Complications of Percutaneous Endoscopic Lumbar Discectomy in the Treatment of Herniated Disc: systematic review

Complicações da Discectomia Percutânea Endoscópica Lombar no Tratamento da Hérnia de Disco: revisão sistemática

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ABSTRACT

Introduction: Up to 85% of people suffer from back pain or sciatica at some point in their lives, which may be caused by traumatic, postural or degenerative factors. Disc herniation is one of the main degenerative causes of low back pain worldwide, and it can be surgically addressed by percutaneous endoscopic lumbar discectomy (PELD) in recent years, a minimally invasive procedure. This study analyzes the most frequent complications of this operation, in addition to addressing a case report with an atypical complication.

Methods: A systematic review was performed following the PRISMA protocol, through a search on the PubMed platform with articles published in the last 5 years. The clinical case was obtained by retrospective analysis of medical records and data completion by the surgeon.

Results: A total of 5171 patients were submitted to some PELD technique, with complications reported in 553 patients, about 10.69% of the total, being the most frequent complications: recurrence, residual disc, numbness, dysesthesia, temporary pain, nerve injury, among others. The case report describes an intra-surgical acute pulmonary edema.

Conclusion: PELD is a safe surgery, with a low complication rate, of a mild degree, affecting about 10% of patients in the targeted search for articles with complications, obtaining an approximate description of the most frequent possible complications of this procedure.

Keywords: Percutaneous endoscopic discectomy; Surgical complications; Minimally invasive; Lumbar herniated disk; Systematic review; Case report

RESUMO

Introdução: Até 85% das pessoas sofrem de dor nas costas ou ciatalgia em algum momento da vida, podendo ser causada por fatores traumáticos, posturais ou degenerativos. A hérnia discal é uma das principais causas degenerativas de lombalgia mundialmente, podendo ser abordada cirurgicamente pela discectomia percutânea endoscópica (DPE) nos últimos anos, um procedimento minimamente invasivo. Este estudo analisa as complicações mais frequentes dessa operação, além de abordar um relato de caso com complicação atípica.

Métodos: Foi realizada uma revisão sistemática seguindo o protocolo PRISMA, através da busca na plataforma PubMed, com artigos publicados nos últimos 5 anos. O caso clinic foi obtido por análise retrospectiva de prontuário e complementação dos dados pelo cirurgião.

Resultados: Obteve-se 5171 pacientes submetidos a alguma técnica da DPE, sendo relatada complicação em 553 pacientes, cerca de 10,69% do total, com complicações mais frequentes a recorrência, disco residual, dores, disestesia, dor temporária, lesão nervosa, entre outras. O relato de caso descreve um edema pulmonar agudo intra-cirúrgico.

Conclusão: A DPE é uma cirurgia segura, apresentando taxa de complicações baixa, de grau leve, acometendo cerca de 10% dos pacientes na busca direcionada de artigos apresentando complicações, obtendo-se uma descrição aproximada das complicações mais frequentes possíveis desse procedimento.

Palavras-Chave: Discectomia endoscópica percutânea; Complicações cirúrgicas; Minimamente invasivo; Hérnia de disco lombar; Revisão sistemática; Relato de caso

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INTRODUCTION

Low back pain is a common symptom in emergencies, affecting different epidemiological groups and age groups. Thus, studies show that about 70 to 85% of the world population suffer from low back pain or sciatic pain at some point in their lives, which may be caused by acute traumatic episodes or in patients with chronic pain, usually due to degenerative disc disorders. These disorders often cause pain through compression of nerve fibers, causing persistent pain in the absence of surgical intervention1.

Percutaneous discectomy is a type of minimally invasive surgery that uses an endoscope to correct spinal disorders, in which it is indicated for herniated disc operation, spinal stenosis, tumor removal, disc cysts and recurrent disc herniation. Correction occurs through the introduction of the endoscope through a small-sized incision, the lumbar region being the most common application of this type of surgery. The main disease to be treated with discectomy is herniated disc, with the lumbar region of the spine being the most affected2.

Therefore, percutaneous discectomy is a technique that has become increasingly common in large spine surgery centers, a technique initially presented by Yeung et al.3 and Hoogland et al.4, between 1997 and 2003, through the development of an endoscopic system, by transforaminal approach. Therefore, other techniques have been developed, such as interlaminar lumbar percutaneous discectomy, and also being included in the percutaneous endoscopic lumbar discectomy (PELD) subgroup.

Compared with open surgery, percutaneous discectomy has several advantages, such as shorter recovery time, minimized blood loss, low risk of infection, lower risk of postoperative pain and use of local anesthesia, a context in which it was preferred more the use and development of these less invasive techniques5.

However, it is clear that there are complications resulting from the procedure, as in any other type of operation, in all the techniques used. The frequency of negative consequences of EPD is rare and often unique depending on the type of patient, comorbidities presented and the skill level of the spine surgeon, as they are classified as minimally invasive6.

Thus, some studies in the literature add the occurrence of complications after performing endoscopic lumbar spine surgery, especially analyzing cases prospectively and retrospectively. However, the most up-to-date systematic reviews on this topic are scarce in the searches performed.

Therefore, the objective of the following study was to analyze scientific articles that addressed patients who, due to various morbidities in the spine, underwent percutaneous discectomy, through an endoscopic procedure, and were affected by different postoperative complications, in order to describe what possible negative outcomes may occur, and be found in this type of surgery. This analysis was performed through a systematic review.

In addition to the systematic review of the literature, we present a clinical case in which there was the occurrence of pulmonary edema as a form of a post-surgical complication, with the purpose of adding information and to evidence the possible complications resulting from percutaneous discectomy. The study was designed to screen articles that addressed any complications of endoscopic spine surgery through percutaneous discectomy.

METHOD

The Patient, Intervention, Comparison, and Outcome (PICO) strategy and the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) method were used to conduct the research. The PICO strategy is described as P = patients requiring spinal disc correction; I = percutaneous/endoscopic discectomy to treat herniated disc; C = considered any type of comparison; O = mild to severe post-surgical complications7.

Thus, filters were used in the search, limiting articles published up to the last 5 years, that is, from 2017 to 2022, only in humans. A search was performed in the PubMed database, with the last search date being May 18, 2022.

The search strategy used was to unify search terms using keywords found in the MeSH and DeCS platform. The first search was for the term: (‘percutaneous diskectomy’ OR ‘percutaneous discectomy’ OR ‘endoscopic discectomy’ OR ‘endoscopic diskectomy’), finding
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541 results on PubMed; the second term was: ('lumbosacral region' OR 'lumbar vertebrae' OR 'lumbar spine' OR 'lumbar'), finding 22,084; the third term was composed by: ('complications' OR 'postoperative complications'), resulting in 485,717. After that, the terms were combined using the formula "#1 AND #2 AND #3".

The first selection took place through the analysis of the article's title and abstract, applying eligibility criteria, through inclusion and exclusion criteria. The inclusion criteria were: 1) clinical trials, retrospective and prospective studies, observational studies and literature reviews that addressed the topic; 2) Treatment with percutaneous or endoscopic discectomy of herniated discs; and 3) complications resulting from percutaneous discectomy.

The exclusion criteria were: 1) articles that did not address the post-surgical complications of percutaneous lumbar discectomy or that addressed other regions; 2) studies that only discuss the description of surgical techniques and were not compatible with the objective of this review; 3) works with the main objective of comparing effectiveness between surgical techniques without described damage related to the operation; and 4) inaccessible or difficult to be translated papers.

After the first search, the inclusion and exclusion criteria were applied to the articles found in the first search through the analysis of titles and abstracts, excluding articles that did not fit the eligibility criteria. There was a second selection based on the complete reading of the articles, following the same criteria and filtering what should be included in the analysis, including studies that somehow addressed surgical complications or negative effects resulting from the surgery.

Data extraction occurred through the complete reading of the articles, seeking pre-established information that would compose the literary review. Thus, in order to summarize and present the data in an organized manner, it was decided to build a table containing the study, the type of study, the surgical technique used, the description of complications, and the total number of patients and number of patients who presented some kind of complication.

The ROBINS-I Risk of Bias in Non-randomized Studies – Interventions scale was used to analyze the risk of bias, since the present study aims to synthesize most of the possible postoperative complications resulting from percutaneous lumbar discectomy in each study, analyzing mainly retrospective and prospective nonrandomized observational and cohort studies. For the other types of study, the Downs and Black criteria were used to analyze literature reviews, meta-analysis and randomized clinical trials. Therefore, since the present study aims to describe the most frequent complications resulting from lumbar discectomy for the treatment of herniated discs, the bias analysis is mainly influenced by the type of study performed, the quality of the sample description and the number of patients in that there was intervention.

Thus, the ROBINS-I criterion analyzes the selected studies in seven error domains, asking about biases before, during and after the intervention performed. Based on the individual classification of each analyzed domain, the risk of bias was classified as low, if all domains have a low risk of bias; moderate, if at least one domain has moderate risk; serious, if at least one is at serious risk; and critical, if at least one domain has critical risk, not being included in the systematic review. Therefore, the articles were classified in the same work description table, in order to facilitate the reading and analysis of the results of the systematic review.

In the background, a description of the case report was carried out, in a retrospective way, through a thorough analysis of the chart, with the purpose of adding a unique complication that can occur in this type of minimally invasive surgery. Thus, an informed consent form was obtained to ensure the privacy of the patient's information, even though this patient is not identified in any part of this article. After carrying out the systematic review, the clinical case was described in the text.

RESULTS

With the combination and elaboration of the complete search formula, 230 results were obtained. After the first analysis, 80 articles remained, in which the eligibility criteria were applied again with the full reading of the studies, removing those that did not describe complications related to the surgery or did not correspond to the established theme. This second selection was carried out through a complete reading of the bibliographic sources, applying the eligibility criteria, resulting in 25 articles included in the research (Flowchart 1).
Among the 25 articles selected, 20 were retrospective type, 2 comparative retrospective type, 5 cohort retrospective type and the remaining 13 common retrospective type. In addition, 2 meta-analysis studies, 1 prospective study, 1 randomized controlled clinical trial and 1 literature review were selected.

Through the complete analysis of the scientific articles analyzed, it was observed that 5171 patients underwent some type of endoscopic percutaneous lumbar discectomy technique (Table 1). Among this total number of patients, the presence of different types of complications was reported in 553 patients, about 10.69% of the total number of patients undergoing this procedure.

All articles included in the systematic review addressed in their results the presence of any complication resulting from the surgery studied, mainly in order to correct a herniated disc.

Of the 553 described complications resulting from the surgery found in the systematic review, the most common were: recurrence, residual disc or need for reoperation (51.53%, n=285), numbness, weakness or dysesthesia (19.52%, n=108), temporary persistence of pain (8.13%, n=45), and nerve root injury (7.95%, n=44)\textsuperscript{6,10-33}. In addition, other less common complications were described but found in different studies, such as: dural rupture, herniation, headache, infection or complications of the surgical wound, hematoma, convulsion, and leakage of cerebrospinal fluid (12.83%, n=71)\textsuperscript{6,10-33}.

Furthermore, seven case report articles were excluded from the systematic review due to the high risk of bias, due to the small sample size of each one. However, addressing some unique manifestations present in these articles is also important to add to the discussion of possible other complications resulting from percutaneous endoscopic lumbar discectomy. These complementary articles not included in the systematic review described the occurrence of: negative pressure pulmonary edema in 1 patient, intraoperative disc prolapse in 3 patients, disc pseudocyst in 5 patients, infected pseudomeningocele in 1 patient, lumbar segmental artery pseudoaneurysm in 1 patient, convulsion in 1 patient, pseudoaneurysm of the common iliac artery and the internal iliac artery in 2 different cases, arteriovenous fistula between the vein and the right common iliac artery in 1 case, pseudomeningocele containing nerve root in 1 case and pneumocephalus with conscious disorder in 1 case\textsuperscript{34-40}.

Flowchart 1. Design of the research conducted.
### Table 1. Systematic Review Results (interlaminar percutaneous endoscopic lumbar discectomy (IPELD); percutaneous endoscopic lumbar discectomy (PELD); transforaminal percutaneous endoscopic lumbar discectomy (TPELD)).

| Study | Study Design      | Surgery               | Complications                                                                 | Patients | Number of Complications | Bias Risk |
|-------|-------------------|-----------------------|-------------------------------------------------------------------------------|----------|-------------------------|-----------|
| Wasinpongwanich et al. | Retrospective  | IPELD                 | Nerve root injury (n=3), Dural tear (n=1), Numbness (n=18), Weakness (n=6), Residual disc (n=1), Recurrence (n=66) | 545      | 94                      | Low       |
| Wu et al. | Comparative Retrospective  | 2-level PELD, PELD with Foraminoplasty | Dyesthesia (n=2), Recurrence (n=1), Residual nucleus pulposus (n=1) | 40       | 4                       | Moderate  |
| Wu et al. | Retrospective  | TPELD “U-Route”       | Dural Rupture (n=1), Nerve Root Injury (n=1), Dyesthesia (n=3), Reoperation (n=1) | 76       | 6                       | Low       |
| Aivi et al. | Meta-analysis   | PELD                  | Dural Rupture (n=2), Recurrent Herniation (n=10), Reoperation (n=10) | 350      | 22                      | Low       |
| Chen et al. | Controlled and Randomized trial | TPELD               | Dural Rupture (n=1), Nerve Root Injury (n=3), Dyesthesia (n=2), Recurrence/Residual (n=5) | 80       | 11                      | Low       |
| Cao et al. | Retrospective  | PELD                  | Herniation (n=18), Neuralgia (n=5) | 402      | 23                      | Low       |
| Yu et al. | Retrospective  | PELD                  | Persistent or intermittent post-surgical pain (n=19), Recurrence (n=1) | 208      | 20                      | Low       |
| Aydin et al. | Retrospective  | PELD                  | Nerve root injury/Dyesthesia (n=4), Reoperation or Herniated disc recurrence (n=5) | 66       | 9                       | Low       |
| Hua et al. | Retrospective  | PELD with Foraminoplasty | Nerve root injury (n=1), Recurrence (n=1), Miscellaneous neurological deficit (n=2) | 84       | 4                       | Low       |
| Raghu et al. | Review     | IPELD, TPELD          | Persistence of temporary pain (n=2), Miscellaneous neurological deficit (n=2), Nerve root injury (n=1), Durotomy (n=1), Dyesthesia (n=2), Leg numbness (n=2) | 157      | 10                      | Moderate  |
| Wang et al. | Retrospective  | PELD                  | Nerve stimulation symptom (n=2), Recurrence (n=1) | 51       | 3                       | Low       |
| Song et al. | Retrospective  | PELD                  | Recurrence (n=18), Nerve root injury (n=5), Dural tear (n=1), Superficial incisional infection (n=1), Wound hematoma (n=1) | 267      | 25                      | Moderate  |
| Zhou et al. | Cohort Retrospective  | PELD, IPELD           | Recurrence (n=12), Incomplete herniation removal (n=6), Nerve root injury (n=5), Dural rupture (n=4), Hyperalgesia (n=10), Epidural hematoma (n=1), Bleeding from radicular artery injury (n=1), Convulsion (n=1) | 426      | 40                      | Low       |
| Bao et al.  | Retrospective  | PELD with Foraminoplasty | Reoperation (n=2), Temporary persistence of symptoms (n=4) | 55       | 6                       | Low       |
| Xu et al.  | Retrospectivo coorte | TPELD, Bi-Needle PELD | Recurrence of symptoms (n=4), Reoperation (n=2), Bacterial discitis (n=1), Dyesthesia (n=2), CSF leak (n=1) | 44       | 10                      | Moderate  |
| Yu et al.  | Retrospectivo coorte | DLEPT                 | Recurrence (n=27), Dyesthesia (n=9), Nerve root injury (n=11), Dural rupture (n=13), Complicated operative wound (n=3), Revision (n=22) | 632      | 85                      | Low       |
| Li et al.  | Retrospectivo comparativo | PELD, Bi-Portal PELD | CSF leak (n=1), Headache (n=1), Dyesthesia (n=1), Infection (n=2), Hematoma (n=1), Recurrence (n=1) | 40       | 3                       | Moderate  |
| Jarebi et al.  | Cohort Retrospective  | PELD                  | Dyesthesia (n=2), Unilateral quadriiceps paresis (n=1), Recurrence/Reoperation (n=3) | 29       | 6                       | Low       |
| Ji et al.  | Retrospective  | Foraminoscopic PELD   | Infection (n=1), Hematoma (n=1), Recurrence (n=1), Rebound leg pain (n=2) | 44       | 5                       | Moderate  |
| Mo et al. | Retrospective  | IPELD, TPELD          | Dyesthesia (n=4), Incomplete decompression (n=1), Hyperalgesia (n=1), Dural tear (n=1) | 80       | 7                       | Low       |
| Liu and Zhou | Prospective  | PELD                  | Recurrence (n=14), Dural rupture (n=1), Neurological deficit (n=1), Instability (n=6) | 184      | 22                      | Low       |
| Yin et al. | Meta-analise | IPELD, TPELD          | Dyesthesia (n=43), Nerve root injury (n=7), Dural rupture (n=18), Complicated operative wound (n=6), Recurrence (n=3), Conversion to open surgery (n=9), Incomplete decompression (n=7) | 1156     | 123                     | Low       |
| Lee et al. | Retrospective  | PELD                  | Neurological deficit (n=1), Infection (n=1), Hematoma (n=1), Recurrence (n=2) | 35       | 5                       | Low       |
| Wang et al. | Cohort Retrospective  | TPELD                 | Nerve root injury (n=3), Rebound leg pain (n=3), Recurrence/Residual (n=1) | 101      | 7                       | Low       |
| Zhou et al. | Retrospective  | TPELD                 | Dyesthesia (n=2), Dural tear (n=1) | 19       | 3                       | Moderate  |
| Total                 |                     |                      |                                                | 5171     | 553                     |           |

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CASE PRESENTATION

Male patient, physical status ASA I, 61 years old, 96 kg, 155 cm tall, was admitted for surgical treatment of right central-lateral lumbar disc herniation at L5-S1. Preoperative complementary exams were normal, with no pathological changes.

The patient had pain in the right leg for seventy days, with reduced dorsiflexion strength of the right hallux and positive Lasègue at 45º, with symptomatic worsening in the last 10 days. Computed tomography of the lumbosacral spine confirmed the diagnosis of right central lateral disc herniation at L5-S1.

With the patient positioned in the ventral decubitus position, after antisepsis, infiltration of the skin and deep planes was preceded with 1% lidocaine without vasoconstrictor, and access to the median was performed for the passage of endoscopic and optical trocars. The surgery proceeded normally with identification of the vertebral space and muscle and ligament planes.

About 40 minutes into the procedure, the patient began to experience hemodynamic instability with hypotension and tachycardia, impaired pulmonary and cardiac auscultation.

It was decided that the procedure should be interrupted, with the necessary measures being instituted, the patient was referred to the clinically stable ICU, sedated and using vasoactive drugs.

After intensive support and complementary exams, the patient presented a chest tomography with bilateral pulmonary edema with normal cardiac enzymes with no markers for cardiac involvement.

After reviewing the case, a diagnosis of acute pulmonary edema was made. The patient received intensive support and treatment and was discharged from the hospital on the 14th day of the event.

DISCUSSION

Through a complete reading of the articles analyzed, it was found that this higher rate of recurrence occurs due to a large learning curve due to the difficulty of surgery, as it is a minimally invasive method, a fact that causes difficulty in obtaining results with a lower rate of complication for surgeons with less experience.

Other very frequent complications among the others are the various peripheral neurological disorders, manifesting as numbness, weakness or dysesthesia, a fact that occurs due to the manipulation of structures close to the nerve roots that interact with the spinal cord, but that despite generating discomfort to the patient, it was observed to be limited to the first two postoperative weeks. The same reasoning applies to the permanence of pain, as most cases that did not require reoperation showed total improvement in this type of complication within a period of one to two weeks.

Some articles separately described the occurrence of nerve root injury, generating temporary peripheral neurological disorders that improved with pharmacological treatment, in most cases, or that required reoperation.

In addition, other complications were responsible for a smaller number in each study but were frequently found in the different studies, such as dural rupture, herniation, headache, infection or complication of the surgical wound, convulsion or leakage of cerebrospinal fluid, mainly caused by intraoperative disturbances in the suture of the incised structures, due to structural weaknesses or iatrogenically, causing disruption of important structures due to the difficulty of manipulation by the endoscope.

For single complications, the presence of unique findings was reported, not found in any other study of the systematic review, such as pulmonary edema, disc prolapse, disc pseudocyst, infected pseudomeningocele, pseudoaneurysm and arteriovenous fistula, requiring further studies on the cause, pathophysiology and management of these less frequent complications.

In addition, some articles addressed important specificities regarding the incidence of complications, through comparisons between two groups, of the cohort type. One of the studies analyzed the statistical difference between the number of complications and the evolution of these occurrences, comparing obese and non-obese adolescent patients. This study demonstrated that there were no statistically significant differences between the two groups, demonstrating efficacy and safety in PELD.
Another situation described was in the comparison between day surgery vs nonday surgery, which are surgeries in which the patient is released on the same day, compared to surgeries in which the patient is hospitalized, approximately 3 to 4 days, respectively. In this case, the study found statistically irrelevant differences between the rate of readmission, complications, rate of satisfactory results, demonstrating in this case that PELD has the same safety and efficacy both in the same-day discharge approach and in the prolongation of hospital stay, situation that should be studied in depth and that can generate lower hospital costs, greater efficiency and credibility to the procedure.

From the aspect of this case reported, there is therefore the occurrence of acute pulmonary edema. After researching the literature on the possible causes, the most feasible one is explained by the water overload during the irrigation of the intervertebral space during the procedure, causing an increase in the patient’s blood volume and, consequently, an increase in systemic blood pressure.

CONCLUSION

With this, it is noticeable that Endoscopic Percutaneous Discectomy is a safe surgery and has a low complication rate, affecting about 10% of patients in the studies analyzed in the last five years in a database search aimed at selecting articles that presented complications. Therefore, a likely real rate of complications is significantly reduced in the various articles that did not address complications worthy of note, since these studies were excluded from the systematic review because they did not address the purpose of this study. Thus, it is understood the complications resulting from Endoscopic Percutaneous Discectomy and its details about causes, effects and incidence.

Regarding the limitations, it is clear that some studies had a small number of complications, since it is a minimally invasive endoscopic procedure, in which the main objective is the surgical resolution of the pathological mechanism with the least possible side effect. In addition, there were studies that did not address the need for reoperation and failure in the surgical technique as a type of complication, a fact that may have caused fewer studies and, consequently, patients screened in the systematic review.

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