Original Research Article

Percutaneous Endoscopic Transforaminal Discectomy versus Conventional Open Lumbar Discectomy for Lumbar Disc Herniation: a Systematic Review

Abstract

Introduction: Despite several surgical methods for lumbar disc herniation, open lumbar microdiscectomy is considered the gold standard. Recently, percutaneous endoscopic lumbar discectomy is also frequently performed for lumbar disc herniation.

Objectives: The aim of this study is to determine whether percutaneous endoscopic lumbar discectomy and conventional open lumbar microdiscectomy show better results as a surgical treatment of lumbar disc herniation.

Methods: The analysis of this review, research papers examining endoscopic percutaneous endoscopic transforaminal discectomy and conventional open discectomy were investigated, both of which are surgical methods for treating lumbar disc herniation. Papers from 1973, when percutaneous endoscopic lumbar discectomy was first introduced until 2022 searched in the Google Schoolar and PubMed databases.

Results: The 8 papers with 5,314 patients were selected. The comparative study revealed that percutaneous endoscopic lumbar discectomy has significantly better outcome than open lumbar microdiscectomy. The comparison between PETD procedures and conventional open discectomy show that all procedures have a good result. However, the PETD procedure has advantages including better visual analog pain scale (VAS), better confidence interval, lower oswestry disability index, shorter operating time, shorter hospitalization time, lower complication rate, lower recurrence rate and reoperation rate is also low.

Conclusion: While percutaneous endoscopic lumbar discectomy shows better results than conventional open discectomy in several items. Conventional open discectomy still shows good clinical results. It is therefore envisaged that a systematic review trial with a large study sample and more literature will be needed in the future to compare these two surgical methods.

1. Introduction

The intervertebral disc consists of an inner nucleus pulposus (NP) and an outer annulus fibrosus (AF). The central NP is a site of collagen secretion and contains numerous proteoglycans (PG), which facilitate water retention, creating hydrostatic pressure to resist axial compression of the spine (Kadow T, 2015). The NP is primarily composed of type II collagen, which accounts for 20% of its overall dry weight. In contrast, the AF functions to maintain the NP within the center of the disc with low amount of PG; 70% of its dry weight is comprised of primarily concentric type I collagen fibers (Kalb S, 2012). In LDH, narrowing of the space available for the thecal sac can be due to protrusion of disc through an intact AF, extrusion of the NP through the AF though still maintaining continuity with the disc space, or complete loss of continuity with the disc space and sequestration of a free fragment (Raj M. Amin, 2017).

Lumbar disc herniation (LDH) refers to rupture of the annulus fibrosa and protrusion of the nucleus pulposus at L3-4 or above and has a low incidence of 1-10.4% but a high misdiagnosis rate (Yuce I, 2019). The upper and lower LDH have unique anatomic differences, including a small spinal canal, a narrow distance between the exiting nerve roots and the dura, a short nerve root, and an adjacent location with lumbosacral enlargement of the spinal cord (Lee D.S, 2013). Thus, surgical decompression for LDH is quite important, although the challenges and risks of surgery are higher and the results are less than satisfactory (Ziquan Li, 2020).

In recent years, more and more clinical studies have confirmed that percutaneous endoscopic lumbar discectomy has the same efficacy as conventional surgery but has advantages such as minimal bleeding, reduced soft tissue damage, and shorter postoperative recovery time (Kim M, 2018). With the development and advancement of surgical techniques, percutaneous endoscopic transforaminal discectomy (PETD) is reported to be a viable alternative to LDH that does not require laminectomy and Dural traction (Shin M.H, 2019). however, related articles on PETD for LDH are limited, and there have been no studies comparing conventional open discectomy in treating LDH. Therefore, we carried out a systematic review study of PETD versus conventional open discectomy to evaluate the surgical outcomes and advantages of each technique and describe a specific technique strategy for PETD for LDH.

2. Objectives

The aim of this study was to evaluate the surgical outcomes and advantages of each technique as well as to describe the specific PETD technique strategy for LDH.

3. Methods

3.1 A systematic search was performed on PubMed and Google Scholar for a randomized trial from inception to July 10, 2022. A randomized controlled trial investigating multiple surgical approaches in lumbar disc herniation identified without language restrictions. endoscopic discectomy, percutaneous endoscopic transforaminal discectomy, and conventional open discectomy and lumbar herniation were used as keywords. The trial was entered according to the following criteria: (1) a comparison was made between PETD and conventional open discectomy; (2) the trial intervention was PETD and conventional open discectomy (3); the patients were adults who had lumbar herniation and failed conservative treatment; (4) contains at least 1 result of interest. trials were excluded if: the intervention differed from the previous description.

3.2 Screening

After initial identification of titles and abstracts, 7550 articles were obtained from Google scholar, and from PubMed acquired 841, so the total result articles were 8931. The research was screened by title and abstract, and then 306 articles were obtained. The researcher reviewed the full-text category. 296 journals were excluded because they did not meet the requirements. 10 remaining journals were reviewed in full, and 2 were excluded because they were not eligible for inclusion criteria. In the final stage, 8 remaining studies were reviewed and screened for inclusion based on relevance to the subject and outcomes.

3.3 Inclusion Criteria and Exclusion Criteria

The searched papers were selected based on the following criteria: (1) those which were either randomized or nonrandomized controlled trials, (2) those with at least significant degenerative symptoms and patient trauma on LDH who underwent PETD or Conventional Open Lumbar Discectomy, and (3) those on patients who underwent PETD or Conventional Open Lumbar Discectomy for lumbar disc herniation. The papers on those who had a (1) combined surgery and lesions in more than one area, (2) incomplete data and (3) animal trial were excluded.

3.4 Data extraction and Synthesis of Data

The researchers extracted data independently. Interesting trial characteristics and results were carefully extracted and examined. The primary outcomes were operative time, length of hospital stay, volume of blood loss and complication rate between PETD and conventional open discectomy. Secondary outcomes were clinical outcomes evaluated with MACNAB criteria, reoperation rate, recurrence rate, visual analogue scale (VAS), oswestry disability index (ODI), Japanese orthopedic association back pain evaluation questionnaire (JOA) between PETD and conventional open discectomy. Fluoroscopy time, operation time, postoperative bed rest time and clinical outcome were evaluated by MACNAB criteria. To compare the effects of several surgical techniques more precisely, a subgroup analysis was performed based on: trial intervention.

3.5 Assessment of risk of bias

The selection process risk-of-bias criteria was used for evaluating the risk of bias in each included trial. The classifications of bias were based on 7 items: random sequence generation (selection bias), allocation concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), selective reporting (reporting bias) and other bias. Each item was rated as low risk, unclear risk, or high risk.

Figure 1. Article Search Process

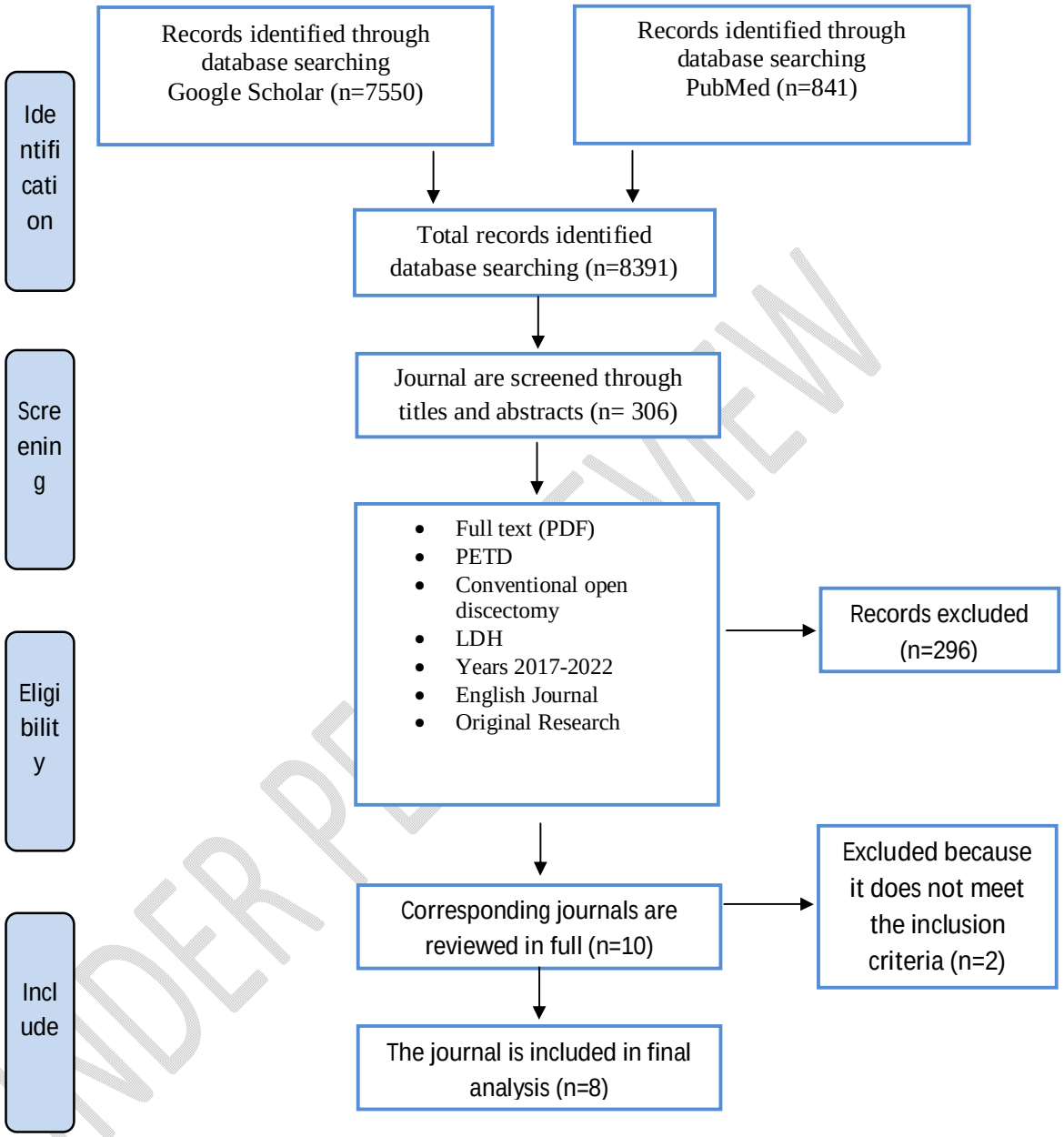

Table 2. studies Characteristic

No	Author	Title	Objectives	Methods study / design study	Instrument	Sample	Result
1.	(Wei-shang Li et all., 2022)	Comparison of endoscopy discectomy versus non-endoscopic discectomy for symptomatic lumbar disc herniation: a systematic review and meta-analysis	to systematically compare the effectiveness and safety of endoscopic discectomy (ED) with non-endoscopic discectomy (NED) for treatment of symptomatic lumbar disc herniation (LDH)	Systematic review and meta-analysis	Randomized control trial	(n=2258)	The length of hospital stay of percutaneous endoscopic lumbar discectomy (PELD) was shorter than fenestration discectomy (FD). Significant differences in intraoperative blood loss volumes were found between PELD with FD and MED with OD.
2.	(Colin Komahen et all., 2022)	Clinical outcomes of transforaminal percutaneous endoscopic lumbar discectomy in Malaysia	present clinical outcomes of TPED among the Malaysian population.	Retrospective study	Retrospective analysis	(n=30)	of 30 patients were included for PETD procedure with a mean age of 40.7 years. most had radiculopathy with a mean symptom duration of about 6.5 months. The mean Analog Scale Score (VAS) was significantly reduced 6 months postoperatively. the mean Oswestry Disability Index increased significantly, and three quarters of the patients had excellent outcomes based on the Macnab Criteria. only 3 experienced complications (nerve injury, recurrence, and skin irritation) but there was no relationship between Macnab outcome and patient characteristics

3.	(Uleschenko D.V. et all., 2022)	Evaluation of Outcomes of Surgical Treatment of Herniated Discs in the Lumbar Spine by Different Methods on the VAS and Oswestry Scales	to evaluate the outcomes of surgical treatment of disc herniation in the lumbar spine using different methods (microdiscectomy vs. endoscopy) according to the VAS and Oswestry scales.	Comparison study	Retrospective analysis	(n=54)	The advantage of endoscopic surgical techniques over microdiscectomy, which reduces the duration of hospitalization with the same clinical effect, was found.
4.	(Cheng Ma et all., 2021)	Comparison of percutaneous endoscopic interlaminar discectomy and open fenestration discectomy for single-segment huge lumbar disc herniation: a two years follow-up retrospective study	The purpose of this retrospective study was to compare the surgical outcomes of percutaneous endoscopic interlaminar discectomy (PEID) and OFD for single-segment huge lumbar disc herniation (HLDH).	Retrospective study	Retrospective analysis	(n=91)	Compared with the traditional surgery, PEID has the following benefits: less trauma, less bleeding, speedy recovery, and shorter hospitalization. Therefore, PEID may be a promising alternative to traditional surgery.
5.	(Xingping Xu et all., 2021)	Clinical efficacy and safety of percutaneous spinal endoscopy versus traditional open surgery for lumbar disc herniation: systematic review and meta-analysis	Systematic analysis of the incidence of percutaneous spinal endoscopic technique and traditional open surgery for lumbar disc herniation.	Systematic review and meta-analysis	Randomized control trial		Compared with the traditional open surgical treatment of lumbar disc herniation, percutaneous spinal endoscopic technology has obvious advantages in reducing nerve root injury, dural injury, and surgical area wound complications, but it is limited to preventing the technical characteristics of the surgical site, which is worse than that of open surgery.
6.	(Ziquan Li et all., 2020)	Percutaneous endoscopic transforaminal discectomy versus conventional open lumbar discectomy for upper lumbar disc herniation: a comparative cohort study	To compare studies have evaluated PETD for upper LDH, and no study has compared the advantages of endoscopic procedures versus conventional surgery	Comparative cohort study	Two group random control trial	(n=42)	It can be concluded that PETD surgically yields satisfactory results in the treatment of upper LDH and results in a reduced incidence of iatrogenic injury, minimal activity recovery, and accelerated ambulation recovery

							compared to conventional surgical methods.
7.	(Manyoung Kim et all., 2018)	A Comparison of Percutaneous Endoscopic Lumbar Discectomy and Open Lumbar Microdiscectomy for Lumbar Disc Herniation in the Korean: A Meta-Analysis	to determine through a meta-analysis whether PELD or OLD has better results as a surgical treatment for lumbar disc herniation in the Korean population.	Meta-analysis	Secondary data collection	(n=1254)	Percutaneous endoscopic lumbar discectomy showed better results than open lumbar microdiscectomy in some items, but open lumbar microdiscectomy still showed good clinical results.
8.	(Rongqing Qin et all., 2018)	Percutaneous Endoscopic Lumbar Discectomy Versus Posterior Open Lumbar Microdiscectomy for the Treatment of Symptomatic Lumbar Disc Herniation: A Systemic Review and Meta-Analysis	The purpose of this systematic review and meta-analysis was to compare the clinical efficacy between percutaneous endoscopic lumbar discectomy (PELD) versus posterior open lumbar microdiscectomy (OLMD) for the treatment of symptomatic lumbar disc herniation.	Systematic review and meta-analysis	Secondary data collection	(n=1585)	the PELD group had a higher incidence of residual disk or incomplete decompression than did the OLMD group. In addition, no significant difference was detected in the operation time between the 2 groups, but the PELD group was associated with shorter hospital stay and time of return to work.

3.6 Methodological characteristic

Base on the eight studies reviewed, three used the systematic review and meta-analysis method (Wei-shang Li et all., 2022), (Xingping Xu et all., 2021), (Rongqing Qin et all., 2018). Two used retrospective study (Colin Komahen et all., 2022) and (Cheng Ma et all., 2021). Two comparative study (Uleschenko D.V. et all., 2022) and (Ziquan Li et all., 2020). One used meta-analysis (Manyoung Kim et all., 2018).

3.7 Intervention methods

Out of the eight studies, three studies used systematic review and meta-analysis (Wei-shang Li et all., 2022), (Xingping Xu et all., 2021), (Rongqing Qin et all., 2018). Two studies used a retrospective study (Colin Komahen et all., 2022) and (Cheng Ma et all., 2021). Two comparative study (Uleschenko D.V. et all., 2022) and (Ziquan Li et all., 2020). One study used a meta-analysis (Manyoung Kim et all., 2018).

4. Result

Of 8.391 record initially identified eight studies were assessed by full-text review. A total of 306 papers were searched, and 296 of them, which did not meet the selection criteria, were excluded. Figure 1 illustrates how the papers were selected, and the final 8 papers satisfied the inclusion criteria and were included in this study's analysis. 7 out of 8 studies showed that a comparison between PETD procedures and conventional open discectomy showed that all procedures showed good results. However, the PETD procedure has advantages including better visual analog pain scale (VAS), better confidence interval, lower oswestry disability, shorter operating time, shorter hospitalization time, lower complication rate, lower recurrence rate and reoperation rate is also low.

5. Discussion

In total, the systematic review obtains eight articles that relevant to the subjects and outcomes. The disadvantage of the conventional posterior approach is that patients must undergo internal fixation and lumbar fusion, as the excessive removal of bony tissue may induce iatrogenic spondylolysis and segmental spinal instability. To avoid the iatrogenic instability and spinal fusion resulting from conventional posterior lumbar discectomy for LDH, minimally invasive percutaneous endoscopic transforaminal surgery that was previously used for lower LDH has become an alternative technique for treating LDH; compared with the conventional approach, PETD for LDH reportedly results in decreased iatrogenic injury, accelerated rehabilitation, and reduced hospitalization.

The distinctive advantages of PETD over conventional posterior lumbar discectomy may depend on the following factors First, PETD results in shorter operative duration, minimal blood loss and wound drainage, less wound complications and postoperative instability due to the reduced iatrogenic tissue trauma resulting from the small skin incision, less paravertebral muscle injury, and preservation of posterior ligamentous and bony structures. Second, PETD is feasible

under local anesthesia combined with conscious sedation, contributing to less anesthesia-related complications and quicker recovery with a shorter inpatient stay. The early rapid recovery has been shown to be effective at reducing deep vein thrombosis. Furthermore, using the transforaminal endoscopic approach at the lumbar level enables the extruded disc to be removed without Dural retraction, and the segmental motion can be preserved. In consequence, unnecessary application of an implant could be reduced by PETD for the treatment of LDH.

5.1 Preoperation

a. Vas score

Among the 8 papers, 7 the mean of leg pain in patients after PETD and Conventional Open Lumbar Discectomy at follow-up days 1, 3 months and 12 months after surgery decreased using the VAS score. of the second group which was assessed by the vas score showed that conventional lumbar discectomy showed the postoperative score was 3-4. while the PETD shows a significant vas score of 1-2.

b. JOA score

Among the 8 papers, 8 presented the JOA score before surgery in both groups of patients had a moderate and severe mean severity after PETD and conventional open discectomy were performed, the results of the evaluation of the JOA score increased quite well. of the two measures have a significance value that has no difference.

c. Oswestry disability index

Among the 8 papers, 8 presented the Oswestry Disability Index before surgery in both groups of patients had a moderate and severe mean severity after PETD and conventional open discectomy, the results of the evaluation of the Oswestry Disability Index experienced a fairly good improvement. of the two measures have a significance value that has no difference.

d. Macnab Classification at the Final Follow-Up

Among the 8 papers, 8 presented the results of the Macnab score (success rate), and 1,039 subjects were included in the analysis: 357 in the PETD group and 682 in the Open Lumbar Discectomy group. Those who answered with excellent or good were defined as successful, and 298 among the 357 subjects in the PETD group answered with successful in the Macnab criteria. Among the 682 subjects in the Conventional Open Lumbar Discectomy group, 564 answered with successful. There were no significant differences in the average Macnab score (success rate) between the PETD and Conventional Open Lumbar Discectomy group groups

5.2 Intraoperation

The conventional open lumbar discectomy group in the procedure, the operation was performed under general anesthesia in the prone position on a radiolucent operating table. A midline skin incision is made and the paravertebral muscles are divided. Scar tissue is carefully removed to identify the edges of the previous laminotomy, and the surgeon is careful not to tear the dura mater. Various surgical procedures are performed including implants, microdiscectomy,

laminotomy or laminectomy, and discectomy/without fusion. Each wound is closed in layers after adequate nerve root decompression.

In the PETD group PETD is performed with the patient in the lateral decubitus position under local anesthesia. Surgical segment and puncture entry point were confirmed under AP and lateral C-arm fluoroscopy guidance. The steep angle of passage (35-45°) of the needle and continuous feedback from the patient are thought to injure the Dural sac and traverse the nerve roots. Middle needle at the posterior edge of the intervertebral disc and vertebral body on fluoroscopy as it approaches the pedicle line on the AP fluoroscopy view. The needle is then replaced with a guidewire, an obturator that enlarges through the guidewire, and a functioning cannula (endoscope system) is inserted. The ruptured fragment of the herniated disc was resected endoscopically with forceps and coagulation. Attention is paid to the space between the disc and ligamentum flavum and to the ventral and lateral sides of the traversing nerve roots to ensure that decompression is achieved. At the end of the operation, the surgeon confirmed the following endoscopy: Decompression criteria: free mobilization of nerve tissue, independent pulsation of the Dural sac and nerve roots (consistent with heart rate), restoration of the anatomical position of the nervous tissue, and increased blood supply to the nerve tissue. The surgeon also confirmed that the medication was on the wane and that the intraoperative straight leg therapy was negative.

a. Operation Time.

Among the 8 papers, 4 presented the results of operation time, and subjects were included in the analysis: in the PETD group and in the Conventional Open Lumbar Discectomy. The PETD group's average operation time was 50-60 min, and that of the Conventional Open Lumbar Discectomy was 80-90 min. The PETD group's average operation time was significantly shorter than that of the Conventional Open Lumbar Discectomy.

b. Blood Loss

Among the 8 papers, 1 presented the result of blood loss, and subject were included in the analysis: 201 in the PETD group and 211 in the Conventional Open Lumbar Discectomy The PETD group average blood loss was 20-30cc, and that of the Conventional Open Lumbar Discectomy was 80-120cc. Significant differences were found between PETD with Conventional Open Lumbar Discectomy in intraoperative blood loss volume.

5.3 Post operation

a. Postoperative Paresthesia

Among the 8 papers, 3 presented the heterogeneity test was carried out and it was found that the heterogeneity of the selected studies was small, so systematic review could be performed. systematic review results showed that there was no statistical difference in postoperative paresthesia between percutaneous spinal endoscopy and conventional open surgery.

b. Complication infection Rate

Among the 8 papers, 4 presented the results of the complication rate, and 1,115 subjects were included in the analysis: 392 in the PETD group and 723 in the Conventional Open Lumbar Discectomy group. 15 subjects in the PETD group and 27 subjects in the Conventional Open

Lumbar Discectomy group had complications. There were no significant differences in the complication rate between the PETD and Conventional Open Lumbar Discectomy groups.

c. Direct Nerve Root Damage

Among the 8 papers, 6 presented the heterogeneity test was carried out and it was found that the heterogeneity of the selected studies was small, systematic review results showed that there was no statistical difference in direct nerve root damage between percutaneous spinal endoscopy and conventional open surgery.

d. Reoperation rate

Among the 8 papers, 4 presented the results of the reoperation rate, and 1,065 subjects were included in the analysis: 372 in the PETD group and 693 in the Conventional Open Lumbar Discectomy group. 31 subjects in the PETD group and 43 subjects in the Conventional Open Lumbar Discectomy group had reoperation. There were no significant differences in the reoperation rate between the PETD and Conventional Open Lumbar Discectomy group groups.

e. Disc Recurrence

Among the 8 papers, 6 presented the results showed that there was a systematic statistical difference in disc recurrence between percutaneous spinal endoscopy and traditional open surgery, whereas conventional open discectomy had more recurrences than PETD.

f. Hospital stays.

Among the 8 papers, 4 presented the results of hospital stay, and subjects were included in the analysis: in the PETD group and in the Conventional Open Lumbar Discectomy group. The PETD group's average hospital stay was 2-3 days, and that of the Conventional Open Lumbar Discectomy group was 7-8 days. The PETD group's average hospital stay was significantly shorter than that of the Conventional Open Lumbar Discectomy group

Many complications of PETD surgery have not discussed on this study, because there are just a few literatures that discuss it. Further research should discuss the complications of PETD surgery and review other journals with a larger amount of literature.

6. Conclusion

From all this research it can be concluded that PETD surgery and conventional open discectomy have the same good clinical results. but PETD has advantages which are shortening the operation time, lowering oswestry disability, reducing blood loss, shortening the length of stay, better confidence interval, improving visual analog pain scale (VAS), lowering complication rate, as well as lowering recurrence and reoperation rate. Although not the gold standard, the PETD procedure can also be an alternative for the management of lumbar disc herniation

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