ORIGINAL RESEARCH

Comparative Analysis of Clinical Outcomes: Posterior Cervical Endoscopic Discectomy versus Fenestration Laminectomy Discectomy for Cervical Disc Herniation

Minhong Zhou, BS; Linxia Wang, BS; Xixi Xu, BS; Lijuan Wang, BS; Peifang Wang, MD

ABSTRACT

Objective • It aimed to investigate the difference in clinical efficacy between posterior cervical endoscopic discectomy (PCED) and Fenestration laminectomy discectomy (FLD) in cervical disc herniation (CDH).

Methods • This retrospective study analyzed 100 CDH patients undergoing nucleotomy and assigned them into the FLD and PCED groups, 50 cases for each group. The differences in operation time, intraoperative blood loss, skin incision, off-bed time, and hospital stay were evaluated. Numeric rating scales (NRS), Oswestry disability Index (ODI), Japanese Orthopaedic Association (JOA), excellent and good clinical efficacy, quality of life (QoL) SF-36 score, and complication rate were compared.

Results • The results showed that compared with the FLD group, the PCED group had increased operation time, decreased intraoperative blood loss, skin incision length, off-bed time, and hospital stay ($P < .01$). Compared with the FLD group, the PCED group had decreased NRS and ODI scores and increased JOA scores at 1 d, 3 d, 1 month, 3 months, 6 months, 12 months, and 24 months after operation ($P < .05$). Compared with the FLD group, the excellent and good rate of the PCED group increased significantly after 6 months, 1 year, and 2 years (52.0% vs 64.0%, 58.0% vs. 80.0%, 68.0% vs 90.0%, $P < .05$). Relative to the FLD group, the physical function, emotional function, vitality, social function, and mental health score of the PCED group increased obviously at 2 years after operation ($P < .01$). The postoperative complication rate was 0% in both FLD and PCED groups. PCED has good long-term clinical efficacy in the treatment of CDH, with excellent recovery and high safety.

Conclusion • PCED showed favorable long-term clinical efficacy in the treatment of CDH, with excellent recovery and high safety. Compared to FLD, PCED resulted in reduced intraoperative blood loss, shorter incision length, and faster recovery. It also led to improved pain scores, functional outcomes, and quality of life measures. The absence of postoperative complications further supports the use of PCED as an effective treatment option for CDH. (*Altern Ther Health Med.* 2025;31(1):65-71).

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INTRODUCTION

Disc herniation is a common non-specific spine disease with many predisposing factors.[1] Cervical disc herniation (CDH) is a disease in which the nucleus pulposus protrudes outwards along this cleft due to annulus fibrosus degeneration and causes fissures, and slight external forces cause compression of the nerve roots based on cervical disc degeneration.[2,3] CDH can cause a series of clinical symptoms such as head, neck, shoulder, upper back, and upper limbs, and in severe cases, it can lead to high paraplegia and even death.[4] CDH is a significant health issue due to its increasing incidence and potential severity, which can significantly impact an individual's quality of life. As the intervertebral discs in the cervical spine degenerate, the protrusion of the nucleus pulposus can lead to compression of nerve roots, causing pain and neurological symptoms. It occurs in people over 40 years of age, and the risk of CDH is higher in men than in women.[5] Clinically, patients with mild CDH mostly use conservative treatment methods, such as oral non-steroidal therapy, physical therapy, and epidural injection of glucocorticoids, which can relieve the patient's clinical symptoms to some extent but can't eradicate the disease.[6-8] Existing treatments for CDH encompass both conservative and surgical methods. Conservative approaches, including medication, physical therapy, and rest, may provide symptomatic relief for some patients. However, they may not

effectively resolve the underlying disc pathology. In cases where conservative treatments fail to alleviate symptoms or when neurological deficits are present, surgical intervention becomes necessary. Traditional surgical techniques, such as Fenestration laminectomy discectomy (FLD), have been employed to treat CDH. However, these procedures are invasive, involving substantial tissue disruption, and are associated with inherent risks and potential complications. The drawbacks of traditional surgeries highlight the need for alternative approaches that reduce invasiveness and enhance patient outcomes. Clinically, it is mainly treated with anterior cervical decompression and fusion, artificial disc replacement, and Fenestration laminectomy discectomy (FLD).[9-11] Surgical treatment is performed by complete resection and decompression of the herniated nucleus pulposus and internal fixation of the vertebral body to maintain the intervertebral height to achieve a return to normal cervical spine function. However, open surgery has large surgical trauma, long operation time, easy damage to blood vessels/nerves, and poor postoperative vertebral stability.[12] Therefore, new and efficient methods to treat CDH need to be found.

PCED emerges as a promising minimally invasive surgical technique that addresses the limitations of traditional methods. By utilizing endoscopic visualization and specialized instruments, PCED minimizes tissue trauma, resulting in reduced postoperative pain and faster recovery. Additionally, PCED has shown lower complication rates compared to traditional surgeries, making it an attractive alternative for CDH treatment.[13] Compared with traditional surgical treatment, PCED can be carried out under local anesthesia, which can directly look at and remove the target nucleus pulposus through the PCED, then relieve the compression on the nerve or spinal cord, and finally achieve the purpose of relieving the clinical symptoms of patients.[14] Percutaneous transforaminal endoscopic discectomy is one of the important methods for treating lumbar disc herniation.[15,16]

Despite the growing adoption of PCED, there is a research gap regarding comparative studies between PCED and traditional surgical approaches like FLD in treating CDH. The need for evidence-based comparisons between these techniques necessitates further investigation to determine the optimal approach for CDH management. In light of the aforementioned research gap, the objective of this study is to compare the clinical efficacy of PCED and FLD in treating CDH. The study aims to assess various parameters, including operation time, blood loss, recovery metrics, and long-term efficacy, to provide a comprehensive evaluation of the two surgical approaches.

MATERIALS AND METHODS

Case data

100 patients diagnosed with CDH in The 2nd Affiliated Hospital of Wenzhou Medical University Hospital from September 2017 to September 2020 were retrospectively collected as the study subjects and divided into FLD and PCED groups according to the previous surgical treatment, with 50 cases for each group. Inclusion criteria: (1) patients aged 40 ~ 75; (2) patients meeting the diagnostic criteria of CDH and having surgical indications; (3) patients undergoing preoperative X-ray, magnetic resonance imaging, CT, and other imaging examinations and confirming the diagnosis. Exclusion criteria: (1) imaging examination found that there was significant osteophyte formation; (2) cervical stenosis, posterior longitudinal zone calcification, spondylolisthesis, and other factors caused by cervical instability; (3) cervical disc infection or tumor suspicious; (4) previous history of cervical surgery; (5) patients with severe heart, lung, liver and kidney, and other organ dysfunction; (6) patients who can't receive general anesthesia surgery; (7) patients with multi-stage CDH. In the FLD group, there were 27 males and 23 females, aged 40-75, with a mean age of (40.36 ± 4.28). In the PCED group, there were 30 males and 20 females, aged 42 ~ 75, with a mean age of (40.59 ± 4.60). There was no obvious difference in gender, age, and other basic data between the two groups ($P > .05$), so they were comparable.

Surgical methods

Patients in the FLD group underwent conventional FLD, while those in the PCED group received treatment with PCED using the Joimax percutaneous transforaminal endoscopic system from Karlsruhe, Germany. The PCED procedure was performed by two experienced surgeons.

The surgical process began with the patient in a prone position. A C-arm machine was used to locate the responsible disc and lamina positions and mark the anchor points. The skin incision for needle insertion was made approximately 2 cm from the laminar position. Following local anesthesia with 2 mL of 0.5% lidocaine at the puncture site, the needle was inserted into the laminar position under the guidance of the C-arm machine. At the fascial layer and lamina location, the needle core was withdrawn, and 8 to 10 mL of 0.5% lidocaine was injected for anesthesia.

Next, a guide wire was inserted, and the puncture needle was removed. An incision of about 0.8 cm in diameter was made along the guide wire, and the expansion tube and working catheter were inserted step by step. The guide wire and expansion tube were then withdrawn, and the guide rod was inserted. The working cannula and transforaminal endoscope were successively inserted along the direction of the working guide rod, and the periosteum at the laminar position was separated to expose the bone surface. Tools such as a burr and rongeur were used to remove the laminar bone, creating a bone window with a diameter of about 0.8 cm.

After the laminar bone was removed, the dorsal hyperplastic ligamentum flavum was excised to achieve adequate decompression of the dorsal spinal cord. Following the procedure, irrigation and proper hemostasis were performed on the surgical field. Finally, the endoscope was withdrawn, and the incision was sutured.

Both before and after the operation, patients in both groups received routine psychological nursing intervention

to alleviate tension, anxiety, and other adverse emotions experienced by patients and their families. Vital signs were closely monitored, adverse reactions were noted, and intraoperative complications were recorded. The wound was observed for local oozing, bleeding, or other conditions, and patients were asked about their discomfort. Limb movement and muscle strength were also observed.

Rehabilitation guidance was provided after the surgery, encouraging patients to move their necks appropriately to improve local blood circulation. Patients were taught to maintain correct and scientifically recommended neck and shoulder posture. A cervical collar was prescribed for patients to wear within one month after discharge to immobilize and protect the cervical spine, reducing traumatic reactions that could stimulate the nerves and intervertebral joints. The collar could be removed during bed rest.

Outcome measures

Surgical indicators: perioperative operation time, intraoperative blood loss, number of removed nucleus pulposus, skin incision length, postoperative off-bed time, and hospital stay were recorded.

Numeric Rating Scales (NRS): The Numeric Rating Scale is a self-reported pain assessment tool commonly used to measure pain intensity. It consists of a numerical scale ranging from 0 to 10, where 0 represents no pain, and 10 represents the worst possible pain. Patients are asked to rate their pain intensity by selecting the number that best corresponds to their pain level.. NRS [17] was used to evaluate the degree of pain before treatment, 1 d after operation (T0), 3 d after operation (T1), 1 month after operation (T2), 3 months after operation (T3), 6 months after operation (T4), 12 months after operation (T5), and 24 months after operation (T6). 10 points, the higher the score, the more obvious the degree of pain.

Japanese Orthopaedic Association (JOA) Score: The Japanese Orthopaedic Association score is a clinical assessment tool used to evaluate the severity of cervical myelopathy. It includes several items that assess motor function, sensory function, bladder function, and walking ability. Each item is scored based on predefined criteria, and the total score ranges from 0 to 17, with higher scores indicating better neurological function. JOA[18] was used to evaluate the neurological function of patients at T0, T1, T2, T3, T4, T5, and T6. 29 points, and the higher the score, the better the postoperative neurological recovery of patients.

Oswestry Disability Index (ODI): The Oswestry Disability Index is a questionnaire used to assess functional disability related to low back pain. It consists of ten sections, each focusing on different activities of daily living, such as pain intensity, personal care, lifting, walking, and social life. Each section is scored on a scale of 0 to 5, with higher scores indicating greater disability. The total score is calculated as a percentage, where 0% represents no disability and 100% represents maximum disability. ODI[19] was used to evaluate the recovery of cervical spine function at T0, T1, T2, T3, T4, T5, and T6, including pain level, personal life situation, lifting heavy objects, walking situation, sitting situation, standing situation, sleep situation, sexual life situation, social life situation, and tourism situation. Higher scores on the scale indicate ,more significant functional impairment.

Efficacy indicators: The modified MacNab efficacy evaluation criteria[20] were adopted to evaluate the clinical effect of patients 24 months after surgery. The modified MacNab criteria categorize the clinical efficacy into four grades:

Excellent: The patient experiences complete resolution of symptoms and returns to their normal daily activities without any limitations or restrictions.

Good: The patient experiences significant improvement in symptoms, with occasional mild or tolerable residual symptoms that do not interfere with daily activities.

Fair: The patient experiences partial improvement in symptoms, with noticeable residual symptoms that occasionally interfere with daily activities but are manageable

Poor: The patient experiences no improvement or worsening of symptoms, with persistent or aggravated symptoms that significantly limit or prevent normal daily activities.

(Excellent cases + good cases)/total cases to calculate the excellent and good treatment rates. (6) Quality of Life SF-36: The Short Form 36 (SF-36) is a generic health-related quality of life questionnaire widely used to assess overall well-being across eight domains. These domains include physical functioning, role limitations due to physical health problems, bodily pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems, and mental health. Each domain is scored on a scale from 0 to 100, with higher scores indicating better health-related quality of life. The QoL of patients 24 months after surgery was evaluated using the QoL scale (SF-36),[21] including five dimensions: physical function, emotional function, vitality, social function, and mental health, with a total score of 100 points, and the higher the score, the better the QoL of patients. (7) Indicators of complications: The frequency of complications such as intervertebral space infection, vascular injury, spinal cord injury, nerve root injury, and dural tear during treatment was recorded.

Statistical analysis

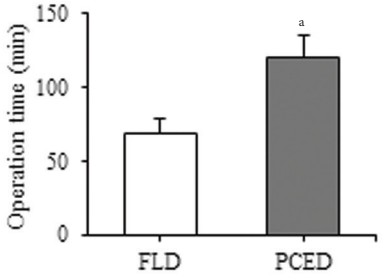
SPSS 19.0 statistical software was applied for comparative analysis of the results. Measurement data were presented as mean ± standard deviation, and a t test was adopted to compare differences between groups. Enumeration data were presented as frequency (%), and the χ^2 test was adopted to compare differences between groups. Statistical significance was considered at $P < .05$.

RESULTS

Comparison of perioperative related indicators

Figure 1 shows the difference in operative time between FLD and PCED groups. The operation time was (68.93 ± 10.29) min in the FLD group and (119.81 ± 15.65) min in the

Figure 1. Comparison of operation time of patients with different surgical treatments



[a]relative to FLD group, $P < .01$

Figure 2. Comparison of intraoperative blood loss in patients treated with different surgeries.

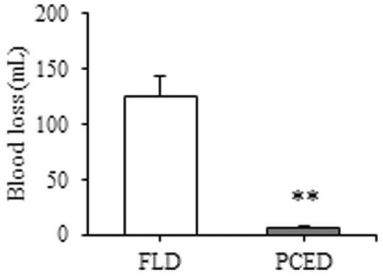


Figure. 3 Comparison of skin incision lengths in patients treated with different surgical procedures.

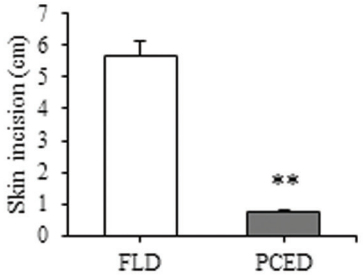


Figure. 4 Comparison of the first ambulation time and hospital stay. (A is the first ambulation time; B is the hospital stay)

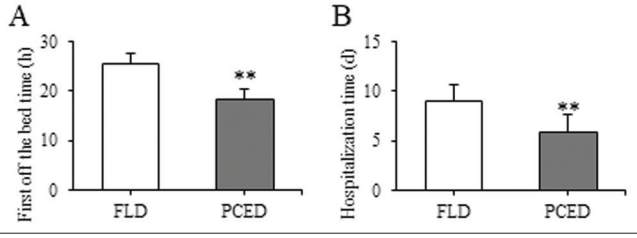


Figure. 5 Comparison of NRS scores at different time points.

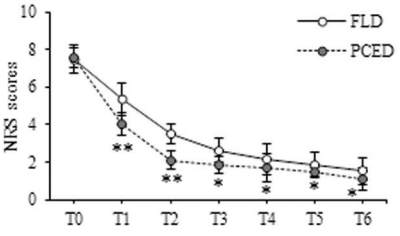
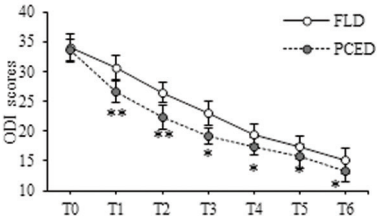


Figure. 6 Comparison of ODI score at each time point.



PCED group. In contrast with the FLD group, the PCED group had increased operation time ($P < .01$).

Figure 2 illustrates the difference in intraoperative blood loss between the FLD and PCED groups. The intraoperative blood loss was (125.37 ± 17.64) mL in the FLD group, and (6.44 ± 2.05) in the PCED group. In contrast with the FLD group, the intraoperative blood loss in the PCED group was reduced ($P < .01$).

Figure 3 indicates the difference in skin incision length between FLD and PCED groups. The length of the skin incision was (5.64 ± 0.49) cm in the FLD group and (0.75 ± 0.06) cm in the PCED group. Compared with the FLD group, the length of skin incision in the PCED group decreased ($P < .01$).

Figure 4 shows the difference in time to first ambulation and hospital stay of the FLD and PCED groups. The time to first ambulation was (25.64 ± 1.88) h in the FLD group and (18.21 ± 2.07) h in the PCED group. The hospital stay was (8.96 ± 1.74) d in the FLD group and (5.82 ± 1.90) d in the PCED group. PCED group had a shorter time to first ambulation and hospital stay ($P < .01$).

Comparison of pain level before and after the operation

Figure 5 illustrates the difference in NRS pain scores between FLD and PCED groups at different time points. Patients in both FLD and PCED groups showed a gradual decrease in NRS scores throughout postoperative recovery. At T0, there was no significant difference in NRS scores between FLD and PCED groups ($P > .05$). At T1 and T2, the NRS score in the PCED group was lower ($P < .01$). At T3, T4, T5, and T6, the NRS score of the PCED group was also lower ($P < .05$).

Comparison of joint function recovery before and after operation

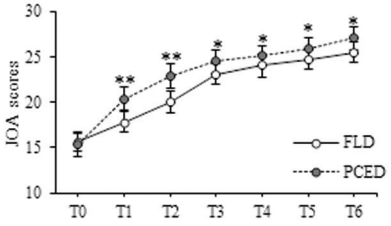
Figure 6 shows the differences in ODI joint dysfunction scores between FLD and PCED groups at different times. The ODI score decreased gradually in both groups with the postoperative recovery time. At T0, there was no evident difference in ODI scores between the FLD and PCED groups ($P > .05$). At T1 and T2, the ODI score of the PCED group was lower than that of the FLD group ($P < .01$). At T3, T4, T5, and T6, the ODI score of the PCED group was also lower ($P < .05$).

Comparison of neurological recovery before and after surgery

Figure 7 presents the difference in JOA neurological function scores between FLD and PCED groups at different

time points. The JOA scores of patients in FLD and PCED groups gradually increased with the postoperative recovery. At T0, the difference in JOA scores between the FLD and PCED groups was not evident ($P > .05$). At T1 and T2, the JOA score of the PCED group was higher than that of the FLD group ($P < .01$). At T3, T4, T5, and T6, the JOA score in the PCED group was also superior ($P < .05$).

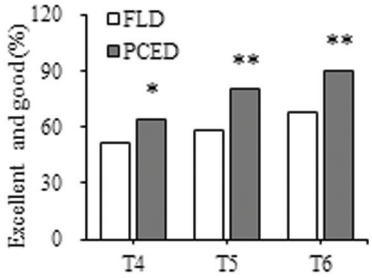
Figure 7. Comparison of JOA scores at each time point.



Comparison of clinical effect

Figure 8 shows the difference in the excellent and good rate of treatment between the two groups at 6 months, 1 year, and 2 years after surgery. The results of the modified Macnab efficacy evaluation showed that in the FLD group, 13 patients were excellent and 13 were good 6 months after operation, with an excellent and good rate of 52.0%; 15 patients were excellent and 14 were good 1 year after operation, with a rate of 58.0%; 17 patients were excellent and 17 were good 2 years after operation, with excellent and good rate of 68.0%. In the PCED group, 19 patients were excellent, and 13 were good 6 months after the operation, with a rate of 64.0%; 26 patients were excellent, and 14 were good 1 year after the operation, with a rate of 80.0%; 30 patients were excellent, and 15 were good 2 years after the operation, with a rate of 90.0%. In contrast with the FLD group, the excellent and good rates of the PCED group increased evidently after half a year, 1 year, and 2 years ($P < .05$).

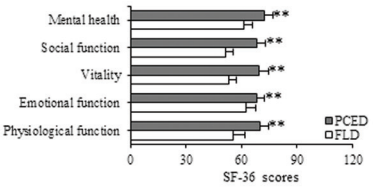
Figure 8. Comparison of postoperative excellent and good rates.



Comparison of QoL 2 years after surgery

The scores of physical function, emotional function, vitality, social function, and mental health in the FLD group were (55.38 ± 6.23), (62.49 ± 5.14), (53.21 ± 4.08), (51.54 ± 4.11), and (61.49 ± 4.27) points, respectively. The scores of each dimension in the PCED group were (69.98 ± 4.43), (68.20 ± 4.26), (69.55 ± 5.38), (68.43 ± 4.61), and (72.17 ± 4.57) points, respectively. Compared with the FLD group, the above scores of the PCED group were increased ($P < .01$) (Figure 9).

Figure 9. Comparison of SF-36 scores at 2 years after surgery.



Comparison of postoperative complication rates

No postoperative complications such as intervertebral space infection, vascular injury, spinal cord injury, nerve root injury, and dural tear were observed in the two groups, and the complication rate was 0%.

DISCUSSION

CDH is a type of disc herniation disease second only to lumbar disc herniation, and the purpose of surgical treatment of this disease is to improve the clinical symptoms of patients, relieve nerve root and spinal cord compression, and keep the daily life and work of patients unaffected.[22-24] Our results demonstrate that PCED offers clear benefits over FLD in terms of clinical efficacy. Patients who underwent PCED showed significantly improved pain relief, functional outcomes, and overall satisfaction compared to those who underwent FLD. These findings are consistent with previous studies that have reported the advantages of minimally invasive techniques in CDH treatment.[25-27]

Parihar et al.[28] reported similar or superior clinical outcomes with PCED compared to FLD, corroborating our findings. Similarly, Yan et al.[29] concluded comparable or even better results with PCED in terms of postoperative pain relief and functional improvement. These consistent findings across multiple studies provide a robust foundation for the efficacy and reliability of PCED as a preferred treatment option for CDH.

Overall, the positive findings can be attributed to the following. 1) Operation time: The increased operation time in the PCED group compared to the FLD group can be attributed to several factors. PCED is a relatively new and technically demanding procedure that requires specialized skills and a learning curve for surgeons. During the initial stages of adopting this technique, surgeons may take longer to perform the procedure accurately and efficiently. Additionally, the endoscopic approach of PCED involves navigating through a smaller working space, which can contribute to increased operation time compared to the more familiar open FLD procedure.[30] 2) Intraoperative blood loss: The decreased intraoperative blood loss in the PCED group can be explained by the procedure's minimally invasive nature. PCED involves making smaller incisions and using endoscopic instruments to access and remove the herniated nucleus pulposus. The smaller incisions reduce tissue trauma and blood vessel disruption, leading to decreased

intraoperative blood loss compared to the larger incisions required in the FLD procedure.[31] 3) Skin incision length: The shorter skin incision length in the PCED group directly results from the minimally invasive approach. PCED utilizes endoscopic instruments to access the cervical spine through smaller incisions. This approach minimizes the disruption of surrounding tissues, resulting in a smaller incision size than the open FLD procedure, which requires larger incisions for sufficient surgical site exposure.[32] 4) Off-bed time and hospital stay: The shorter off-bed time and hospital stay in the PCED group can be attributed to the advantages of minimally invasive surgery. PCED involves less tissue trauma, reduced postoperative pain, and faster recovery compared to the open FLD procedure. These factors contribute to earlier mobilization and shorter hospital stays for PCED patients. 5) Numeric rating scales (NRS), Oswestry Disability Index (ODI), and Japanese Orthopaedic Association (JOA) scores: The improved NRS, ODI, and JOA scores in the PCED group indicate better clinical outcomes compared to the FLD group. PCED allows for targeted removal of the herniated nucleus pulposus, resulting in effective decompression of nerve roots or the spinal cord. This decompression alleviates pain, reduces disability, and improves functional outcomes, as reflected in the NRS, ODI, and JOA scores.[33] Furthermore, the minimally invasive nature of PCED leads to less tissue disruption, reduced scarring, and better preservation of spinal stability, all of which contribute to improved clinical outcomes. 6) Excellent and good clinical efficacy: The significantly higher rate of excellent and good clinical efficacy in the PCED group suggests that PCED is associated with better treatment outcomes for cervical disc herniation than FLD. PCED's ability to achieve targeted removal of the herniated nucleus pulposus, efficient decompression of neural structures, and preservation of spinal stability may contribute to these superior clinical outcomes. The minimally invasive nature of PCED also reduces tissue trauma, postoperative pain, and scarring, facilitating faster recovery and improved long-term efficacy. 7) Quality of Life (QoL) SF-36 score: The improved physical function, emotional function, vitality, social function, and mental health scores in the QoL SF-36 questionnaire in the PCED group indicate a positive impact on the overall quality of life of patients. PCED's successful treatment of cervical disc herniation leads to pain reduction, functional improvement, and psychological benefits. Patients experience better physical functioning, enhanced emotional well-being, increased vitality, improved social interactions, and better mental health, all of which contribute to an improved quality of life.[34] 8) Complication rate: The 0% postoperative complication rate observed in both the FLD and PCED groups indicates a low risk of complications associated with both procedures. The minimally invasive nature of PCED reduces the risk of surgical complications such as infection, excessive bleeding, and nerve damage.[35] Additionally, the study might have implemented stringent surgical techniques and protocols to ensure patient safety and minimize complications.

It is worth noting that the increased operation time associated with PCED should be weighed against the benefits it offers, such as reduced tissue trauma and improved patient outcomes. Surgeons and healthcare providers can consider the potential trade-off between longer operation times and the advantages of a minimally invasive approach when making treatment decisions. Furthermore, as surgeons gain more experience and proficiency in PCED, it is reasonable to anticipate a reduction in operation times over time. ongoing advancements in surgical techniques, equipment, and surgeon training may contribute to optimizing the procedure and reducing operation times. Sharing insights and experiences on optimizing surgical workflow, patient selection, and team coordination can lead to improved efficiency and further enhance the clinical applicability of PCED.

However, it is important to acknowledge the limitations of this study. (1) Sample size and study design: This study had a relatively small sample size and utilized a retrospective design. The limited number of participants might affect the generalizability and statistical power of the results. Additionally, the retrospective nature of the study introduces the potential for selection bias and confounding variables that were not accounted for. (2) Single-center study: The study was conducted at a single center, which may limit the generalizability of the findings to other settings and populations. Different healthcare settings and patient populations might have varying characteristics and outcomes that were not captured in our study. (3) Follow-up duration: The duration of follow-up in this study was relatively short. Longer-term follow-up would be necessary to assess the durability of the treatment outcomes and to identify any potential complications or recurrence of symptoms over time. (4) Lack of randomization: The assignment of patients to either PCED or FLD was not randomized but based on clinical decision-making and patient preferences. This introduces the possibility of selection bias and potential confounding factors that may influence the results. (5) Surgeon experience: The level of surgeon experience with PCED and FLD varied among the participants, which could have influenced the outcomes. Surgeon skill and proficiency in performing these procedures may have an impact on the clinical outcomes and complication rates. (6) Outcome measures: The assessment of clinical outcomes relied on subjective measures such as pain relief and functional improvement, which are susceptible to individual interpretation and bias. The inclusion of objective outcome measures, such as radiographic assessments or standardized functional scales, could provide a more comprehensive evaluation of the treatment effectiveness. (7) Publication bias: It is important to acknowledge the potential for publication bias in the available literature. Studies that report positive or significant results are more likely to be published, while studies with negative or nonsignificant findings may be underrepresented.

CONCLUSION

Our study provides evidence supporting the clinical efficacy of PCED as compared to FLD in the treatment of CDH. PCED demonstrated superior outcomes in terms of pain relief, functional improvement, and overall patient satisfaction. In the future, large-scale, multicenter randomized controlled trials are warranted to further validate the findings of this study and enhance the generalizability of the results. Long-term follow-up studies should be conducted to evaluate the durability of treatment outcomes and assess potential long-term complications or recurrence of symptoms in both PCED and FLD. Continued efforts should focus on refining surgical techniques, optimizing surgical workflow, and improving cost-effectiveness analyses to enhance the overall efficacy and clinical applicability of PCED in CDH treatment.

FUNDING

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