term and postoperative VAS scores to eliminate the influence of the operation itself. The secondary outcomes included operative time; blood loss; out-of-bed exercise and hospital stay.

The Cochrane Collaboration's Review Manager was used to pool the data. Mean difference and 95% CIs were calculated to pool the functional outcome [15, 16]. Statistical heterogeneity between studies was assessed by using the chi-square test with significance set at $P<0.1$, and heterogeneity was quantified using the I^2 statistic. The random-effects model was used if there is heterogeneity ($I^2>50$) between studies; otherwise, the fixed-effects model was used [16, 17].

Quality assessment and evidence grading

The methodological quality of RCTs was assessed by the Cochrane risk of bias tool [16]. The methodological quality of retrospective studies was assessed by the modified Newcastle-Ottawa scale, which consists of three factors: patient selection, comparability of the study groups, and assessment of outcome [16, 17]. The total scores are 9. We defined RCTs and these articles achieved more than 7 scores as high quality articles.

Table 3. The results of comparison of PLED and MED are showed below

Outcomes of interest	Study no.	PELD*	MED	WMD/OR* (95% CI)	*p* value	S3 tudy heterogeneity			
		Patient no.	Patient no.			x^2	df	I^2, %	*p* value*
Primary outcomes									
Complications	7	306	244	0.68 (0.29, 1.56)	0.36	3.9	6	0	0.69
Recurrence	5	429	368	1.77 (0.74, 4.22)	0.2	1.3	4	0	0.86
Excellent or good results	6	504	441	1.23 (0.77, 1.97)	0.39	5.72	5	13	0.33
Long-term VAS* score	5	248	188	-0.37 (-0.45, -0.27)	<0.001	6.47	4	38	0.17
Postoperative VAS score	4	335	289	-0.57 (-0.94, -0.19)	0.003	11.39	3	74	0.01
Long-term ODI* score	4	163	159	-2.00 (-4.63, 0.62)	0.13	23.1	3	87	<001
Secondary outcomes									
Hospital stay [days]	6	241	223	-1.98 (-3.11, -0.84)	<0.001	143.43	5	97	<0.01
Blood loss [ml]	5	590	532	-49.61 (-80.67, -18.56)	0.002	2031.7	4	100	<0.01
Operation time [min]	7	661	612	16.51 (2.38, 30.63)	<0.001	346.43	6	98	<0.01
Out-of-bed exercise [days]	6	241	223	-1.98 (-3.11, -0.84)	<0.001	65.65	1	98	<0.01

PELD=Percutaneous endoscopic lumbar discectomy; MED=Microendoscopic discectomy. WMD/OR=weighted mean difference/odds ratio; CI=confidence interval; df=degrees of freedom VAS=Visual analog creatinine; ODI=Oswestry disability index.

Table 4. Sensitivity analysis comparison of decompression alone and decompression with fusion shows below

Outcomes of interest	Study no.	PELD*	MED	WMD/OR* (95% CI)	p value	Study heterogeneity			
		Patient no.	Patient no			x^2	df	I^2, %	*p* value*
Primary outcomes									
Complications	5	205	173	1.14 (0.40, 3.23)	0.81	0.99	4	0	0.91
Recurrence	5	429	368	1.77 (0.74, 4.22)	0.2	1.3	4	0	0.86
Excellent or good results	5	401	383	0.82 (0.45, 1.50)	0.52	0.87	4	0	0.93
Long-term VAS* scores	3	147	117	-0.05 (-0.32, -0.21)	0.68	0.14	2	0	0.93
Postoperative VAS scores	3	310	276	-0.62 (-1.18, -0.06)	0.03	10.03	2	80	<0.01
Long-term ODI* scores	3	87	101	-0.23 (-0.92, 0.45)	0.5	0.33	2	0	0.85
Secondary outcomes									
Hospital stay [days]	6	241	223	-1.98 (-3.11, -0.84)	<0.001	143.4	5	97	<0.01
blood loss [ml]	4	378	324	-45.32 (-87.66, -2.97)	0.04	1522	3	100	<0.01
Operation time [min]	7	661	612	16.51 (2.38, 30.63)	<0.001	346.4	6	98	<0.01
Out-of-bed exercise [days]	6	241	223	-1.98 (-3.11, -0.84)	<0.001	65.65	1	98	<0.01

PELD=Percutaneous endoscopic lumbar discectomy; MED=Microendoscopic discectomy. WMD/OR=weighted mean difference/odds ratio; CI=confidence interval; df=degrees of freedom VAS=Visual analog creatinine; ODI=Oswestry disability index.

We used UK Cochrane Centre of Evidence to estimate the level of evidence of these articles, which defines single randomized controlled trail as level of evidence: 1b; a single cohort studies as level of evidence: 2b; a single case-control studies as level of evidence: 2b and low quality cohort or case-control studies as level of evidence of 4.

Sensitivity analysis and publication bias

Sensitivity analyses, which were assessed by using high quality articles, were performed to explore the potential sources of heterogeneity and to eliminate the effect of low quality articles. Funnel plots were used to screen for potential publication bias.

Results

Search results

The literature search found 1014 (70 articles from PubMed, 287 from Web of Science, 15 from Cochrane Library, 132 from Embase, 482 from Wan Fang, and 28 from CNKI) potentially relevant articles (**Figure 1**). After two reviewers independently browsed titles and abstracts of these studies cautiously, 974 articles were excluded. Among these studies, 127 were duplications and 19 were reviews. A total of 180 articles didn't mention PELD and MED, 13 case reports, two animal researches and 633 studies didn't compare the outcomes of these two techniques. Forty articles were left for full

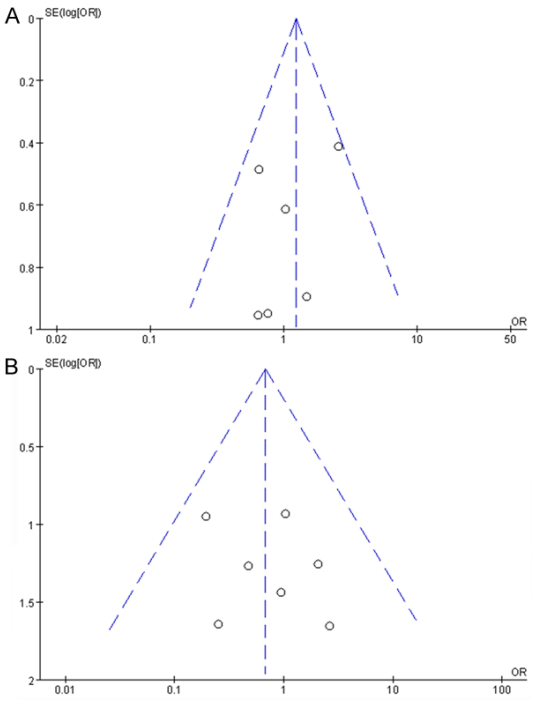

Figure 2. A. Funnel plot which was illustratedby excellent or good result shows the publication bias. SE=standard error, OR=odds ratio. B. Funnel plot which was illustrated by complication shows the publication bias. SE=standard error, OR=odds ratio.

text review. Three of them were meeting abstract; 14 articles had no data we were interested in; three articles didn't compare the outcomes of these two techniques; and 10 articles were submitted by the same authors or same institutions. Finally, ten articles were brought into this Meta-analysis.

Characteristics of selected articles

The characteristics of these selected articles were shown in **Table 1**. The main characteristics we were interested in are patient number, mean follow-up, age, the approach of PELD, and the position of herniation. A total of ten articles contained 1524 patients were analyzed in this Meta-analysis ultimately. There is one small sample randomized controlled trail (level of evidence: 1b) [18] andsix high quality retrospective studies (level of evidence: 2b) [13, 19-23]. Whereas other three retrospective studies' quality were generously low (level of evidence: 4) [24-26]. Although three articles were put in by the same institutions, the patients who were brought into studies were from different time periods and the patients they analyzed were not repeated.

Risk of bias

The quality of included studies was detailed in **Table 2**. The six criteria of matching were age, duration of conservative treatment, preoperative VAS scores, preoperative ODI scores, lesion segment, and the type of herniation. We defined the small sample randomized controlled trail as high quality studies and it was not estimated by the modified Newcastle-Ottawa scale. Among the rest nine articles, one achieved eight scores, five achieved seven scores, and other three were all below seven scores.

Primary outcomes

Seven articles including 550 patients reported the outcome of complication (**Table 3**). The rate of complication in the PELD group and in the MED was similar (OR: 0.68, 95% CI: 0.29~1.56, P=0.36). Heterogeneity was very low (x^2=3.90, df=6, I^2=0%, P=0.69).

Five studies containing 797 patients analyzed the result of recurrence, which demonstrated on statistically significant difference between two groups (OR: 1.77, 95% CI: 0.74~4.22, P=0.2). There was hardly any heterogeneityin his index (x^2=1.30, df=4, I^2=0%, P=0.86), too.

Excellent or good result was reported by six articles. The outcomes showed that the rate of excellent or good was similar in these two groups (OR: 1.23, 95% CI: 0.74~4.22, P=0.39). Similarly, the heterogeneity was very low (x^2=5.72, df=5, I^2=13%, P=0.33).

Visual Analogue Scale Pain Score was divided into two segments, including long-term VAS score and postoperative VAS score, separately. Five studies including 436 patients revealed that PELD group can release pain more evidently, when compared with MED group (WMD: -0.37, 95% CI: -0.45~-0.27, P<0.001). Meanwhile, other four articles containing 624 patients showed that postoperative VAS score was also lower in PELD group (WMD:-0.57, 95% CI:-0.94~-0.19, P=0.003). The heterogeneity in the index of postoperative VAS score was more than 50% (x^2=11.39, df=3, I^2=74, P=0.01).

Long-term Oswestry Disability Index score was reported by four articles, which demonstrated that there was no significant difference in these two groups (WMD: -2.00, 95% CI: -4.36~0.62,

P=0.13). Heterogeneity is high in this index (x^2=23.10, df=3, I^2=87, P<0.01).

Secondary outcomes

Seven studies including 1273 patients revealed that the mean operative time in PELD group in longer than MED group (WMD: 16.51, 95% CI: 2.38~30.63, P<0.001). Five studies including 1122 patients estimated blood loss, which showed that patients in MED group had more blood loss than MED group (WMD: -49.61, 95% CI: -80.67~-18.56, P=0.002). Other two indexes of secondary outcomes, including hospital stay, and out-of-bed exercise, demonstrated that the outcomes of PELD group were all superior to MED group, in the hospital stay (WMD: -1.98, 95% CI: -3.11~-0.84, P<0.001) and in the out-of-bed exercise (WMD: -1.98, 95% CI: -3.11~-0.84, P<0.001).

Sensitivity analysis and publication bias

After three low quality articles were eliminated, seven articles, including one small sample RCT and six high quality retrospective studies were left for sensitivity analysis. The outcomes were showed in **Table 4**. The results of sensitivity analysis were similar to original outcomes, except for the long-term VAS score. In sensitivity analysis, there was no significant difference in long-term VAS score in both groups. Meanwhile, the heterogeneity of sensitivity analysis was generally lower in primary outcomes and no obvious changes in secondary outcomes, when compared with the original outcomes.

Funnel plot (**Figure 2A**, **2B**) contains six and seven studies describing excellent or good result and complication, separately. Both pictures were showed that all articles lie inside the 95% CI and the distribution is symmetrical which can indicate no obvious publication bias.

Discussion

From this Meta-analysis, we can clearly see that in the aspect of complication, recurrent, excellent or good result, long-term VAS score, and long-term ODI score, there were no statistically significant difference in PELD group and MED group. PELD was more efficient than MED in postoperative VAS score, hospital stay, blood loss, and out-of-bed exercise, whereas operative time was shorter in MED group.

The complication rate was generally low in both groups. In selected ten articles, there were no serious complication be reported in two groups, and the majority patients suffer from postoperatively transient pain and numbness. All these symptoms were gradually alleviative after conservative treatment. A small portion of patients experienced the dural tear, whereas all of them were cured by conservative treatment or drainage. No patients needed an additional surgery on account of complications. Some other articles also reported that one of 188 patients in MED had wound infectious needed debridement, antibiotics and dressings and recovered without further complications [27]. Yeung et al. reported that two of 307 patients experienced disc space pyogenic infection when experienced PELD and required further surgical management [12]. Whether the rate or the kind of compilation, there were no significant difference in two groups.

Recurrent lumbar disc herniation in this study had no significant difference in two groups. Both PELD and MED were reported to treat the recurrent lumbar disc herniation successfully. To avoid scar tissue caused by the last surgery, a different method would be better to be used to cure the recurrent herniation. If the recurrence occurred in the lower lumbar disc, such as L4/L5 or L5/S1, especially in the level of L5/S1, the choice of operative techniques was more various. Kogias et al. had reported than MED, endoscopic transforaminal and interlaminar discectomy have been used to perform redo discectomy for recurrent lumbar disc herniation. The reported success rates are MED 81-90%, ETD 81-95%, and EID 60-95%. Which surgical methods would be performed on recurrent LDH was decided by many factors, such as the type, position, last operative technique and so on. Whereas everydiscectomy techniques can solve any herniation, we can choose a more appropriated surgical method after we evaluated the situation of patient.

The feeling of patients was estimated by excellent or good results, long-term VAS score, postoperative VAS score and long-term ODI score. Except for long-term VSA score, the outcomes were similar in original and sensitivity analysis. After the low quality article was excluded, the heterogeneity (I^2) decreased from 38 to 0, which demonstrated that the outcome of this article was different from other studies on anal-

ysis of the same index obviously. After reviewed many literatures, the change of VAS score in a long-term follow-up was also not different in two groups. We defined VAS score was evaluated within one week after operation as postoperative VAS score. Postoperative VAS score didn't reflect the efficacy of these two surgical methods, but showed that postoperative pain was slighter in percutaneous endoscopic discectomy. Smaller incision, shorter operative time and less muscle and soft tissue damage may contribute to this result.

The secondary outcomes were all significantly different in PELD and MED groups. In this Meta-analysis, operative time is shorter in MED groups, whereas the outcomes of surgical time in different articles submitted by different authors were discrepant. On the one hand, operative time was related to the proficiency of the surgeon. If the hospital developed one of these two techniques earlier, or the number of patients treated by one method is much larger than the other one, surgeons may master the technique which frequently used more skillfully. On the other hand, the procedure of PELD is more complex, especially at the step of location and puncture. After insertion of the working sleeve and endoscope, internal decompression of the disc was performed [28]. Meanwhile, the whole process was performed at indirect vision and through an approximately 8 mm channel. All these may lead to longer operative time in PELD group. The time stayed in bed was shorter in PELD group. Some studies had reported that two hours following surgery the patients can mobilise and be discharged home [29]. In addition to the four indexes we discussed above, a few studies compared the length of incision without providing standard deviation. The average length was 8 mm in PELD, [29] and 10 mm longer in MED, [23] which can reduce the rate of incision complications and the damage of muscle and soft tissue.

After concluding three articles which referred to the position of herniation, we found that two operative methods were both suitable for posterolateral, foraminal, or extraforaminal disc herniation [18, 24, 26]. In the study of Yeung et al, which included intracanal and extracanal (foraminaland extraforaminal) herniations. Recurrent herniations and missed fragments after previous surgical interventionat the index level also were included. All these types of disc herniation were under the surgery of PELD group [12]. Nevertheless Kogias et al indicated that the major advantage of PELD is the nil dural tear rate but coexisting lateral recess stenosis or dislocated disc fragments present some limitations of the technique. MED has no such limitations but a higher dural tear rate [30]. If sequestering material had migrated beyond the lower edge of the cranial pedicle or over the middle of the caudal pedicle, percutaneous endoscopic discectomy through the interlaminar approach can solve this prombem [31].

According to the approaches PELD can be divided into Transforaminal and Interlaminar discectomy. Most articles compared the outcomes between transforaminal approach and MED. Only two of ten selected articles mentioned the interlaminar approach, and the segment which operates generally performed on was L5/S1 [13, 23]. On the one hand, interlaminar approach has been introduced for the L5/S1 segment where the transforaminal approach is sometimes hindered due to the iliac crest [30]. On the other hand, the interlaminar space was broader in the segments of L4/L5 and L5/S1. Although the interlaminar approach had less risk of injury to the exiting root and may be applied comfortably even for less experienced surgeons due to the familiar anatomy with open surgery, [32] general anesthesia was applied for all patients, which may improve the risk of surgery [33]. Henmiet al reported that percutaneous transforaminal endoscopic discectomy accompanied with foraminoplasty can not only remove the high migratedherniated nucleus pulposus, but also performed under local anesthesia [34]. Notwithstanding, which approach was better is still controversial and needed further research. With the development of instrument and the accumulation of experience, PELD will be the new trend in minimally invasive lumbar discectomy.

Of course, there are also many important limitations in this article. First, the quality of some articles included in this Meta-analysis was low. There was a small sample RCT, 6 high quality retrospective articles, and the left 3 studies' qualities are all low, so more RCTs were needed in this field to compare the effect of PELD and MED. Second, ten articles including 1524 patients were analyzed in this Meta-analysis. The sample was not enough large and more related researches were needed in this field. Third, heterogeneity in this Meta-analysis was a little high in some indexes, epically in second-

ary outcomes. Heterogeneity was not significant for dichotomous outcomes but was significant for most of the continuous variables. Included studies, researched in different countries, adopted different surgical indications, matching criteria, operative approach, and measurement of outcomes, which might contribute to the significant heterogeneity. Pooling of data using the random-effects model might reduce the effect of heterogeneity but does not abolish it. Finally, we only compared the outcomes of PELD and MED. Due to the limits of the data, the interlaminar and transforaminal approaches cannot be compared with MED separately. This may be one reason leaded to the generation of the heterogeneity.

Nowadays, some studies had reported that these two techniques can be used to treat the degenerative stenosis. Whether the outcomes of this Meta-analysis are suitable for degenerative spinal diseases, like spondylosthesis or scoliosis, needs further investigation.

Disclosure of conflict of interest

None.

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