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Original Article

Percutaneous endoscopic lumbar discectomy versus conventional discectomy for lumbar disc herniation

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Abstract: Background: Controversy continues in regarding with the treatment options for lumbar disc herniation (LDH), including conventional discectomy (CD) and percutaneous endoscopic lumbar discectomy (PELD). The present meta-analysis aims to compare the efficacy and safety of CD and PELD in the surgical treatment of LDH. Methods: The Cochrane Register of Controlled Trials, PubMed, and EMBASE databases were searched for studies comparing PELD and CD in treating LDH. Statistical analysis was conducted using the software Review Manager. The relative risk was calculated for dichotomous outcomes, the mean differences were used for continuous outcomes, and the standardized mean differences for data from disparate outcome measures. Results: Five trials with a total of 392 patients were included in this study. PELD afforded a significantly better rate of patient satisfaction than CD (RR: 0.91; P = 0.85). However, there was no difference between the two procedures in terms of the pain in the lower back and buttocks (P = 0.64), relief of radiculopathy (P = 0.77), relief of abnormal reflexes (P = 0.38), relief of sensory deficit (P = 0. 20), relief of motor weakness (P = 0.63), rate of dura injury (P = 0.97), impaired wound healing (P = 0.87), frequency of urinary retention (P = 0.88), rates of transient dysesthesia (P = 0.69), recurrence rates (P = 0.85), and reoperation rates (P = 0.75). Conclusion: Therefore, we concluded that the currently popular PELD is as safe and efficient as CD in the management of LDH, while also providing better patient satisfaction than CD.

Keywords: Lumbar disc herniation, conventional discectomy, percutaneous endoscopic lumbar discectomy, meta-analysis

Introduction

Since its introduction in early 20th century [1], endoscopy has advanced rapidly, becoming the standard approach in various clinical diagnostic and therapeutic procedures such as arthroscopy and laparoscopy. Endoscopy has become increasingly popular with physicians because of its ability to minimize traumatization and adverse procedural consequences.

Lumbar disc herniation (LDH) is a very common reason for spine surgery [2]. LDH is an important cause of disability, leading to a high number of disability-adjusted life years in both developed and developing countries [3]. Currently, the treatment options for LDH include conventional discectomy (CD) and percutaneous endoscopic lumbar discectomy (PELD). Because of its high success rate of approximately 90% and good result [4, 5], CD is considered the standard surgical method in the management of LDH unresponsive to conservative therapy. However, CD is associated with some complications, including epidural scarring, destabilization of spinal canal structures, and tissue traumatization [6, 7]. In 1975, Hijikata *et al.* [8] introduced a new method-percutaneous discectomy-for the treatment of LDH. Subsequently, considerable advances were made to this minimally invasive technique. Severe trauma is associated with possible complications [9-11]. PELD is a minimally-invasive method that can reduce the tissue damage and operative time [12-14]. However, concerns have been expressed regarding the low success rate, possibility of insufficient decompression, the theoretically elevated risk of injury to exiting nerve, and a steep learning curve associated with PELD [15]. In addition, the osseous structure of the spine can compromise the mobility of the instrument. A recent meta-analysis by

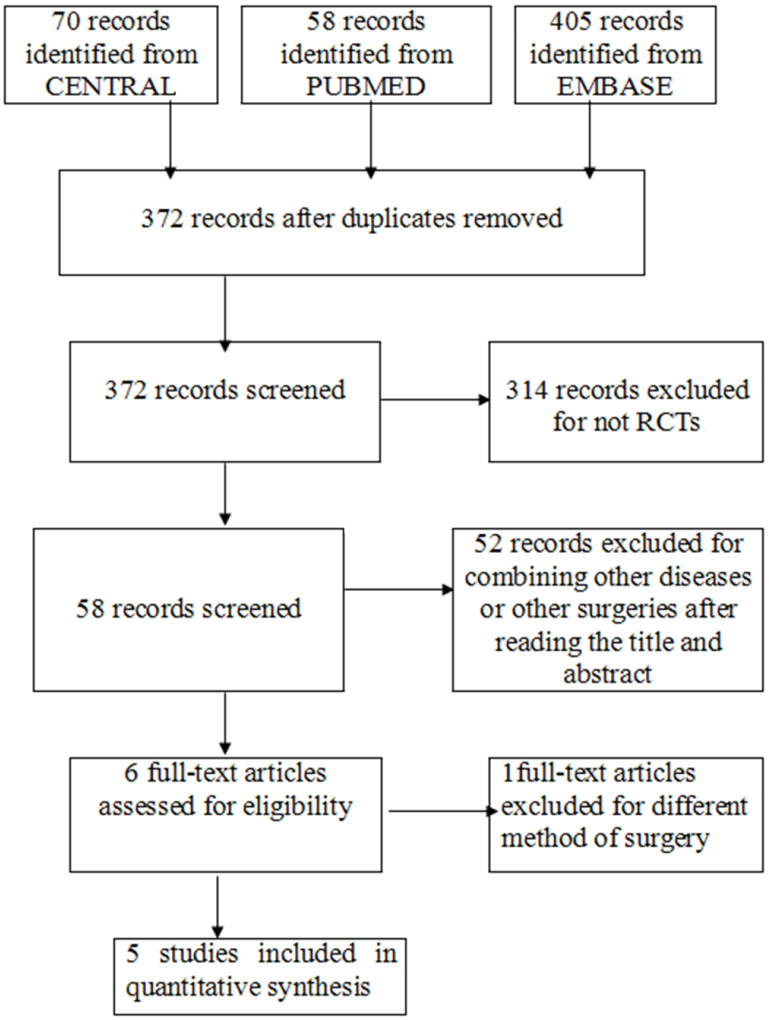

Figure 1. Flow diagram depicting the method of selecting the studies for the meta-analysis.

Chang et al. [16] compared minimally invasive discectomy (MID) (such as PELD and microendoscopic discectomy) with standard discectomy (SD). PELD has become increasingly popular among surgeons. However, only a few randomized controlled trials (RCTs) have been published on the comparison between PELD and CD, and no recent meta-analysis has been published on this subject. Although the study by Chang et al. [17] may appear similar to ours, the surgical methods, trials, and data sets analyzed in our study were different from those in their study. Therefore, before PELD acquires widespread acceptance, it is necessary to systematically evaluate its efficacy and safety.

This meta-analysis aims to compare the efficacy and safety of CD and PELD in the surgical treatment of LDH.

Methods

Eligibility criteria and literature search

We searched the Cochrane Register of Controlled Trials (CENTRAL, Issue 1 of 12, January 2014), PubMed (1980 to January 2014), and EMBASE (1980 to January 2014) databases to identify all the studies comparing the efficacy and safety of PELD and CD for LDH. The search was performed using the following keywords: "lumbar disc herniation" and "surgery" or "treatment" or "therapy" or "complications" or "adverse effect" and "randomized controlled trial" and the medical subject headings (MeSH) "intervertebral disc degeneration/complications" or "intervertebral disc degeneration/prevention and control" or "intervertebral disc degeneration/surgery" or "intervertebral disc degeneration/therapy" and randomized controlled trial. We then selected only studies conducted on human subjects. The inclusion criteria were as follows in terms of the target population, interventions examined, and study methodology, respectively: (1) patients with a clinical diagnosis of LDH; (2) CD and PELD; and (3) RCTs comparing CD with PELD in terms of efficacy or safety. The exclusion criteria were as follows: (1) patients having LDH associated with other diseases such as segmental instability, spinal stenosis, spondylolisthesis, and sequestered disc; (2) examination of other interventional measures, such as chemonucleolysis; and (3) case reports, case-control studies, and cohort studies.

The database search retrieved 533 studies: 70, 58, and 405 from CENTRAL, PubMed, and EMBASE, respectively. Two independent reviewers selected the relevant studies. The titles and abstracts of these studies were then examined and 6 of them [13, 17-21] selected for further

Table 1. Characteristics of included studies comparing conventional discectomy (CD) and percutaneous endoscopic discectomy (PELD) for lumbar disc herniation (LDH)

Authors group (time)	Country	Study type	Interventions	Length of Follow-up (months)	Sample size (CD: PELD)	For analysis
Mayer HM (1993)	Germany	RCT	CDvsPELD	24	40 (20: 20)	(1) (2) (3) (4) (5) (6) (9) (10)
Frank U (1998)	USA	RCT	CDvsPELD	24	60 (30: 30)	(1) (2) (3) (4) (5) (6) (7)
Stephen J (2002)	USA	RCT	CDvsPELD	24	27 (10: 17)	(1)
Sebastian R (2007)	Germany	RCT	CDvsPELD	24	178 (87: 91)	(1) (3) (8) (9) (10) (11) (12)
Sebastian R (2009)	Germany	RCT	CDvsPELD	24	87 (42: 45)	(1) (3) (7) (8) (9) (10) (11) (12)

For analysis: (1) satisfactory; (2) pain in low back and buttocks; (3) radicular symptoms; (4) reflex abnormality; (5) sensory deficits; (6) motor weakness; (7) dura injury; (8) wound problem; (9) urinary retention; (10) transient dysesthesia; (11) recurrence; (12) reoperation.

analysis. The full texts of these 6 studies were then examined and one study by Chatterjee [18] was excluded from the analysis because it employed different surgical methods. The remaining 5 RCTs were deemed to be the primary relevant studies and were included in this meta-analysis (**Figure 1**).

Outcome assessment

The measured outcomes included the following: patient satisfaction; improvement of symptoms (pain in the lower back and buttocks, radiculopathy, abnormal reflexes, and sensory deficits); complications (dura injury, impaired wound healing, urinary retention, and transient dysesthesia); and recurrence and reoperation.

Data extraction and quality assessment

From each paper, we gathered data on the following parameters: study type; interventions investigated; follow-up duration (months); sample size of both treatment groups (CD: PELD); presence or absence of random sequence generation; allocation concealment; blinding of participants, personnel, and outcome assessment; completion of outcome data; and selective reporting. The data were extracted independently by 2 researchers on the basis of the prespecified selection criteria. Disagreements were resolved by mutual discussion. We used the Cochrane Collaboration risk of bias tool to assess the quality of the included trials.

Statistical analyses

Statistical analysis was conducted using the software Review Manager, version 5.2 (The Nordic Cochrane Centre, the Cochrane Collaboration, 2012). The heterogeneity in each study was assessed by visual inspection of the forest plot and I^2 tests. Significance levels of more than 50% for the I^2 test were considered as evidence of heterogeneity. The I^2 test was used to estimate the total variation across studies. With regard to the analysis of the treatment effects assessed in the studies, the relative risk (RR) was calculated for dichotomous outcomes. On the other hand, for continuous outcomes, the mean differences (MD) were used for studies with comparable outcome measures and the standardized mean differences (SMD), for data from disparate outcome measures; both values were provided with 95% confidence interval (CI). The fixed model effect was applied when there was no statistical evidence of heterogeneity and the random effect model, if such evidence was obtained.

Results

Characteristics and qualities of the included studies

Five trials conducted on a total of 392 patients were identified as the primary relevant group, on the basis of the inclusion criteria. The study characteristics are presented in **Table 1**. Selection bias can be avoided by adequate allocation concealment [22]; one study [19], which used sealed envelopes, was considered to have adequate randomization and allocation concealment, while the status of the four other studies could not be clearly verified (**Table 2**). All outcome assessments can be compromised by a lack of blinding [23], but blinding of patients is generally difficult because patients are legally entitled to be aware of the nature of the

Table 2. Quality assessment of randomized controlled trials comparing conventional discectomy (CD) and percutaneous endoscopic discectomy (PELD) using Cochrane Collaboration's tool for assessing risk of bias

Authors group (time)	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting
Mayer HM (1993)	Unclear	Unclear	N/A	Y	Y	Y
Frank U (1998)	Y	Y	N/A	Unclear	Y	Y
Stephen J (2002)	Unclear	Unclear	N/A	Unclear	N	Unclear
Sebastian R (2007)	Unclear	Unclear	N/A	Y	Unclear	Y
Sebastian R (2009)	Unclear	Unclear	N/A	Y	Unclear	Y

Y low risk of bias, N high risk of bias, Unclear unclear risk of bias, N/A not applicable.

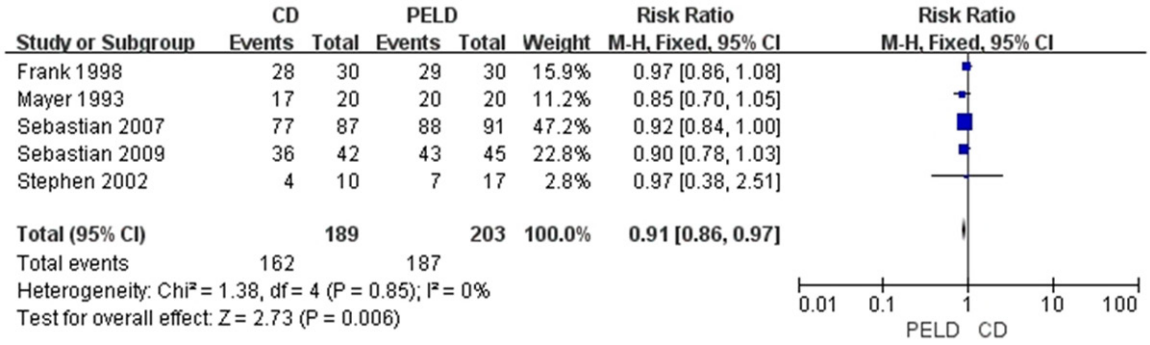

Figure 2. Comparison of conventional discectomy and percutaneous endoscopic discectomy in terms of patient satisfaction.

administered treatment. Three studies [13, 17, 21] involved blinding of outcome assessment. Two studies [17, 21] had no case that was lost to follow-up, whereas three studies [17, 19, 20] provided data on the dropout percentage and cases lost to follow-up. Four of the studies [13, 17, 19, 21] were free of selective reporting. The following are the categories for which CD and PELD were compared:

Patient satisfaction

Data pooled from the five selected trials evaluating a total of 392 patients indicated that PELD afforded a significantly better rate of patient satisfaction than CD (RR: 0.91; 95% CI: 0.86-0.97; P = 0.85, I^2 = 0%) (**Figure 2**).

Symptom relief

Pain in lower back and buttocks: A fixed-effects model meta-analysis of two trials based on a total of 99 patients yielded a pooled risk ratio that showed that there was no statistical difference between CD and PELD in terms of the status of pain in the lower back and buttocks at 24 months after surgery (RR: 1.50; 95% CI: 0.90-2.48; P = 0.64; I^2 = 0%) (**Figure 3A**).

Radiculopathy: Data obtained in four trials on 365 patients suggested that there was no statistical difference between CD and PELD in terms of relief of radiculopathy (RR: 1.25; 95% CI: 0.82-1.90, P = 0.77; I^2 = 0%) (**Figure 3B**).

Reflex abnormality: The pooled risk ratio of two trials on 75 patients showed that there were no differences between the two surgical techniques in terms of the relief of abnormal reflexes at 24 months after surgery (RR: 1.04; 95% CI: 0.46-2.36; P = 0.38; I^2 = 0%) (**Figure 3C**).

Sensory deficit: Data from two trials involving 89 patients suggested that there was no statistical difference between CD and PELD in terms of postoperative relief of sensory deficit (RR: 1.31; 95% CI: 0.84-2.06; P = 0. 20; I^2 = 0%) (**Figure 3D**).

Motor weakness: Two studies conducted on 65 patients provided data on postoperative relief of motor weakness. The analysis showed that

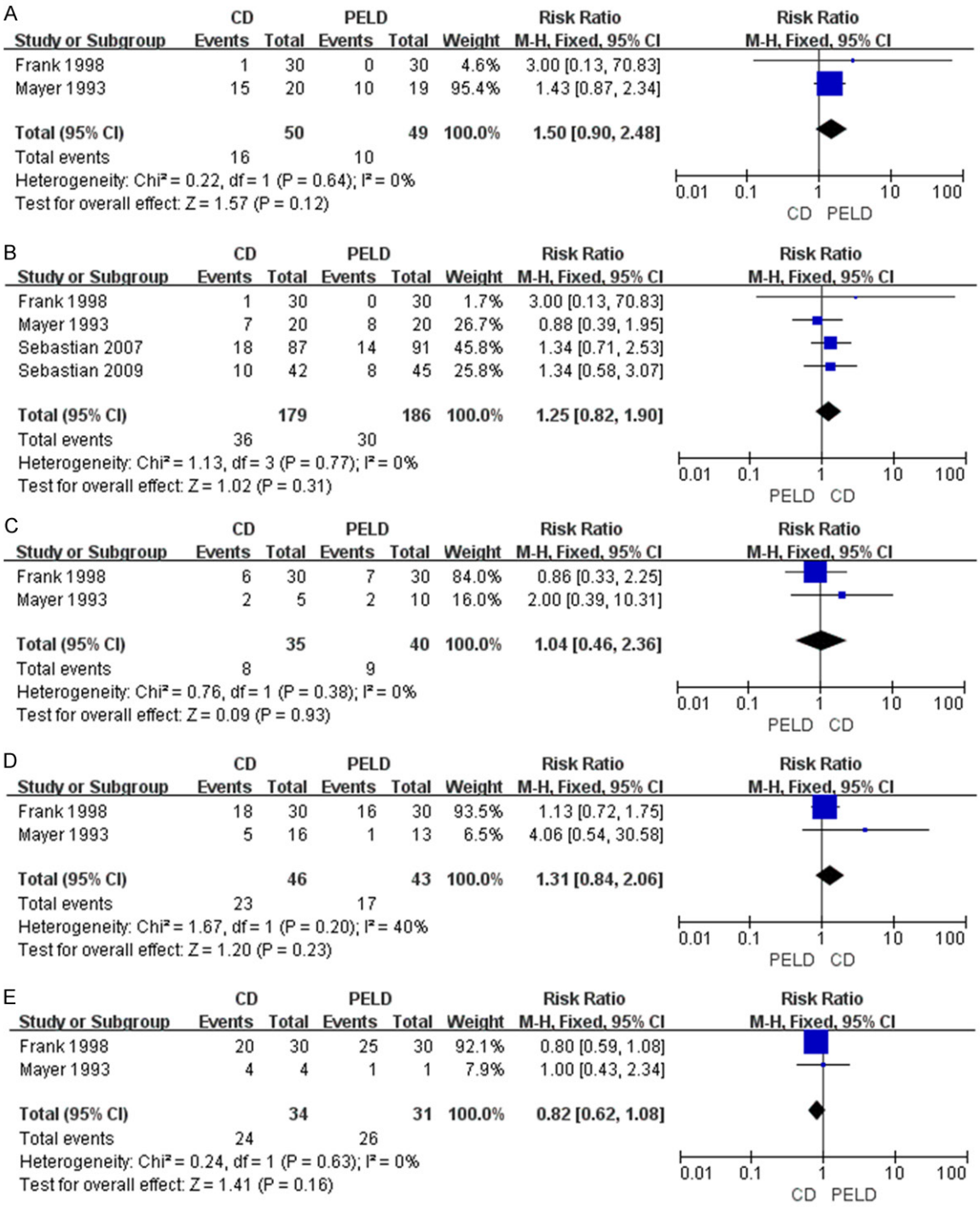

Figure 3. A: Forest plot showing the relief of pain in the lower back and buttocks resulting from CD vs PELD; B: Forest plot showing the relief of radiculopathy that result from CD vs PELD; C: Forest plot showing the relief of abnormal reflexes resulting from CD vs PELD; D: Forest plot showing the relief of sensory deficits that result from CD vs PELD; E: Forest plot showing the relief of motor weakness resulting from CD vs PELD.

the CD and PELD did not differ from each other in terms of relief of motor weakness (RR: 0.82; 95% CI: 0.62-1.08; P = 0.63; I^2 = 0%) (**Figure 3E**).

Complications

Dura injury: Two relevant studies showed that CD and PELD did not differ with respect to the

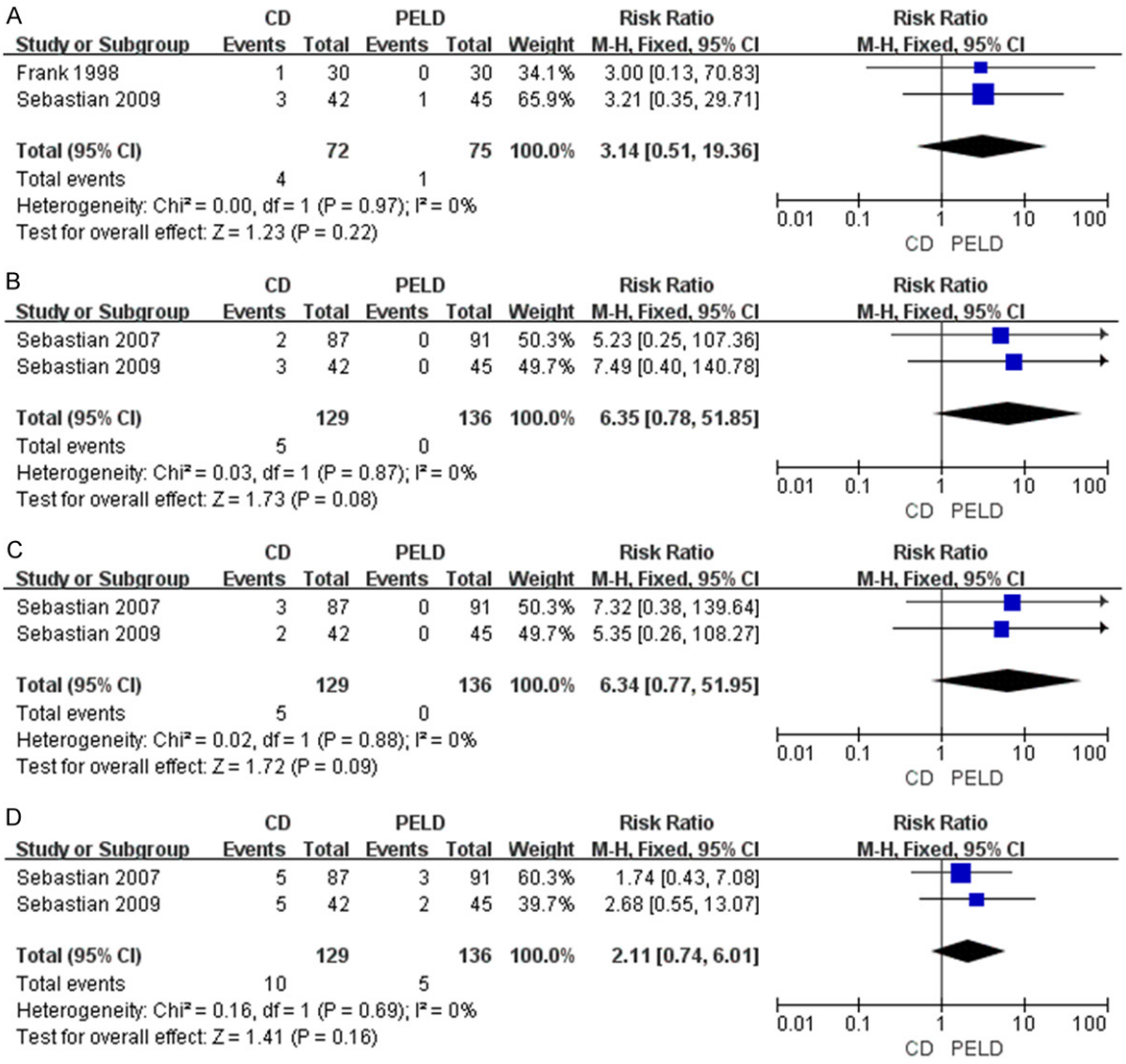

Figure 4. A: Forest plot showing the dura injury resulting from CD vs PELD; B: Forest plot showing the impaired wound healing that result from CD vs PELD; C: Forest plot showing the urinary retention resulting from CD vs PELD; D: Forest plot showing the transient dysesthesia after surgery that result from CD vs PELD.

rate of dura injury (RR: 3.14; 95% CI: 0.51-19.36; P = 0.97; I^2 = 0%) (**Figure 4A**).

Impaired wound healing: Two trials reported data on impaired wound healing due to infection or delay in wound healing and showed no statistical differences between the two methods (RR: 6.35; 95% CI: 0.78-51.85; P = 0.87; I^2 = 0%) (**Figure 4B**).

Urinary retention: In 2 studies comprising a population of 265 patients, no statistically significant difference was noted between CD and PELD in terms of the frequency of urinary retention after surgery (RR: 6.34; 95% CI: 0.77-51.95; P = 0.88; I^2 = 0%) (**Figure 4C**).

Transient dysesthesia: Data of two trials on 265 patients showed that CD and PELD did not differ in terms of the rates of postoperative transient dysesthesia (RR: 2.11; 95% CI: 0.74-6.01; P = 0.69; I^2 = 0%) (**Figure 4D**).

Recurrence and reoperation

Data pooled from three trials conducted on 305 patients in all indicated that there was no statistical difference between the two methods in terms of recurrence rates (RR: 0.75; 95% CI: 0.30-1.86; P = 0.85; I^2 = 0%) (**Figure 5A**). Three studies that included 305 patients provided data on the reoperation rates, which showed no significant difference between CD and PELD

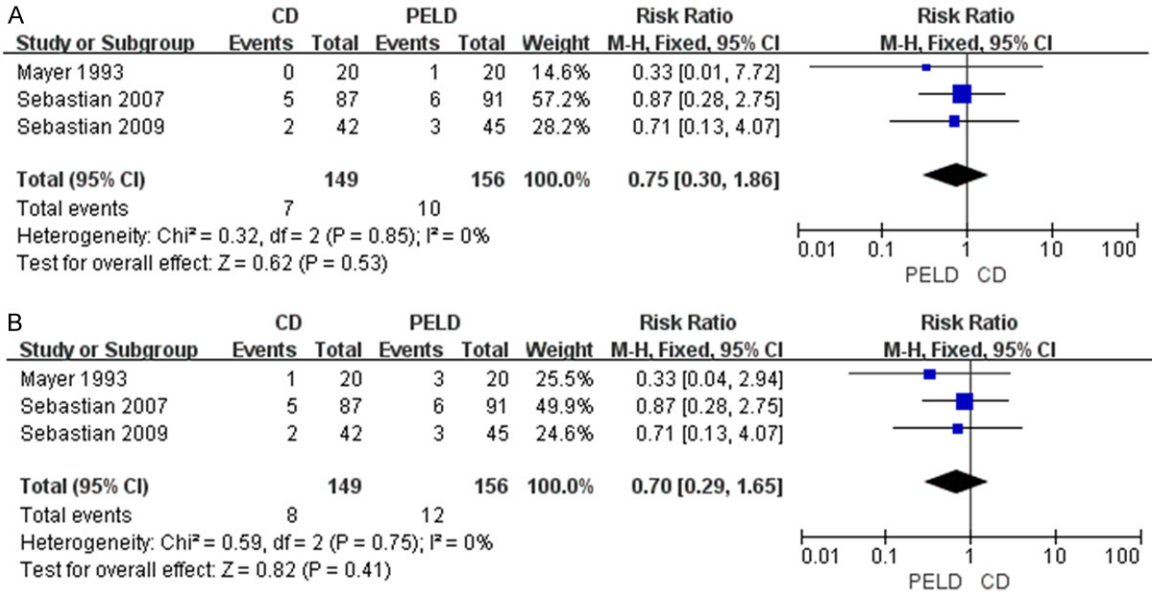

Figure 5. A: Forest plot showing the recurrence resulting from CD vs PELD; B: Forest plot showing the reoperation that result from CD vs PELD.

(RR: 0.70; 95% CI: 0.29-1.65; P = 0.75; I^2 = 0%) (**Figure 5B**).

Publication bias

In our meta-analysis, we did not account for the possibility of publishing bias because the number of studies included was less than nine.

Discussion

This meta-analysis included data from 5 prospective RCTs involving 189 and 203 patients with LDH treated with CD and PELD, respectively. Our meta-analysis indicated that PELD afforded significantly better patient satisfaction than CD. However, the two surgical approaches showed no significant differences with respect to the other outcomes assessed, i.e., symptom relief, rate of complications, and rates of recurrence and reoperation.

Analysis of the efficacy and safety of any treatment is very important before it is widely accepted. Surgery is considered for the patients who fail to respond to comprehensive conservative treatment measures. It is also known that patients can show spontaneous improvement over time under adequate conservative treatment [24]; this can result in an overestimation of the efficacy of a given surgical treatment administered without sufficient trial of conservative treatment approaches. Further, some investigators have suggested that some of the good outcomes observed soon after surgery may be reversed with time [25]. All the patients investigated in the studies included in our meta-analysis had received sufficient conservative treatment and had been followed up for periods as long as 24 months. The efficacy of a procedure can be evaluated through patient satisfaction and symptom relief. Although CD is the gold standard for LDH, our meta-analysis showed that PELD afforded better patient satisfaction than CD. Since no statistical differences were noted between the two procedures in terms of symptom relief, we can also infer that PELD is as efficient as CD in the management of LDH. The safety of a treatment measure is evaluated on the basis of the rates of complications, recurrence, and reoperation associated with the procedure. Since the two methods yielded similar results in these aspects, we can infer that PELD is as safe as CD in the treatment of LDH.

The goal of surgical correction of LDH is sufficient decompression with minimization of traumatization and resultant sequelae. CD is performed under the cover of general anesthesia. The procedure involves skin incision, dissection of the paraspinal muscles, removal of the yellow ligament, penetration of the spinal canal,

manipulation of the nerve root, dissection and coagulation of the epidural vessels, perforation of the annulus fibrosus and the posterior longitudinal ligament, and finally removal of the nucleus pulposus. Sufficient decompression can be achieved under direct visualization. PELD is performed under local anesthesia [26, 27] and can minimize the traumatization and its sequelae. However, the procedure is associated with a steep learning curve, and sometimes, sufficient decompression cannot be achieved with this approach. In a few cases in the trials included in this meta-analysis, some patients had residual or recurrent symptoms after PELD and required subsequent CD, which provided good results.

Because PELD is a minimally-invasive method, some surgeons believe that it is effective enough to replace CD as the primary corrective procedure for LDH [28]. Others consider that there is no sufficient evidence to justify this preference [29]. More high-quality studies on larger groups of patients are required to compare the two methods and confirm the results statistically.

As is the case with most meta-analyses, it is necessary to consider the results of our studies in the light of certain limitations. Firstly, our meta-analysis was conducted using a public method and was designed to enable repeated research selection and inclusion. Studies were identified by electronic searches of the CENTRAL, PubMed, and EMBASE databases, without restriction of language. Although the search strategy was broad and extensive, not all related prospective RCTs studied were included; this was mainly because of publication bias, which may exclude any obvious outcome differences between the two therapeutic methods. In our meta-analysis, we did not account for the possibility of publishing bias because the number of studies included was small. Secondly, we attempted to collect data for other parameters, such as the operative time, duration of postoperative disability, intraoperative blood loss, duration of narcotic use, time at which patient resumed work, the clinical assessment scores, and so on. However, we could not obtain intact data in terms of mean and SD, and the clinical scores reported in the studies were based on different assessment criteria. Therefore, these data of continuous variables could not be compared. Thirdly, PELD included interlaminar and transforaminal approaches. But we did not find enough related studies to compare the interlaminar approach with the transforaminal approach. So the interlaminar approaches with the transforaminal approach were all included in PELD. Fourthly, detection bias may be generated because of a lack of blinding of participants and outcome assessment [23]. In some studies, the number of cases included was small and the proportion of cases lost to follow up was more than 10%, which may introduce attrition bias. Fifthly, the results of an observational study may be influenced by unmeasured confounders, which may introduce other sources of bias.

In conclusion, our meta-analysis showed that PELD and CD were similar with respect to symptom relief, complication rates, and rates of recurrence and reoperation. However, PELD afforded better patient satisfaction than CD. Therefore, we concluded that the currently popular PELD is as safe and efficient as CD in the management of LDH, while also providing better patient satisfaction than CD.

Disclosure of conflict of interest

None.

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