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Review Article

Percutaneous transforaminal endoscopic discectomy versus microendoscopic discectomy for lumbar disc herniation: a systematic review and meta-analysis

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Abstract: *Background:* Several studies have compared the efficacy and safety of percutaneous transforaminal endoscopic discectomy (PTED) with microendoscopic discectomy (MED) in treating lumbar disc herniation (LDH), however, with contradictory results. This systematic review and meta-analysis aimed to compare the effectiveness and safety between PTED and MED in addressing LDH. *Methods:* A comprehensive literature review was conducted in four common databases. All the clinical studies focusing on the comparison between PTED and MED for LDH were evaluated. Meta-analyses of clinical variables were performed. *Results:* A total of 5 studies involving 500 LDH patients were included into this study. There were 254 patients in PTED group and 246 patients in MED group. PTED was significantly related to smaller length of incision (MD=-1.02 cm, 95% CI=-1.21-0.83 cm, P<0.01), less blood loss (MD=-15.46 ml, 95% CI=-22.76-8.16 ml, P<0.01), shorter postoperative in-bed time (MD=-58.74 hours, 95% CI=-99.21-18.27, P<0.01) and length of hospital stay (MD=-1.27 days, 95% CI=-2.07-0.47, P<0.01) when compared to MED. However, increased radiation exposure was detected in PTED group (MD=10.00 seconds, 95% CI=7.67-12.33 seconds, P<0.01). Additionally, there were no obvious differences between two groups in operative time (P=0.47) or satisfaction rate (P=0.53). As for patient-reported outcomes, no obvious differences were observed between PTED and MED in Visual Analogue Scale (VAS), VAS of back pain (VAS-BP), VAS of leg pain (VAS-LG), Japanese Orthopedic Association Scores (JOA) or Oswestry Disability Index (ODI). *Conclusion:* PTED and MED were both sufficient and safe in addressing LDH. PTED was superior to MED in length of incision, blood loss, postoperative in-bed time, and length of hospital stay. However, PTED was distinctly associated with increased radiation exposure compared to MED.

Keywords: Percutaneous transforaminal endoscopic discectomy, microendoscopic discectomy, lumbar disc herniation, meta-analysis

Introduction

Lumbar disc herniation (LDH) is the most common cause of sciatica [1]. Pain relief can be obtained after receiving conservative treatments in most LDH cases [2]. However, a certain percentage of patients fail the conservative treatments and have to be surgically treated [3]. With development of medical instruments, minimally invasive spine surgery (MISS) is becoming increasingly popular worldwide [4]. MISS has several advantages compared to open spine surgeries, including less blood loss, shorter operative time, faster function recovery, and comparable clinical outcomes [5, 6]. Microendoscopic discectomy (MED), as a very common MISS, was first described by Foley et al. in 1997 [7]. Plenty of studies have confirmed the efficacy and safety of MED in treating LDH [8, 9]. Similarly, percutaneous transforaminal endoscopic discectomy (PTED), first described by Yeung et al. in 2002, is another usual MISS in the management of LDH and induces favourable outcomes [10]. PTED and MED are both important surgical procedures in treating LDH, however, it is unclear that which of them is superior. Several studies have compared the efficacy and safety of PTED with MED, but had a small sample size and contradictory results [11-15]. Therefore, this study was performed to compare the efficacy and safety of PTED with MED in the management of LDH.

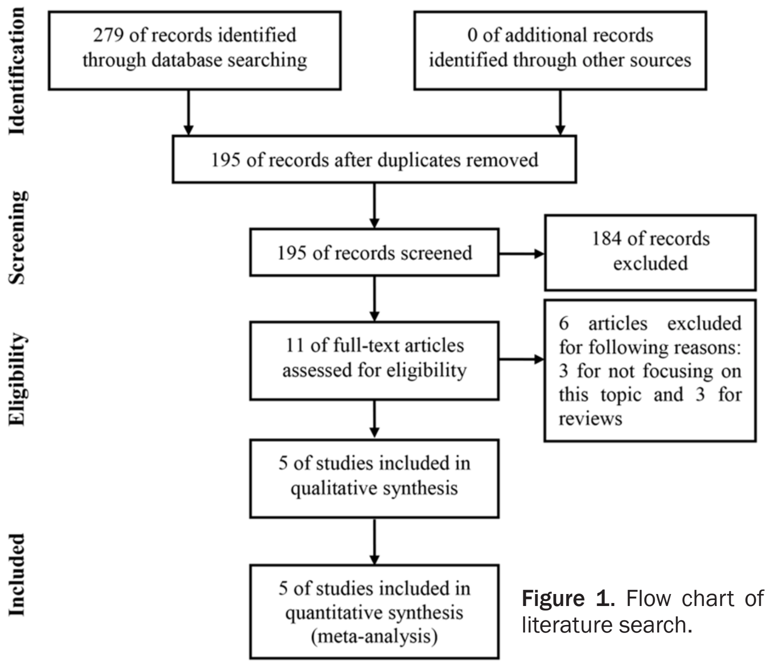

Figure 1. Flow chart of literature search.

Materials and methods

Literature search

PubMed, Embase, Web of Science and Cochrane Database were comprehensively searched up to March 7th, 2018. The search terms were as follows: ("lumbar disc herniation" OR "LDH") AND ("microendoscopic discectomy" OR "MED") AND ("percutaneous transforaminal endoscopic discectomy" OR "PTED" OR "percutaneous endoscopic lumbar discectomy" OR "PELD" OR "percutaneous endoscopic transforaminal discectomy" OR "PETD"). There was no language restrictions. The references of retrieved papers were also carefully evaluated and reviewed for potential relevance. The literature search was independently completed by two investigators. Meta-analysis was performed strictly according to the Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA) [16].

Selection criteria

Inclusion criteria were as follows: (i) clinical studies, whether randomized controlled trials (RCT) or observational studies; (ii) focusing on the comparison between PTED and MED in treating LDH; (iii) sufficient data to extract. Reviews, letters, comments, animal or cell experiments, duplicated studies or patients and studies without insufficient data were all excluded.

Data extraction and quality assessment

Data extraction and quality evaluation were independently completed by two investigators. Extracted data included: the first author, number of patients, gender, mean age of patients, lumbar segment, type of disc herniation and follow up time. The clinical parameters included length of incision, blood loss, operative time, intraoperative fluoroscopy, postoperative in-bed time, length of hospital stay and complications as well as satisfaction rate based on MacNab Criteria (excellent, good, fair, poor) [17]. The patient-reported outcomes included Visual Analogue Scale (VAS), VAS of back pain (VAS-BP), VAS of leg pain (VAS-LG) (0 for no pain; 10 for worst imaginable pain), Japanese Orthopedic Association Scores (JOA) [18] and Oswestry Disability Index (ODI) [19]. The quality of evidence was evaluated using the criteria described by the Cochrane Back Review Group for RCTs [20] and the Newcastle-Ottawa Scale (NOS) for observational studies [21]. Any disagreement during the process of data extraction and quality evaluation was solved by discussing with the third investigator.

Statistical analysis

All analyses were conducted by using Review Manager 5.3 (Cochrane Collaboration). The dichotomous included complications and MacNab evaluation, and odds ratio (OR) and corresponding 95% CI were used to analyze these variables. Mean difference (MD) and Std. mean difference (SMD) were utilized to perform the meta-analyses of continuous variables, including operative time, intraoperative fluoroscopy, VAS scores and so on. I^2 statistic was used to assess the heterogeneity, and the I^2 equal to or less than 50% indicated that heterogeneity was not obvious and the fixed-effect model was employed. If not, the random-effect model was used. Furthermore, funnel plots were generat-

Table 1. The basic information of included studies

Study	Design	Patients (n)		Gender (M/F)		Age (year, mean ± SD)		Lumbar segment (PTED:MED)	Type of disc herniation (PTED:MED)	Follow up (months)	
		PTED	MED	PTED	MED	PTED	MED			PTED	MED
Sinkemani 2015 [14]	R	36	50	23/13	29/21	44.17±6.54	41.46±7.22	L3/4 (3:1), L3/4 L4/5 (4:0), L3/4 L4/5 L5/S1 (0:2), L4/5 (13:17), L4/5 L5/S1 (0:8); L5/S1 (16:22)	NA	>12	>12
Chen 2017 [11]	RCT	80	73	52/28	37/36	40.20±11.40	40.70±11.10	L3/4 or higher (4:0), L4/5 (35:35), L5/S1 (41:38)	Central (15:19), Paracentral (56:48), Extreme lateral (9:6)	>12	>12
Song 2017 [15]	R	30	30	16/14	17/13	54.80±6.50	53.60±6.40	L4/5 (6:5), L2/4 (5:6), T12/L2 (7:6)	Central (6:7), Paracentral (16:14), Extreme lateral (8:9)	>12	>12
Li 2018 [12]	R	48	30	30/18	20/10	18.96±1.99	19.40±1.50	L3/4 (4:4), L4/5 (26:14), L5/S1 (18:12)	NA	>60	>60
Liu 2018 [13]	R	60	63	31/29	32/31	36.20±5.90	33.10±6.70	L3/4 (6:8), L4/5 (54:55)	2A (9:8), 2B (22:23), 2AB (26:28), 3A (1:1), 3B (1:2), 3AB (1:1)	>24	>24

R, retrospective study; RCT, randomized controlled trial; PTED, percutaneous transforaminal endoscopic discectomy; MED, microendoscopic discectomy; NA, not available; M, male; F, female; SD, standard deviation.

Table 2. Study evaluation according to NOS

Items	Selection	Comparability	Outcome	Total
Sinkemani 2015 [14]	3	2	2	7
Song 2017 [15]	3	2	3	8
Li 2018 [12]	3	2	3	8
Liu 2018 [13]	3	2	2	7

NOS, Newcastle-Ottawa Scale.

Table 3. Study evaluation according to Cochrane Collaboration's tool

Items	Chen 2017 [11]
Random sequence generation (selection bias)	Low
Allocation concealment (selection bias)	Unclear
Blinding of participants and personnel (performance bias)	Low
Blinding of outcome assessment (detection bias)	Low
Incomplete outcome data (attrition bias)	Low
Selective reporting (reporting bias)	Low
Other bias	Low

RCT, randomized controlled trial.

ed to evaluate the bias among included studies. All the reported *P* values were two sided, and P<0.05 was considered statistically significant.

Results

The literature search and study selection

As shown in **Figure 1**, 279 papers were initially retrieved. After removal of duplicates, 195 papers remained for further evaluation. Among these papers, 184 papers were directly excluded by scanning the titles or abstracts. Then, 11 papers remained for full text review, and 6 papers were excluded for the following reasons: 3 for not focusing on this topic and 3 for reviews. Ultimately, a total of 5 studies were included into this meta-analysis [11-15]. There was no dispute between two reviewers during the process of study selection.

Basic information of the included studies

The characteristics of included studies are shown in **Table 1**. This meta-analysis consisted of 1 RCT [11] and 4 retrospective studies [12-15]. There were 254 LDH patients (152 males and 102 females) in PTED group and 246 LDH patients (135 males and 111 females) in MED group. The mean age ranged from 18.96 to 54.80 years old in PTED group and 19.40 to 53.60 years old in MED group. Furthermore, a note about the mean age was that *Li 2018* study focused on adolescent LDH [12]. Moreover, all the studies reported the distribution of pathological disc segment [11-15]. Furthermore, 3 studies reported the type of LDH of enrolled patients [11, 13, 15], and the LDH type was evaluated using the Michigan State University (MSU) classification on MRI in the Liu 2018 study [22]. All the patients were followed up more than 12 months. As for quality evaluation, 4 retrospective studies were evaluated using NOS (**Table 2**) [12-15] and 1 RCT was assessed by Cochrane Collaboration's tool (**Table 3**) [11].

Meta-analyses of clinical outcomes

As shown in **Figure 2**, several clinical variables were compared between PTED and MED in treating LDH, including length of incision, blood loss, operative time, intraoperative fluoroscopy, postoperative in-bed time, length of hospital stay and MacNab Criteria. The results indicate that patients receiving PTED had an obviously smaller length of incision compared to those undergoing MED (MD=-1.02 cm, 95% CI=-1.21-0.83 cm, P<0.01; I^2=52%). Less blood loss was observed in PTED group when compared to the MED group (MD=-15.46 ml, 95% CI=-22.76-8.16 ml, P<0.01; I^2=58%). Similarly, patients in the PTED group had a significantly shorter postoperative in-bed time (MD=-58.74 hours, 95% CI=-99.21-18.27, P<0.01, I^2=97%) and length of hospital stay (MD=-1.27 days, 95% CI=-2.07-0.47, P<0.01, I^2=74%) compared to those in MED group. Inversely, patients in the PTED group suffered from more 10.00 seconds radiation exposure than patients in the MED group (MD=10.00 seconds, 95% CI=7.67-12.33 seconds, P<0.01). Additionally, there were no distinct differences between two groups in operative time (P=0.47) or satisfaction rate based on MacNab Criteria (P=0.53).

Meta-analyses of patient-reported outcomes

The meta-analyses to compare the patient-reported outcomes between the PTED and MED were performed. As listed in **Table 4**, there were

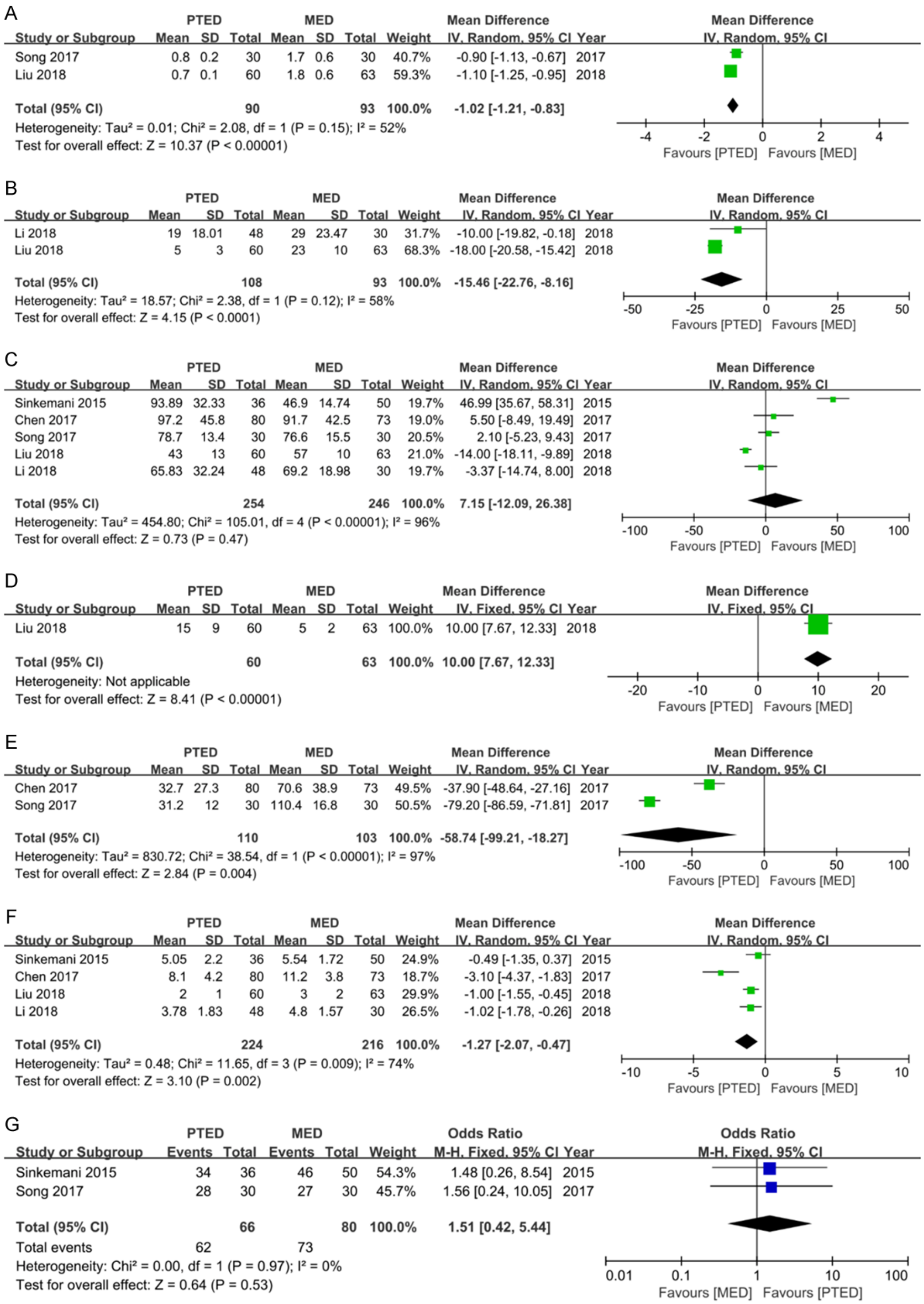

Figure 2. Meta-analyses of main clinical outcomes (A. Length of incision; B. Blood loss; C. Operative time; D. Intraoperative fluoroscopy; E. Postoperative in-bed time; F. Length of hospital stay; G. Satisfaction rate based on MacNab).

Table 4. The meta-analyses of patient-reported outcomes

Variables	Included studies	Patients (n)	Effects	P	I^2 (%)	Model
VAS-BP						
Preoperatively	[11-13]	338	SMD=-0.05, 95% CI=(-0.27, 0.16)	0.64	0	Fixed
Postoperatively	[11-13]	338	SMD=-0.73, 95% CI=(-1.61, 0.16)	0.11	93	Random
VAS-LG						
Preoperatively	[11-13]	338	SMD=-0.03, 95% CI=(-0.25, 0.18)	0.76	0	Fixed
Postoperatively	[11-13]	338	SMD=0.13, 95% CI=(-0.08, 0.35)	0.23	0	Fixed
VAS						
Preoperatively	[15]	60	SMD=-0.09, 95% CI=(-0.59, 0.42)	0.74	NA	Fixed
Postoperatively	[15]	60	SMD=0.00, 95% CI=(-0.51, 0.51)	1.00	NA	Fixed
ODI						
Preoperatively	[11-15]	484	SMD=-0.09, 95% CI=(-0.27, 0.09)	0.33	12	Fixed
Postoperatively	[11-15]	484	SMD=-0.10, 95%CI=(-0.39, 0.19)	0.49	59	Random
JOA						
Preoperatively	[13]	123	SMD=0.29, 95% CI=(-0.06, 0.65)	0.11	NA	Fixed
Postoperatively	[13]	123	SMD=-0.17, 95% CI=(-0.53, 0.18)	0.34	NA	Fixed
RR	[13]	123	SMD=-0.35, 95% CI=(-0.71, 0.00)	0.05	NA	Fixed

VAS-BP, Visual Analogue Scale of back pain; VAS-LG, Visual Analogue Scale of leg pain; VAS, Visual Analogue Scale; JOA, Japanese Orthopedic Association Scores; IR, recovery rate; ODI, Oswestry Disability Index; SMD, Std. Mean Difference; NA, not available.

Table 5. The complications in PTED and MED

Variable	PTED	MED
Dural tear	1	4
Neural injury	3	0
Transient dysesthesia	2	7
Poor wound healing	0	1
Residue/recurrence	9	6
Infection	0	1
Persistent LBP	2	0
Total	17	19

PTED, percutaneous transforaminal endoscopic discectomy; MED, microendoscopic discectomy; LBP, low back pain.

no significant differences between two groups in preoperative VAS-BP (P=0.64), VAS-LG (P=0.76), VAS (P=0.74), ODI (P=0.33) or JOA (P=0.11). Similarly, no evident differences were detected between two groups in postoperative VAS-BP (P=0.11), VAS-LG (P=0.23), VAS (P=1.00), ODI (P=0.49), JOA (P=0.34) or JOA recovery rate (P=0.05).

Meta-analysis of complications

As listed in **Table 5**, complications in the PTED or MED group included dural tear (5), neural injury (3), transient dysesthesia (9), poor wound healing (1), residue/recurrence (15), infection (1) and persistent low back pain (2). The incidence rate of complications was 9.04% (17/188) in PTED group and 11.45% (19/166) in MED group. In additions, there was no significant difference between two groups in the incidence of complications (P=0.56) (**Figure 3**).

Publication bias

Funnel plots were generated to assess the publication bias of included studies. as shown in **Figure 4**, there were no significant publication biases among included studies in the meta-analyses of length of incision (a), blood loss (b), operative time (c), intraoperative fluoroscopy (d), postoperative in-bed time (e), length of hospital stay (f), satisfaction rate based on MacNab (g) or complications (h).

Discussion

Our findings indicate that PTED and MED were both efficient and safe in the management of LDH. With respect to function recovery, there were no obvious differences between the two groups in VAS-BP, VAS-LG, VAS, ODI, JOA or MacNab Criteria. Similarly, patients in the two groups had comparable operative time and satisfaction rate. However, PTED was superior to

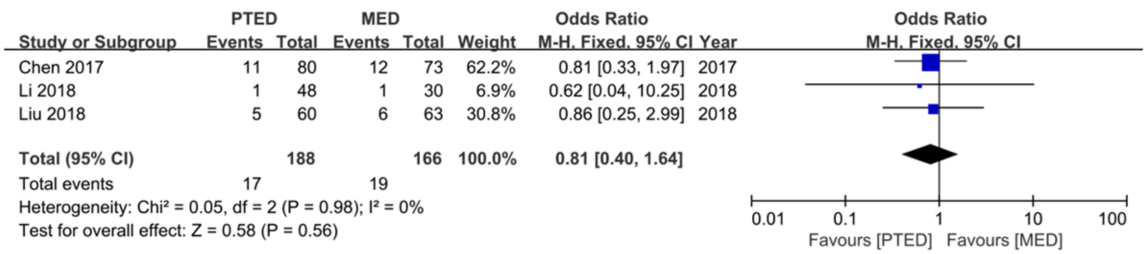

Figure 3. Meta-analyses of complications.

MED in length of incision, blood loss, post-operative in-bed time and length of hospital stay. Furthermore, more intra-operative fluoroscopy was detected in the PTED group. To the best of our knowledge, this study was the first systematic review and meta-analysis to compare the efficacy and safety of PTED with MED in treating LDH.

After first being described by Yeung et al. in 2002, PTED gains increasing popularity in the world [10]. Several studies have confirmed the good effectiveness of PTED in treating LDH [23, 24]. With the development of instruments, the indications for PTED has been widely extended, including adjacent segment disease [25], high-grade migrated LDH [26, 27] and spinal stenosis [28, 29]. Similar to PTED, MED was also a famous MISS in addressing LDH in clinical practice [8, 9]. MED induced less blood loss, shorter operative time, faster recovery and comparable clinical outcomes when compared to open spine surgeries [8, 9]. In our study, significant reduction was observed in function indicators in both groups postoperatively, including VAS, ODI and JOA as well as MacNab Criteria. Our results are in accordance with previous studies and manifested that PTED and MED both could effectively deal with the LDH [8, 9, 23, 26]. However, our results also reveal that PTED is distinctly associated with smaller length of incision, less blood loss, shorter post-operative in-bed time, and reduced length of hospital stay compared to MED. This finding suggests that PTED might be more minimally invasive than MED for LDH. Conversely, the current study found that patients undergoing PTED might suffer from increased radiation exposure compared to MED. In clinical practice, repeated fluoroscopy during the puncture process is the most important source of radiation exposure [30]. For most surgeons operating the PTED, the accurate puncture is a huge challenge, which is also the main cause of steep leaning cure of PTED. With the increase of the surgery amount, the improved puncture accuracy will help lower the radiation exposure [30, 31]. In additions, several techniques or measures have been proposed to reduce the radiation exposure in PTED, including improvement of puncture accuracy, use of protective gear and appropriate manipulation of fluoroscopic equipment [32].

Complication was another major concern for surgeons and patients. In our study, the incidence rate of the complication was 9.04% in PTED group and 11.45% in MED group, which was similar to previous studies [8-10, 24, 27]. No significant difference was observed between two groups in managing LDH. This finding indicates that both of them are safe for the treatment of LDH.

Although our study was the first meta-analysis to compare the effectiveness and safety of PTED with MED, several limitations should be considered when interpreting the results. First, although we have tried our best to search relevant studies, only 5 studies were included into the meta-analysis. The small sample size might lower the reliability of the conclusions. Second, obvious heterogeneity was detected in the meta-analyses of several variables, included postoperative in-bed time and blood loss. Subgroup analysis was not performed on account of the limited studies. Instead, a random-effect model was applied, which might reduce the persuasion of the results. Third, several factors might affect the selection between PTED and MED in treating LDH for specific patients. However, we only could obtain the reported data in published articles, which was an inherent shortcoming of the meta-analysis. In spite of these limitations, our meta-analysis provided new evidence on the comparison between PTED and MED in the treatment of LDH.

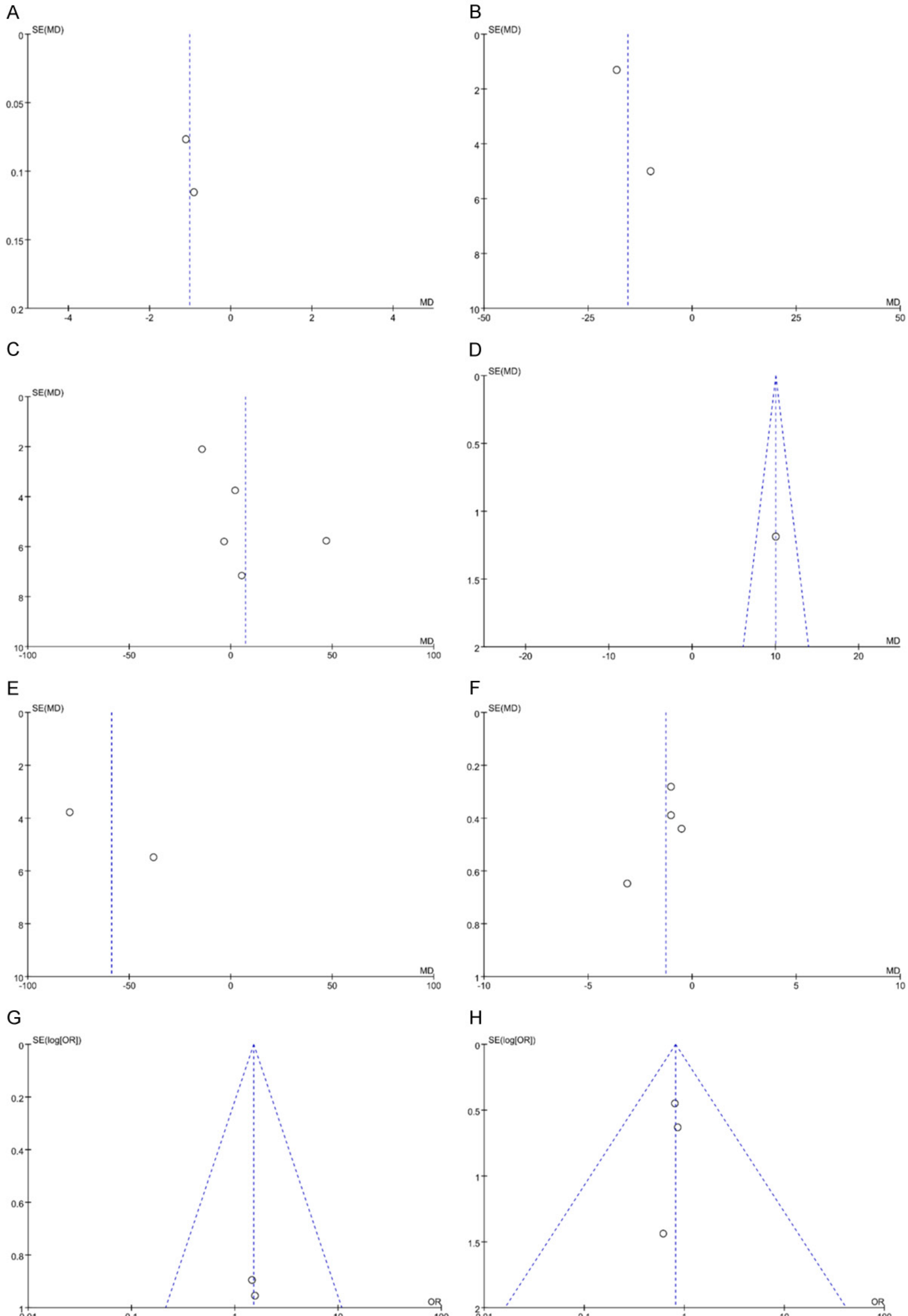

Figure 4. Funnel plots of main clinical outcomes and complications. (A. Length of incision; B. Blood loss; C. Operative time; D. Intraoperative fluoroscopy; E. Postoperative in-bed time; F. Length of hospital stay; G. Satisfaction rate based on MacNab; H. Complications).

Conclusion

PTED and MED both can address LDH sufficiently and safely. PTED is superior to MED in length of incision, blood loss, postoperative in-bed time, and length of hospital stay. However, PTED is associated with increased radiation exposure compared to MED.

Disclosure of conflict of interest

None.

Abbreviations

LDH, lumbar disc herniation; MISS, minimally invasive spine surgery; MED, microendoscopic discectomy; PTED, percutaneous transforaminal endoscopic discectomy; PRISMA, Preferred Reporting Items for Systematic reviews and Meta-analyses; RCT, randomized controlled trial; VAS, visual analogue scale; VAS-BP, VAS of back pain; VAS-LG, VAS of leg pain; JOA, Japanese Orthopedic Association Scores; ODI, Oswestry Disability Index; NOS, Newcastle-Ottawa Scale; OR, odds ratio; MD, mean difference; SMD, Std. mean difference; MSU, Michigan State University.

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