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Comparison of Surgical Treatment of Intervertebral Fusion and Nucleus Pulposus Removal in The Treatment of Varying Degrees of Disc Herniation: A Systematic Review with Meta-Analysis

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Abstract

Objectives: To compare the efficacy of intervertebral fusionand removal of the nucleus pulposus in the treatment of herniated discs. Methodology: systematic review with meta-analysis in which the bibliographic search through the electronic databases: PubMed/MEDLINE and Cochrane Library without language restriction of publications untilApril 26, 2024. Results: The studies showed insignificant differences between the variations in the Oswestry disability indices of patients undergoing endoscopic microdiscectomy and open discectomy, a greater algic condition, greater bloodloss and length of hospital stay for the open discectomy procedure. Conclusion: Endoscopic microdiscectomy is related to better outcomes.

Keywords: Herniated disc; nucleus pulposus protrusion; intervertebral fusion; orthopedic procedures.

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1. Introduction

The spine is composed of discs, vertebrae, fibrocartilage, and nucleus pulposus. With the increase in the obese population in recent years and the technological revolution, inadequate and excessive ergonomic recruitment has been the etiology of biomechanical or pathological overload, with consequent compression of the nucleus pulposus causing a protrusion, known as a herniated disc. This affects the patient's quality of life, either through pain or limited movement, given the potential for damage to the spinal nerve root or, in some cases, the spinal cord.

Prevalence data indicate that 80% of herniated discs occur in the lumbar region and are more common in adults aged 30 to 50 years. Treatment begins almost entirely with a conservative approach, and the indication for surgery aims to provide significantly faster pain relief compared to conservative therapy, in addition to scientific evidence of better neurological recovery.

Among the surgical options, microendoscopic surgery (MED) and conventional open surgery (OD) stand out. With increasing technological advances, the degree of complications in thoracoscopic surgery is lower, ensuring benefits in morbidity and mortality, hospitalization time, and functional recovery. However, there is retraction of the paravertebral muscles, postoperative pain, and bone resection.

The possibility of direct visualization for safe removal of disc material indicates that 96% of patients obtain good and excellent results and a reduced complication rate. Thus, this proposed study aims to compare the efficacy between microendoscopic discectomy (MED) and open discectomy (OD) procedures in the treatment of disc herniation.

2. Methodology

This proposed study is a systematic review with meta-analysis, in which a bibliographic search was conducted using the electronic databases PubMed/MEDLINE and Cochrane Library, with no language restrictions on publications up to October 26, 2023, using a search strategy combining keywords and MeSH terms and the Boolean operator AND/OR. The search terms “Herniated disc” AND “nucleus pulposus protrusion” AND “intervertebral fusion” AND “orthopedic procedures” were used.

As this is a meta-analysis of published works, there was no need for approval by an ethics committee or institutional scientific review board. The reference lists of previously published articles were searched for additional relevant studies that met the eligibility criteria.

This systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.

Eligibility criteria

The eligibility criteria were determined according to the PICOS principle (Population, Intervention, Comparator, Outcomes).

1) Population: patients diagnosed with herniated disc

2) Intervention: surgery to correct herniated disc

3) Comparator: Oswestry Disability Index in surgical correction of lumbar disc herniation using endoscopic microdiscectomy and open discectomy techniques.

4) Outcome: Microendoscopic discectomy is superior to the open discectomy technique in terms of the Oswestry Disability Index variable.

Studies were excluded if they were: (1) Studies with incomplete data for analysis; (2) Non-randomized controlled trials, comparative studies, editorial articles, letters to the editor, review articles, meta-analyses, expert opinions, conference articles, or books; (3) Repeated or overlapping publications by the same author or institution; (4) Articles containing other surgical interventions for the treatment of herniated discs.

Two authors participated in the extraction of the following data from each of the included studies: name of the first author, year of publication, country of origin of the study, patient demographics, therapeutic regimen of each group, total study sample size, and radiological follow-ups. Disagreements were resolved by consensus.

The methodological quality of the studies that met the inclusion criteria was assessed using the Cochrane

Collaboration tool for determining risk of bias in Review Manager, version 5.3 (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark).

The systematic review protocol was registered in the International prospective register of systematic reviews (PROSPERO) under ID CRD42024557771.

3. Results

Initially, 164 articles were selected. After a superficial evaluation of the studies, those published more than 15 years ago were eliminated, leaving 37 studies. After analyzing the titles and abstracts, 20 studies that did not evaluate the results of patients undergoing microendoscopic discectomy and open discectomy were eliminated. Finally, after reading the remaining 17 articles in full, five were selected for this study (Figure 1).

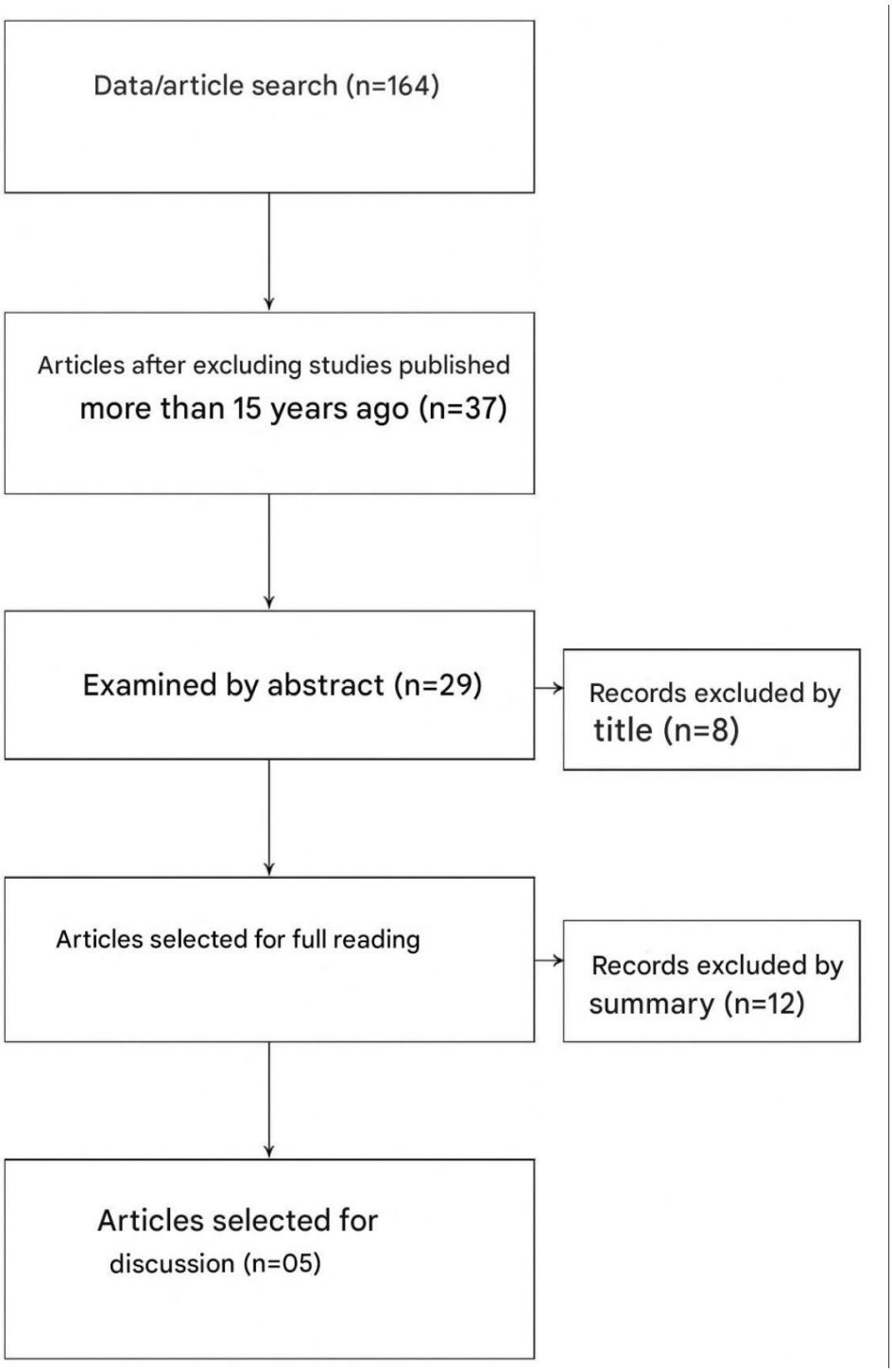

Figure 1 – Selection of studies according to the PRISMA methodology.

Table 1 contains the results obtained by the selected studies (Table 1).

Study	Approach	F/M patients	Results
Bhavuk e col	Endoscopic microdiscectomy Open discectomy	32/80	Surgical time; Intraoperative blood loss; Low back pain; Oswestry Disability Index.
Sherwan is col	Endoscopic microdiscectomy Open discectomy	39/21	VAS; Oswestry Disability Index; hospital admission; return to activities; recurrences; complications.
Yadav e col	Endoscopic microdiscectomy Open discectomy	31/29	VAS; Oswestry Disability Index; hospital admission; complications.
Mohamed et al	Endoscopic microdiscectomy Open discectomy	88/112	NRS (Numeric Rating Scale); Oswestry Disability Index; hospital admission; return to activities; recurrences; complications
Righesso et al	Endoscopic microdiscectomy Open discectomy	23/17	Oswestry Disability Index; hospital admission; return to activities; recurrences; complications

Table 2 shows the pre- and postoperative Oswestry Disability Index (ODI) scores for endoscopic microdiscectomy and open discectomy in the treatment of disc herniation (Table 2).

Study	Sample	Age	ODI WITH	ODI WITH	GO AWAY	Post-operative
						ODI
Bhavuk e col	112 patients	37 years	25.7+-1.5	13.0+-1.3	21.0+-1.4	14.0+-1.5
Yadav e col	60 patients	57.5 years	15.3+-1.6	10.2+-0.6	15.0+-0.1	10.4+-0.9
Mohamed et al	patients 200	years 30.9	72.7+-8,5	21.5+-5,1	70.8+-8,8	59.6+-5,3
Righesso et al	40 patients	46 years	54.0+-28	12.0+-2	50.0+-22	10.0+-12

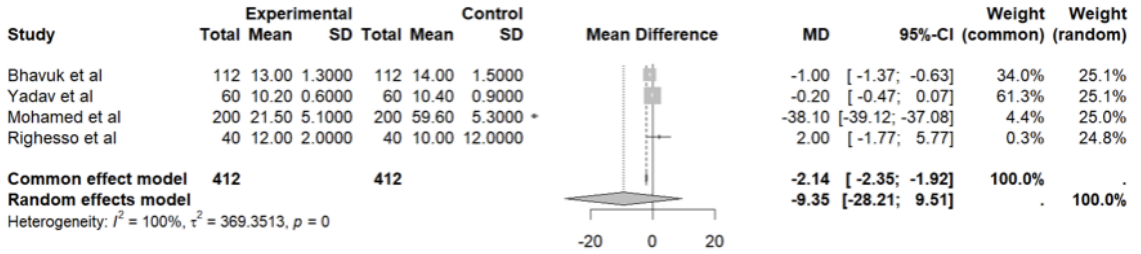

Figure 2 shows the forest plot of the Oswestry disability index analysis in the surgical treatment of herniated discs (Figure 2).

The randomized clinical trial by Bhavuk et al. evaluated treatments for lumbar disc herniation by microendoscopic discectomy (55 patients participated in the group) and open discectomy (57 patients). The duration of symptoms reported by patients undergoing microendoscopic discectomy (MED) was 11.6 ± 9.5 months and 16.7 ± 15 months for those undergoing open discectomy (OD). The surgical and anesthetic times for the MED procedure were 84 ± 36 and 217 ± 76 minutes, respectively. For open discectomy (OD), the surgical and anesthetic times were 56 ± 33 and 170 ± 38 minutes. Blood loss during the surgical procedure was 41+-12 ml of blood in MED and 306+-120 ml in OD ($p<0.001$). Regarding hospital stay, those who underwent microendoscopic discectomy stayed for 3+-1 days versus 12+-3 days in open surgery ($p<0.001$). The Oswestry Disability Index (ODI), which assesses function in daily activities in people with back pain for patients undergoing MED preoperatively, was 25.78 versus 13.02 one month after the procedure. For OD, the preoperative value was 21.02 versus 14.05 one month after the procedure. The complications reported for the MED group were five dural leaks controlled with gel foam, foot elevation, and three days of acetazolamide; four patients had temporary urinary retention; two had transient neuralgia of the S1 dermatome, and one patient had recurrence of disc herniation after seven months and was treated with open discectomy. The complications associated with the OD group were five dural leaks that were controlled, six patients had temporary urinary retention, three had urinary tract infection, and one had foot drop.

In the randomized clinical study by Sherwan et al., all patients suffered from symptomatic L4-5 lumbar disc herniation. Thirty patients underwent open discectomy and 30 underwent endoscopic microdiscectomy. The Visual Analogue Scale (VAS) was used as a parameter for

evaluating the procedure. The group that received open fenestration treatment had a preoperative VAS for leg pain of 9.63+ -0.49 versus 1.46+-0.5 and 0.56+-0.5 after 1 and 3 months of the procedure, while the same preoperative score for back pain was 7.73+-0.78 versus 3.7+-0.46 and 1.73+-0.4 after 1 and 3 months of OD. The group undergoing endoscopic microdiscectomy treatment had a VAS for leg pain of 9.53 ± 0.5 preoperatively, compared to 1.33 ± 0.47 and 0.46 ± 0.5 after 1 and 3 months postoperatively, respectively. The VAS for preoperative back pain in this group was 7.66+-0.75 versus 2.20+-0.4 and 1.73+-0.44 after 1 and 3 months of MED.Regarding hospital stay, it was 2.1 days in the OD group and 1.06 days in the MED group (p<0.001), the cost of surgery was 1,996 reais for those who underwent open surgery and 3,003 reais for minimally invasive treatment (p<0.001), and the time to return to daily activities was 7.33 for OD and 4.03 for MED (p<0.001). There was no relationship between the study group and recurrence of disc herniation (5 patients in the OD group versus 4 in the MED group p=1.000). No significant difference was reported in the Oswestry disability index. In the group undergoing discectomy, 2 patients had severe disability and 3 patients had moderate disability, while in the group undergoing microendoscopic discectomy, 2 patients had severe disability and 2 patients had moderate disability (P = 1,000).

In the study by Yadav et al., 30 patients underwent microendoscopic discectomy and 30 underwent open discectomy. The mean surgical time for the MED procedure was 84 ± 41 minutes, while 199 ± 51 minutes were reported for OD. Blood loss was 14.0 ± 12.2 ml versus 626.6 ± 289 (p < 0.001) for MED and OD, respectively. The length of hospital stay for patients undergoing the minimally invasive procedure was 10+-4 days, and for those undergoing the open procedure, it was 22+-7.9 days (p=0.0402). The preoperative VAS MED was 5.7+-0.6, after 1 day this number was 3.7+-0.6, and after 6 weeks it was 0.06+-0.3. For the OD group, the preoperative VAS was 5.9 ± 0.3, 4.0 ± 0.1 after 1 day, and 0.4 ± 0.9 after 6 weeks. The preoperative Oswestry disability index for the MED group was 15.3 ± 1.6 and 10.2 ± 0.6 six weeks after the procedure. The preoperative values for the OD group were 15.0 ± 0.1 and 10.4 ± 0.9 after six weeks (p < 5418).

Mohamed et al. evaluated 200 patients with herniated discs, 78 between the L5-S1 vertebrae and 92 between the L4-L5 vertebrae. Ninety patients were treated with open discectomy and the other 110 patients with endoscopic microdiscectomy. The surgical time for the MED group (98.8 min ± 26.9) and the control group (97.27 min ± 13.5) (P = 0.622). The blood loss associated with the procedures was 41.68 ± 13.18 mL during the MED procedure versus 124.22 ± 24.5 mL during the OD procedure (P \ 0.05). Regarding the average length of hospital stay, patients undergoing MED stayed for 10.4 ± 3.5 hours, while those undergoing OD stayed for 82.3 ± 18 hours (P \ 0.05). The time to return to work was 8.5 ± 2.6 in MED and 31.4 ± 3.9 in OD. For the MED group, there was significant relief of the mean NRS pain score in the legs and back, which decreased from 8.9 ± 0.8 and 3.3 ± 1.1, respectively, to 1.05 ± 0.57 and 1.43 ± 0.8 over 8 years (P \ 0.001). The OD group also showed a decrease in the mean NRS leg pain score from 8.8 ± 0.8 preoperatively to 2.18 ± 0.8 at 8 years (P \ 0.001). However, the mean NRS back pain score showed a significant increase from 3.17 ± 0.85 preoperatively to 7.53 ± 0.58 at 8 years, with a mean difference of 4.35 ± 1.07. There was no significant difference between the preoperative values of the two groups for NRS leg pain (P = 0.430) and NRS back pain (P = 0.293). The Oswestry disability index assessment showed a significant improvement for the MED group, from 72.7 ± 8.5% preoperatively to 21.51 ± 5.15% at the end of follow-up, with a mean difference of 51.2 ± 9.7% (P \ 0.001). For the OD group, the mean Oswestry score decreased from 70.8 ± 8.8% preoperatively to 59.66 ± 5.30%, a difference of 11.17 ± 9.5% (P \ 0.001). According to MacNab's modifier criteria, in the MED group, 92.6% of results were excellent, 4.2% were good, 1.1% were fair, and 2.1% were poor. For the OD group, 42.2% had excellent results, 28.9% had good results, 24.4% had fair results, and 4.4% had poor results. The total success rate for the MED group was 96.8% and 71.1% for the OD group.

Righesso et al. presented a randomized clinical trial in which 40 patients diagnosed with disc herniation, 57.9% had L4-L5 involvement, and 42.1% had L5-S1 involvement. The mean surgical time for the MED procedure was 82.6+-21.9 minutes and for the OD procedure was 63.7+-15.5 minutes (p<0.01). The mean blood loss was 40+-11 ml in the MED group and 50+-10 ml in the OD group (p 0.98). The length of hospital stay was 26+-16 hours for patients undergoing open surgery and 24+-11 hours for those undergoing minimally invasive surgery. The preoperative pain score for OD was 9+-7, 1.2+-1 12 hours after the procedure, and 1+-1 after 3 months. The same score for the MED group was 7.9+-6 preoperatively, 2+-1 after 12 hours, and 0.8+-1 after 3 months. The preoperative Oswestry score for OD was 50+-22, 10+-12 after 1 month, and 11+-13 after 3 months. For the MED group, the preoperative value was 54+-28, 12+-2, and 8+-3 after 1 and 3 months of intervention, respectively.

4. Discussion

For the treatment of herniated discs, the standard surgical technique is open microdiscectomy. However, there has recently been an evolution in minimally invasive procedures, which have become a viable alternative for spinal pathologies. These minimally invasive techniques for herniated disc surgery involve the use of a microscope or endoscopy to reduce tissue damage and achieve good clinical results comparable to conventional open surgery.

Microscopic discectomy (MED) is a paramedian intramuscular procedure that uses a tubular retractor and an endoscope instead of subperiosteal muscle dissection, which is performed in conventional open procedures. This MED muscle division technique results in reduced tissue damage, since subperiosteal muscle dissection is avoided. In addition, this intervention does not disturb the tissue venous systems, helping to prevent venous stasis and chronic edema of the nerve roots. As a result, this treatment option results in decreased fibrosis within the canal, less morbidity, earlier return to work, and greater overall patient satisfaction.

Endoscopic microdiscectomy was associated with a significant reduction in intraoperative bleeding compared to the open procedure. The length of hospital stay was also longer in the OD group. In most studies, the MED group was associated with longer operating times, which may be related to the greater learning curve required to perform the minimally invasive procedure.

The studies showed insignificant differences between the variations in Oswestry disability indices among patients undergoing endoscopic microdiscectomy and open discectomy. However, those who performed the visual analog scale (VAS) analysis associated significant differences between the mean values of low back pain between the two groups, with patients undergoing MED reporting less postoperative pain. In this case, because MED is a minimally invasive procedure, it is associated with less tissue damage and consequent less soft tissue and bone compromise.

In recent years, there has been an increased demand from patients for minimally invasive surgery, and traditional open spine surgery has been gradually replaced by this technique. Both methods are effective in relieving radicular pain and leg pain, although MED has some advantages, such as less anesthetic exposure, less back pain, and less blood loss. In view of this, MED is a safe and efficient alternative to open and conventional dissection for patients with lumbar disc herniation.

5. Conclusion

Endoscopic microdiscectomy, as a minimally invasive procedure, is associated with a lower Oswestry disability index, lower visual analog scale (VAS), shorter hospital stays, and faster rehabilitation when compared to open discectomy.

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