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Comparison Of Endoscopic and Open Decompression of The Ulnar Nerve in Cubital Tunnel Syndrome: A Systematic Review with Meta-Analysis

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INTRODUCTION

Cubital tunnel syndrome (CTS) is the second most common compressive neuropathy of the upper limb, associated with symptoms of pain, paresthesia and hand weakness, with a significant impact on patients' quality of life.[1] The primary surgical treatment is decompression

of the ulnar nerve using the open in situ technique, with good scientific evidence and a low complication rate. [2]

Minimally invasive techniques, such as endoscopic in situ decompression (EISD), have emerged as an alternative, promising smaller scars, less postoperative pain and faster functional return. Doubts remain about the safety, efficacy and complication profile of these techniques when compared to open in situ decompression (OISD).[2]

Randomized clinical trials, such as those by Elwenspoek et al. in 2014-2017 with 45 patients, showed equivalence in clinical outcomes (Bishop's excellent/optimal score between 90-96%), but with less chronic scar pain and better aesthetic satisfaction in the endoscopic group, albeit with a longer operative time. Another randomized double-blind study (2008-2011, 56 cases) corroborated the similarity of functional results, observing a higher incidence of hematomas in the endoscopic group. [2,3]

Two contemporary meta-analyses consolidate this perception: The meta-analysis of 686 cases revealed endoscopic decompression with longer surgical duration, increased risk of hematoma and acute pain, but less postoperative paresthesia and better grip strength. And a previous meta-analysis comparing eight studies (582 patients) confirmed equivalent efficacy, highlighting less painful scar sensitivity in the endoscopic group .[3]

To this end, despite equivalence in functional and clinical outcomes, EISD offers advantages in terms of scar, chronic pain and grip strength, at the cost of longer surgical time and risk of hematoma, more robust and standardized studies are needed. This systematic review with meta-analysis aims to rigorously compare efficacy, safety and technical quality between endoscopic and open decompression of the ulnar nerve in CTS, with a focus on clinical impact and decision-making guidelines for orthopaedic practice.

Methodology

This study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and registered on the PROSPERO platform under ID CRD420251141090.

Search strategy

A systematic search was carried out in the PubMed, Embase, Scopus, Web of Science and Cochrane Central Register of Controlled Trials (CENTRAL) databases, from their creation until July 2025. The terms used included combinations of the descriptors: "ulnar nerve", "cubital tunnel syndrome", "endoscopic decompression", "open decompression", "in situ decompression", "randomized controlled trial" and "clinical trial". Filters were applied to restrict the results to randomized controlled trials (RCTs) and comparative clinical trials. In addition, gray literature was investigated through clinical trial registries and bibliographies of included articles.

Inclusion criteria

Studies that met the following criteria were included:

Randomized clinical trial (RCT) or controlled clinical trial;

Population: adult patients diagnosed with cubital tunnel syndrome;

Intervention: endoscopic decompression of the ulnar nerve;

Comparator: open in situ decompression of the ulnar nerve;

Outcomes: functional improvement (Bishop score, DASH, or similar), operative time, postoperative pain, complications (hematoma, persistent paresthesia, nerve injury), and time to return to work.

Exclusion criteria

The following were excluded

Retrospective studies, case series, narrative reviews or case reports;

Studies with patients undergoing anterior transposition of the ulnar nerve or concomitant procedures;

Articles not available in English, Portuguese or Spanish;

Studies with fewer than 10 patients per group.

Selection of studies

Two independent reviewers screened the titles and abstracts identified. Potentially eligible articles were read in full for final evaluation. Disagreements were resolved by consensus or with the participation of a third reviewer.

Data extraction

The following data was extracted from each included study:

Authors, year of publication, country of conduct;

Sample characteristics (number of patients, gender, average age);

Surgical technique used (endoscopic or open);

Scales used for functional assessment;

Clinical and operative outcomes;

Duration of follow-up

Assessment of methodological quality

The quality of the studies was assessed using the Cochrane Risk of Bias 2.0 tool for randomized clinical trials. The domains assessed included: random sequence generation, allocation concealment, blinding of participants and assessors, incomplete data and selective reporting.

Statistical analysis

The meta-analysis was carried out using Review Manager (RevMan) 5.4 software. Mean differences (MD) were calculated for continuous outcomes and risk ratios (RR) for dichotomous outcomes, both with 95% confidence intervals. Heterogeneity was assessed using the I^2 test, which was considered significant when >50%. Random effects models were applied when heterogeneity was high. The presence of publication bias was investigated using funnel plots.

Results

A total of 29 articles were selected during the search process, and after excluding those published more than 15 years ago, 11 remained. Analysis of the title and abstract allowed the exclusion of 07 papers that did not correspond to the objective of this study. Five articles were read in full, of which one was excluded because it did not meet the inclusion criteria, and finally four were selected for this article (Figure 1).

The four articles selected featured patients diagnosed with cubital tunnel syndrome who had undergone decompression of the ulnar nerve using endoscopic or open in situ surgery. Ulnar nerve dysfunction was assessed using the McGowan score, as well as the VAS (pain analog scale) and the Bishop score to assess functional recovery after surgery. The study included 255 patients, 131 of whom underwent endoscopic surgery and 124 open surgery in situ.

Table 1 shows the articles selected and their results (Table 1).

Table 2 contains the results of the comparison between endoscopic and open techniques in long-term follow-up, using the Bishop score as the outcome. [4,5,6,7]

Figure 2 shows the analysis of functional recovery after surgery comparing endoscopic and open surgery in long-term follow-up (12-24 months), using the proportion of patients classified as "good or excellent" using the Bishop score as the outcome. [4,5,6,7]

Schmidt et al[4] presented a prospective, randomized, double-blind study of 29 patients who underwent endoscopic decompression (ED) and 27 open decompression (OD). The average duration of symptoms was relatively longer in the OD group (19.96 months) compared to the other group (14.17 months), but without statistical significance (p=0.16). In 31 patients the left arm was affected, 21 in the right arm and both in 02 patients. Preoperatively, most of the patients had grade II (64.3%) or III (33.9%) on the McGowan scale, with only one case having grade I. With a mean score of 2.28 (median 2) in the ED group and 2.37 (median 2) in the OD.

After surgery, both groups improved, with a predominance of grade II (72.41% in the ED and 55.56% in the OD) and no major differences between the methods (p=0.27). Mean preoperative pain (VAS) was similar between the groups (3.85 ED vs. 3.16 OD; p=0.42), as was the occurrence of neuropathic pain (44.8% vs. 44.4%; p=1.00). Postoperative pain was low and similar between the groups (VAS: 0.97 vs. 0.85 initially; 0.64 vs. 0.79 in the long term; p = 0.84). In the Bishop score, most patients were classified as "excellent" (15/29 endoscopic; 22/27 open), with few "good", "fair" or "poor" cases, with no significant differences between the methods, showing comparable clinical recovery.[4]

Postoperative wound pain was similar between the groups (mean 6.65 days endoscopic vs. 6.67 days open; p = 0.56). Patients with complaints <6 months had significant initial improvement (p = 0.03), while those with >12 months did not (p = 0.15); in the long term, there was no relevant difference (p = 0.15 and 0.12), indicating that the benefit of early intervention diminishes over time. In electrodiagnostic tests, most

patients showed improvement (21/29 endoscopic; 22/27 open), with a few cases unchanged or worsening, with no significant difference (p = 0.62). The length of decompression did not influence long-term clinical improvement in either group.

In the endoscopic group, the average length was 16.03 cm (p = 0.51), while in the open group it was 8.65 cm (p = 0.79), indicating that the size of the decompression had no significant effect on the results according to the Bishop score. Eight patients required a second surgery, with no significant difference between the groups (p = 0.46). Four did not improve, four had initial relief followed by worsening, and some had serious pre-existing complications or complications during follow-up.

In the long term, excellent and good results were similar between endoscopic (75.9% and 6.9%) and open (70.4% and 11.1%), showing comparable recovery. Surgical time was significantly longer in the ED group (70.45 min) than in the OD (44.63 min; p<0.0001). With experience, the duration of endoscopic surgery progressively decreased (p=0.02; r = - 0.44), while open surgery remained stable (p=0.30 ; r = - 0.21). Hematomas were more frequent in the endoscopic group (7 cases, 24.2% vs. 1 case, 3.7%; p = 0.05), while healing disorders were rare and similar between the groups (3 cases, 10.3% vs. 1 case, 3.7%; p = 0.61).

In the study by Dutzmann et al,[5] 55 patients underwent endoscopic decompression and 59 underwent open in situ decompression. Involvement of the dominant arm was similar between the groups, occurring in 45.8% of patients in the open group and 54.6% in the endoscopic group, with no significant difference (p=0.45). According to the McGowan scale, most patients had grade III (59.3% open; 60% endoscopic), followed by grades II (27.1% and 27.3%) and I (13.6% and 12.7%), with no significant differences between the groups. At 24-month follow-up, excellent or good Bishop's scores were predominant in both groups: endoscopic 31 excellent and 18 good, open 32 excellent and 14 good (p = 0.11). Reasonable or poor results were less frequent: endoscopic 5 and 1, open 12 and 1 (p = 0.11). All the patients with poor results showed an improvement in conduction velocity in electrophysiological studies.

Functional recovery was significantly faster in the endoscopic group, with 76.4% of patients returning to full activity between 2 and 7 days, compared to 18.6% in the open group (p < 0.001). There was a tendency for there to be a correlation between longer duration of pain and longer time to return to functionality (r = 0.185; p = 0.06), although this was not significant. As for pain resolution, 65% of endoscopic patients were pain-free after 3 days, compared to 49% in the open group, showing a trend towards faster improvement in the endoscopic group (p = 0.08). There were no significant differences in the time to return to full activity or in postoperative pain (P = 0.84 and P = 0.57, respectively), but the time to return to full functionality was significantly shorter in the endoscopic group (P = 0.03). In the open surgery group, 23.7% of patients reported tingling around the elbow, 6.7% had scar tenderness and 1.7% had wound infection, without neuromas or ulnar nerve subluxation. In the endoscopic group, 3.6% developed hematomas and 7.2% had subluxation of the ulnar nerve, with some cases requiring further surgery.5

In the prospective study by Krejci et al[6], 22 patients underwent endoscopic surgery for decompression (ED) of the ulnar nerve and 23 underwent open surgery in situ. All had had symptoms for more than six weeks, with a predominance in the right arm in 25 patients. The average McGowan score was 2.5 (median = 3) in the endoscopic group, with two losses to follow-up, and 2.74 (median = 3) in the open in situ decompression (OD) group. As for post-operative pain, assessed by VAS, it was higher in the OD group, remaining above 2 until the fourth day, while in the ED group this value persisted only until the second day. After the seventh day, both groups had VAS < 1. Women reported higher levels of pain compared to men, especially in the OD group, where the mean values remained > 2 until the sixth day. In the ED group, female pain was > 2 only until the third day. Among the men, pain was mild in both groups, exceeding 2 only in the immediate postoperative period (days 0-2).

The only significant statistical difference occurred on the fourth day, with less pain in the female ED group; at the other times, there was no major statistical significance, despite the trend towards lower values in the ED. At 3 months after surgery, 8 patients in the OD group (5 women and 3 men) reported chronic pain associated with healing, with a mean VAS of 3.13 (median 2.5). In 5 cases (4 women and 1 man), the pain persisted after 12 months, with a mean VAS of 2.8 (median 2). The occurrence of pain was significantly higher in the OD group compared to the ED group at 3 months (p=0.011), but there was no difference between the groups after

12 months (p=0.082). Furthermore, no association was found between chronic pain and the sex of the patients, either at 3 months (p=0.642) or 12 months (p=0.314).

The clinical evolution of the patients, assessed by the Bishop scale, showed similar results between the groups after 3 and 12 months of surgery. In the ED group, 18 patients were classified as "Excellent/Good" at 3 and 12 months, while 02 remained "Fair/Medium" at both times. In the OD group, 21 patients were classified as "Excellent/Good" at 03 months and 22 at 12 months, while 02 had a "Fair/Medium" evaluation at 03 months and only 01 at 12 months. These findings corroborate the fact that there were no clinically relevant differences between the techniques throughout the study (p-0.176 and p=0.191, respectively).

As for professional status, there was also no statistically significant difference (p=0.061). As for the appearance of the scars, 95.3% of the patients reported satisfaction, with 70% of the ED group being "very satisfied" and 91.3% of the OD group being "satisfied", with greater satisfaction in the ED group (p<0.00005). After 12 months, the overall assessment of the surgery was similar between the groups (90% ED and 91.3% OD satisfied or very satisfied; p=0.140). Surgeries in the OD group lasted from 12 to 44 minutes (mean 29.6; median 30), while in the ED group they ranged from 20 to 60 minutes (mean 36.4; median 35), being significantly longer (p=0.011). With experience, the average ED time fell from 43 to 29.7 minutes, although preparation remained longer (18.2 min vs. 6.5 min, on average 2.8 times longer). There were no complications, nerve damage or need for reoperation in any group.[6]

In the prospective randomized study by Schwarm et al,[7] 25 patients were in the endoscopic group and 15 in the open group. Eight patients in the ED group and six in the other group had their dominant arm affected. The McGowan score showed that both groups started out predominantly with grade II (moderate) and improved to grade I (mild) at 3 and 12-month follow-ups. In the endoscopic group, the average was 1.84 preoperatively, falling to 1.4 at 3 and 12 months; in the open group, the average was 1.8 initially and 1.3 in the same periods. Although the endoscopic group had more severe cases initially (24% grade III vs. 13.3% in the open group), there was no statistically significant difference in evolution between the groups (p = 0.52 at 3 months and p = 0.86 at 12 months), indicating equivalent clinical improvement between the techniques.

The neurophysiological data showed that, preoperatively, all the patients in both the open and endoscopic groups had pathological values in ulnar nerve conduction (reference: sensory < 44.6 m/s; motor > 3.5 ms). Postoperatively, 20% of each group still had pathological alterations (endoscopic: 5 patients; open: 3 patients), with no statistically significant difference between the techniques, indicating an equivalent rate of residual alterations. The comparison of Bishop scores between the open and endoscopic techniques showed similar results at both 3 and 12 months. At 3 months, the median was 8 in the open group and 7 in the endoscopic group (p = 0.152), while at 12 months both groups reached a median of 8 (p = 0.192). Although the endoscopic technique showed greater initial variation in scores, there was no statistically significant difference in any of the periods, indicating comparable efficacy between the two approaches over time.The average surgery time was 36 minutes for open in situ decompression (IQR 29-51) and 43 minutes for endoscopic decompression with a retractor (IQR 25-53; p = 0.978), showing that the minimally invasive technique required more time, although with no statistically significant difference.

Return to full functionality occurred on average after 4.0 ± 3.6 weeks in the endoscopic group and 4.9 ± 10.1 weeks in the open in situ group. Post-operative pain was similar between the groups (5.9 ± 5.2 weeks ED; 5.2 ± 4.6 weeks OD). Preoperatively, muscle atrophy and hypoesthesia were more frequent in the OD group (53.3% vs. 24%). At 3 months, there was a reduction in both groups, remaining stable at 12 months (20% OD; 24% ED). There were no technical problems or conversion to endoscopic surgery. One infection occurred in each group, treated with antibiotics or surgery. In the endoscopic group, 2 patients had subluxation of the ulnar nerve. Scar pain was reported by 2 patients in each group.[7]

Discussion

The results of this meta-analysis showed that there was no statistically significant difference between endoscopic and open decompression of the ulnar nerve in relation to long-term functional recovery, as assessed by the Bishop score. 4,5,6 The pooled analysis of the studies showed a relative risk close to unity (pooled RR ≈ 1.04; 95%CI ≈ 0.93-1.15), with low to moderate heterogeneity (I^2 ~ 24%). These findings confirm that both techniques have a high clinical success rate, with

no evidence of sustained superiority of one over the other.[4-7]

In terms of safety, the meta-analysis also found no significant differences in the rate of complications between the methods. Events such as persistent wound pain, transient paresthesias, hematomas or superficial infections were infrequent and distributed similarly between the groups. [4-6] The trial by Schwarm et al. including endoscopic retractor release, reinforces the absence of discrepancies regarding the risk of major complications and the need for reoperation. Thus, the current data supports that both techniques are equally safe.[7]

Complementary information from recent literature broadens the interpretation of these findings. Watts and Bain showed that there were no significant differences in overall satisfaction in terms of patient-reported outcomes, corroborating the equivalence observed in objective results.[9] Prospective studies have also confirmed the durability of good endoscopic results in longer follow-ups.[14] From a technical point of view, some authors point out that endoscopy is associated with less tissue aggression, less scarring and potential aesthetic benefits, although it requires a learning curve and specific resources, which may limit its universal adoption. [8,11] Other studies show that, despite initial advantages such as less post-operative pain and ultrasound findings suggestive of less local trauma, these differences do not translate into long-term functional gains compared to the open technique.[12,13]

In parallel, new lines of research such as the EVOCU (Endoscopic Versus Open Cubital tunnel release) protocol seek to overcome the methodological limitations of the literature - small samples, heterogeneity of outcomes and lack of standardization - through pragmatic randomized clinical trials that include patient-centred measures, return to work and quality of life. Contemporary reviews also emphasize the need to incorporate cost-effectiveness analyses and stratification by clinical subgroups (such as manual workers and athletes), who may present specific demands. [15,16]

Conclusion

This meta-analysis showed that endoscopic and open decompression of the ulnar nerve have equivalent efficacy and safety in the treatment of cubital tunnel syndrome, with no significant differences in terms of functional recovery or complication rates in medium and long-term follow-ups. The endoscopic technique may offer initial advantages, such as less tissue aggression and better aesthetic satisfaction, but these benefits do not translate into sustained superior functional results. Therefore, the choice of technique should be individualized, taking into account the surgeon's experience, availability of resources, costs and patient preferences.

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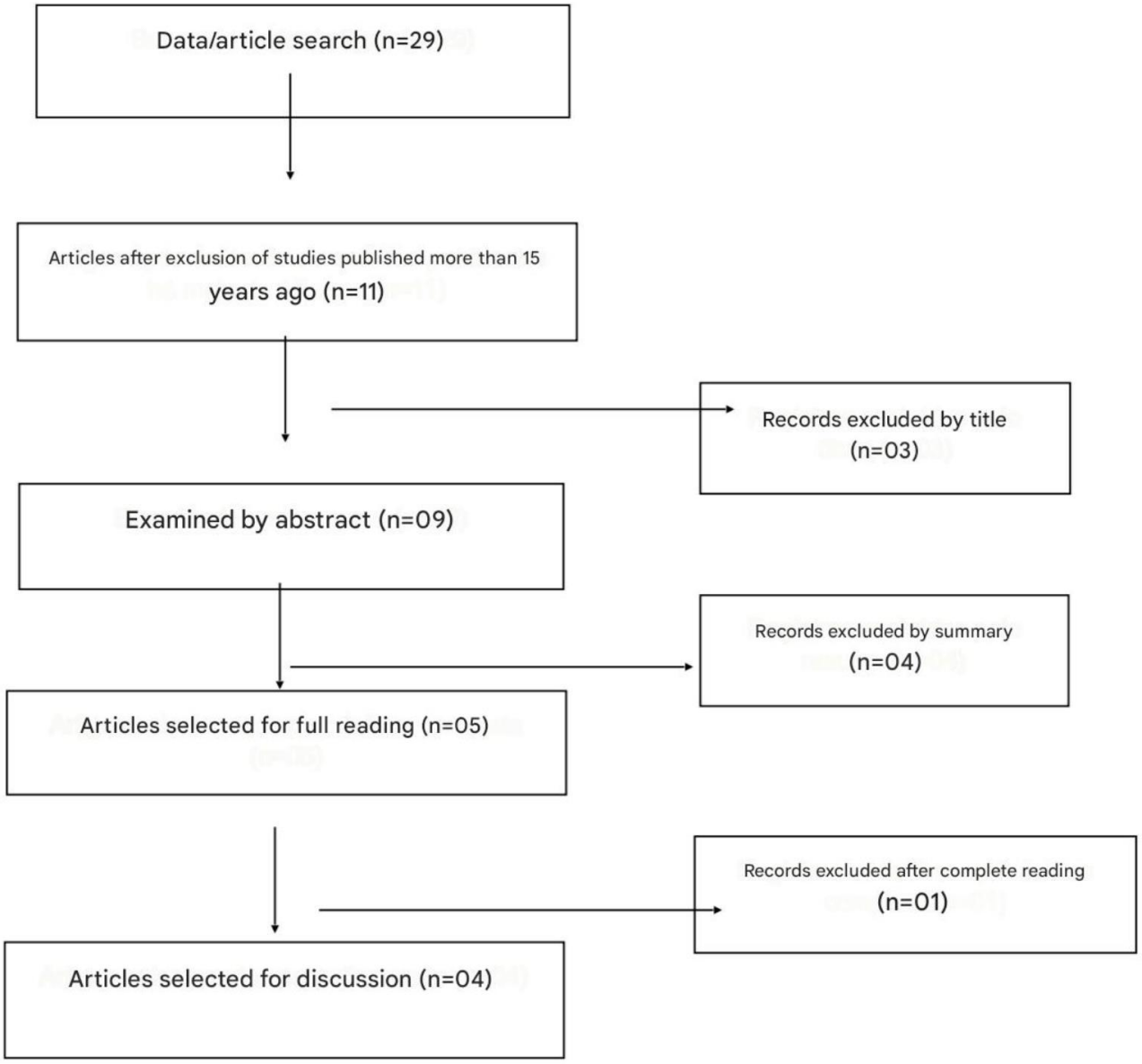
Figure 1 - Studies selected according to PRISMA methodology. [4,5,6,7]



Source: Own authorship (2024).

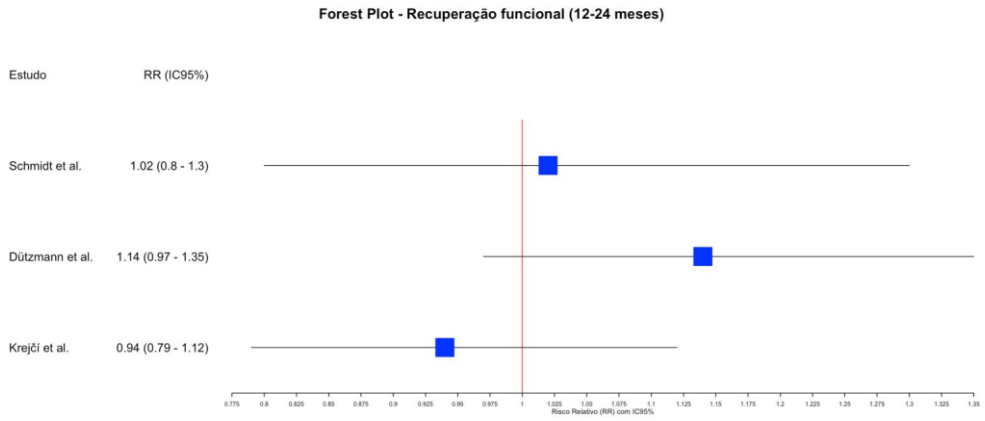
Table 1 - Results obtained by the selected studies. [4,5,6,7]

Study	Approach	Middle Ages	Patients M/F	Results
Schmidt e col	Endoscopic Decompression vs. Open Decompression	49,2	32 / 22	Average duration of symptoms, McGowan Scale, Visual Analog Scale (VAS), Bishop Score, Postoperative wound pain, Electrodiagnostic tests, Length of decompression, Surgical time and Complications.
Dützmann e col	Endoscopic decompression with retractor vs. open decompression	49,2	63 / 51	Affected arm, McGowan Scale, Bishop Score, Functional recovery, Pain resolution, Time to return to full activity without pain and Complications.
Tailor and col	Endoscopic Decompression vs. Open Decompression	54,7	22 / 23	Affected arm, McGowan scale, VAS, Scar-related chronic pain, Bishop score, Professional status, Scar appearance and Surgical time.
swarm e col	Endoscopic retractor surgery vs. open surgery	50	20 / 20	Affected arm, McGowan Scale, Neurophysiological data, Bishop Score, Average surgery time, Return to full functionality, Postoperative pain and Complications.

Table 2 - Functional recovery scores after surgery in long-term follow-up (12-24 months), in patients classified as "good or excellent" in the Bishop score. [4,5,6,7]

Study	Months	Events (Endosc.)	Total (Endosc.)	Events (Open)	Total (Open)	RR(95% IC)
Schmidt e col	16.8	24	29	22	27	1,02 (0,80 - 1,30)
Dützmann e col	24.0	49	55	46	59	1,14 (0,97 - 1,35)
Tailor and col	12.0	18	20	22	23	0,94 (0,79 - 1,12)

Figure 2- Forest plot showing endoscopic and open surgery in long-term follow-up (12-24 months), using the proportion of patients classified as "good or excellent" using the Bishop score as the outcome.



The forest plot shows the relative risks (RR) of good or excellent functional recovery after endoscopic surgery compared to open surgery at 12-24 months. It can be seen that none of the studies showed a statistically significant difference, since all the 95% confidence intervals include the reference value (RR = 1). The study by Schmidt et al. (RR = 1.02; 95%CI 0.80-1.30) indicates no relevant effect, while that by Dützmann et al. suggests a possible advantage of the endoscopic technique (RR = 1.14; 95%CI 0.97-1.35), although without statistical significance. Krejčí et al. showed the opposite trend, with RR = 0.94 (95%CI 0.79-1.12), indicating slightly better results with open surgery, but also without significance. Taken together, the findings suggest equivalence between the techniques, with no clear evidence of superiority of one over the other in the long term.