

# Comparative Effectiveness and Functional Outcome of Open-Door versus French-Door Laminoplasty for Multilevel Cervical Myelopathy: A Meta-Analysis

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## Abstract

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**Keywords:** Open-door laminoplasty; French-door laminoplasty; Multilevel cervical myelopathy; Meta-analysis

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**BACKGROUND:** At present, few reports are comparing these 2 major cervical posterior laminoplasty methods with Open-door and French-door Laminoplasty in terms of neurological recovery, cervical alignment, and surgical complications. Moreover, most of the research has not been well designed.

**AIM:** This study aims to determine comparative effectiveness and functional outcome of open-door versus french-door laminoplasty for multilevel cervical myelopathy.

**METHODS:** The Meta-analysis is used in this study. The study sample is a published research articles on comparative effectiveness and functional outcome of open-door versus french-door laminoplasty for multilevel cervical myelopathy on the internet through databases on PubMed and ProQuest and published between 1997 until December 2018. Weighted mean difference and pooled weighted mean difference are calculated by using the fixed-effect model or random-effect model. Data is processed by using Review Manager 5.3 (RevMan 5.3).

**RESULTS:** This study reviews 58 articles. There are 6 studies conducted a systematic review and continued with Meta-analysis of relevant data. The results showed significant higher postoperative Japanese Orthopaedic Association (JOA) score in open-door laminoplasty (ODL) than French-door laminoplasty (FDL) (weighted mean difference [WMD] = 0.71; 95% confidence interval [CI]: 0.35 to 1.07;  $p < 0.05$ ). The outcome of procedures treatment of multilevel cervical myelopathy revealed the operative time, cervical range of motion, axial canal diameter postoperative, axial pain reduction and complications events in ODL and FDL there was no significant difference. But for a cervical lordotic angle in ODL and FDL, there was a significant difference; the ODL group were significantly lesser than the FDL group. The recovery rate in ODL and FDL, there was a significant difference; the ODL was shown to be significantly higher than FDL ( $p < 0.05$ ).

**CONCLUSION:** This analysis suggests that neither cervical laminoplasty approach is superior, based on the postoperative radiological data and complication rate. But the open-door laminoplasty resulted in a higher functional outcome and recovery rate as compared to the French-door laminoplasty.

## Introduction

Cervical myelopathy is a condition that arises when the spinal canal was narrowing and the cord becomes compressed. This is a common manifestation of chronic spinal cord compression which resulted from degenerative conditions such as spondylosis or ossification of the posterior longitudinal ligament (OPLL). In spine cervical myelopathy, it is arising from spinal cord compression due to cervical degenerative changes which are the most common cause of spinal cord dysfunction in patients older than

55 years. Vague sensory and motor symptoms involving the upper and / or lower extremities are common [1].

A combination of static compression with dynamic factors secondary to motion between the vertebral bodies, a congenitally stenotic canal, changes in the intrinsic morphology of the spinal cord, and vascular factors contributes to the development of myelopathy. A developmentally narrow spinal canal in the anteroposterior plane can help with the development of cervical myelopathy [2].

There are a variety of procedures for treating

cervical multilevel compressive myelopathy. Cervical laminoplasty is an extensile approach used to decompress the spinal cord in a patient with cervical myelopathy [3]. This new surgical technique called "expansive open-door laminoplasty" was devised by the author in 1977, which is relatively easier, safer, and better than the ordinary laminectomy from the standpoint of structural mechanics of the cervical spine in order to avoid post-laminectomy complications, such as postoperative fragility of the cervical spine to acute neck trauma, posterior spur formation at the vertebral body, and malalignment of the lateral curvature as it remained as unsolved problems [4]. Laminoplasty is a well-established procedure and is considered to be a gold standard. Even though it has resulted in favourable outcomes, the procedure has been modified because of its complications such as axial pain, loss of range of motion of the neck, postoperative C5 palsy, and late neurologic deterioration. Therefore, there is now a large variety of expansive cervical laminoplasties [3], [4].

Laminoplasty is ideal for patients with multilevel degenerative stenosis and myelopathy or ossification of the posterior longitudinal ligament. It alleviates spinal cord compression by dorsally expanding the spinal canal, thereby allowing the spinal cord to drift posteriorly away from impinging structures [3], [4].

Although there is still a loss of motion after laminoplasty, some motion was preserved in the treated segments, unlike with laminectomy and fusion. Therefore, laminoplasty may be a preferable option for younger patients without significant arthritis. If significant arthritis and/or axial neck pain is present, however, laminoplasty may not be the best choice because a fusion may provide the best chance for relieving the degenerative symptoms [2], [3].

Cervical laminoplasty is a technique for treating myelopathy and myeloradiculopathy associated with cervical stenosis of various etiologies. Variations include open-door laminoplasty, dome-shaped laminoplasty, double-door (French door) laminoplasty, the dorsolateral decompressive procedure, and others [5]. Fixation is then required to hold the lamina open at each level. There are several options available to keep open the laminoplasty, including sutures, suture anchors, bone blocks, and metal implants [2], [3]. The controversies regarding the preferred surgical treatment for cervical myelopathy is focused on anterior decompression and fusion, posterior laminectomy and fusion, or laminoplasty. As the concept of laminoplasty evolved during the 1970s and 1980s, two competing schools of thought emerged; the so-called "open door" and "French door" methods [6]. The laminoplasty allow for indirect decompression of the spinal cord by opening the lamina on one side, thereby creating a hinge joint that allows the spinal cord to float dorsally [3].

At present, few reports are comparing these 2 major cervical posterior laminoplasty methods in terms of neurological recovery, cervical alignment, and surgical complications. Moreover, most of the research has not been well designed [7].

Recently, it is unknown whether there is a significant difference between these laminoplasty methods, and some review of this comparison was limited. Thus, we compared the effectiveness of the two types of laminoplasty in this meta-analysis aiming at differences in recovery rate, clinical, surgical and radiological outcome and also the complications.

## Material and Methods

### Study design and research sample

This research is a quantitative research with Meta-analysis study design. Meta-Analysis is used to find out the comparative effectiveness and functional outcome of open-door versus french-door laminoplasty for multilevel cervical myelopathy. The research sample is a published research article on the internet through the database on PubMed, ProQuest and Cochrane published between 1997 and December 2017. Those data were manually scanned and reviewed with inclusion criteria: study sample is research with randomized controlled trials and non-randomized comparative, a comparative design for open-door laminoplasty versus French-door laminoplasty, patients with cervical myelopathy from cervical spondylotic myelopathy (CSM) or ossification of posterior longitudinal ligament (OPLL), studies directly comparing open-door cervical laminoplasty with French door cervical laminoplasty, and the studies reported a desirable outcome with continuous variable. Exclusion criteria were those with a cervical fracture, neoplasm, infection, or deformity; noncomparative studies, nonhuman in vivo, in vitro, and biomechanical studies were excluded and research which not available in full-text form.

### Operational definitions

Variables in this study are multilevel cervical myelopathy (open-door versus french-door laminoplasty) and functional outcome (operative time, cervical lordotic angle, the global cervical range of motion, axial canal diameter postoperative, axial pain reduction recovery rate and complications events).

### Research procedure

This study is conducted by collecting data through the identification of published research articles on comparative effectiveness and functional outcome of open-door versus french-door

laminoplasty for multilevel cervical myelopathy on the internet on PubMed, ProQuest, and Cochrane databases (Figure 1).

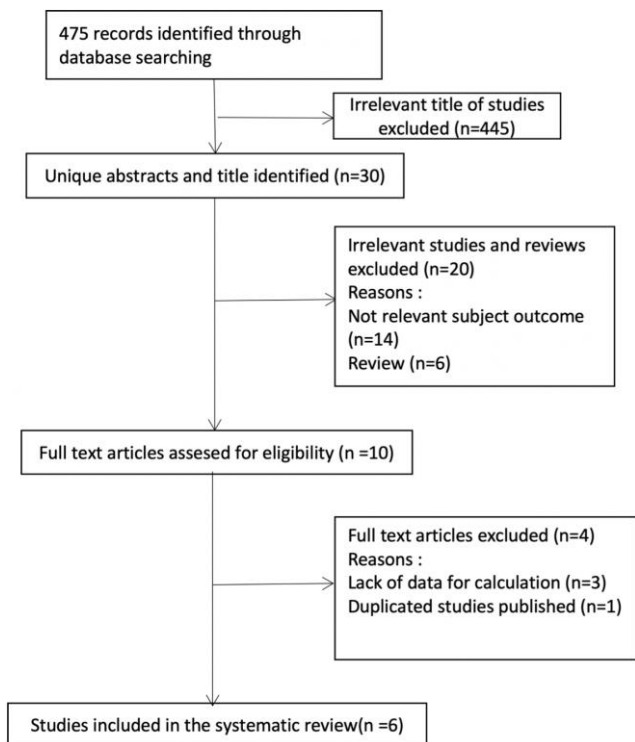


Figure 1: Flow diagram research procedure

**Data collection technique**

Search is limited only to English language articles. This article type is limited to journal articles. Research subjects are limited only to research subjects of a human. The time of publication is limited from 1997 to December 2018. Articles with potentially relevant titles are reviewed abstract, while irrelevant articles are excluded.

Furthermore, the article is reviewed abstract. Articles that have potentially relevant abstracts will then be reviewed in full-text while irrelevant articles are excluded. Furthermore, the article is excluded based on the research variables and the design of the study (randomised controlled trials and nonrandomized comparative).

**Data analysis**

The analysis held to get the value of weighted mean difference which is the combined mean difference value from the research. Data analysis by Weighted mean difference and pooled weighted mean difference method using a *fixed-effect model* or *random-effect model*. Data is analysed by using Review Manager 5.3 (RevMan 5.3).

**Results**

Identification of 58 articles, done by review through the title of the articles, then reviewed abstract, then reviewed in full-text form. Irrelevant articles are excluded. Selection of studies conducted to obtain 6 studies related to comparative effectiveness and functional outcome of open-door versus french-door laminoplasty for multilevel cervical myelopathy (Table 1).

**Table 1. A systematic review of comparative effectiveness and functional outcome of open-door versus french-door laminoplasty for multilevel cervical myelopathy**

First Author, Year	Design Study	Number of Patients (Male/ Female)		Age, Years		Follow up Months	
		ODL	FDL	ODL	FDL	ODL	FDL
Baek <i>et al.</i> , [8]	Retrospective cohort	24	10	55.5	56.2	17.6 ± 23.4	18.8 ± 36.3
Okada <i>et al.</i> , [4]	Prospective randomized trial	17 (10/7)	18 (13/5)	59.9 (31-79)	61.1 (46-79)	27.6	26.2
Park <i>et al.</i> , [9]	Retrospective trial	79 (63/16)	21 (15/6)	55.2 ± 12.7	57.6 ± 11.9	47.9 (25-70)	49.5 (25-70)
Wang <i>et al.</i> , [10]	Prospective study	24 (14/10)	25 (17/8)	59.5 (38-76)	60.4 (36-74)	21.8 ± 2.2	20.6 ± 2.0
Lee <i>et al.</i> , [11]	Retrospective trial	23 (12/11)	28 (25/3)	59.4 ± 1.9	59.3 ± 2.0	24.6 ± 1.3	27.8 ± 1.2
Nakashima <i>et al.</i> , [6]	Prospective randomized trial	44 (29/15)	46 (28/18)	62.6 ± 9.5	63.4 ± 10.7	28.4	29.3

Based on the results of the systematic review, there are 6 studies analysed by meta-analysis. A meta-analysis of comparative effectiveness and functional outcome of open-door versus french-door laminoplasty for multilevel cervical myelopathy (Figure 2).

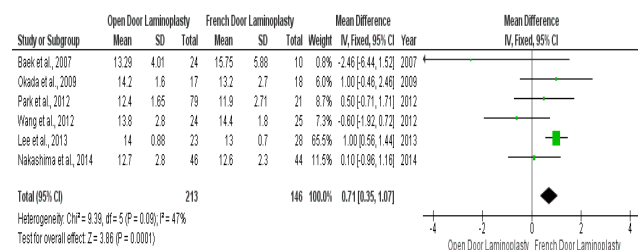


Figure 2: Forest plot showing the weighted mean difference in the Japanese Orthopaedic Association (JOA) score for Open-door laminoplasty versus French-door laminoplasty

Figure 2 the results showed significant higher postoperative Japanese Orthopaedic Association (JOA) score in open-door laminoplasty (ODL) than French-door laminoplasty (FDL) (weighted mean difference [WMD] = 0.71; 95% confidence interval [CI]: 0.35 to 1.07; p < 0.05) (Figure 3). The operative time in ODL and FDL there was no significant difference (WMD = -6.32; 95% CI: -17.16 to 4.53; p = 0.25). The cervical lordotic angle in ODL and FDL there was a significant difference, the ODL group were significantly lesser than the FDL group (WMD = -2.72; 95% CI: -3.60 to -1.84; p < 0.05). The global cervical range of motion in ODL and FDL there was no significant difference (WMD = -4.62; 95% CI: -13.06 to 3.82; p = 0.28).

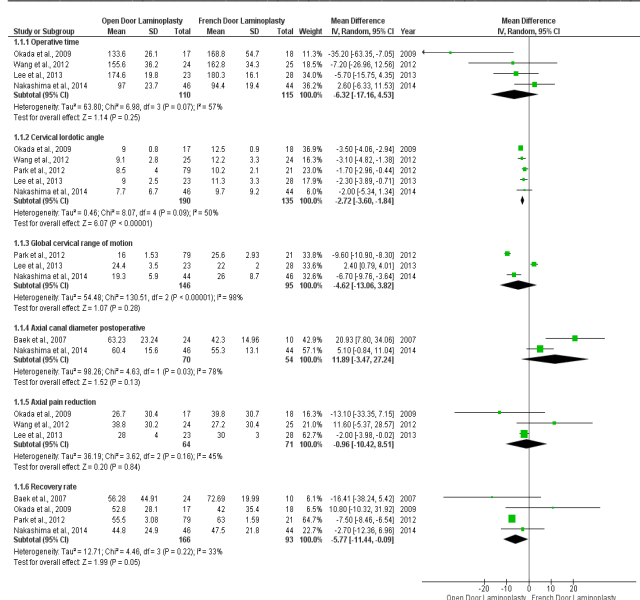


Figure 3: Forest plot showing the weighted mean difference in outcome procedures treatment of the Japanese Orthopaedic Association (JOA) score for Open-door laminoplasty versus French-door laminoplasty

The axial canal diameter postoperative in ODL and FDL there was no significant difference (WMD = 11.89; 95% CI: -3.47 to 27.24; p = 0.13). The axial pain reduction in ODL and FDL there was no significant difference (WMD = -0.96; 95% CI: -10.42 to 8.51; p = 0.84). The recovery rate in ODL and FDL there was significant difference, the ODL was shown to be significantly higher than FDL (WMD = -5.77; 95% CI: -11.44 to -0.09; p < 0.05). The complication events in ODL dan FDL (Figure 4).

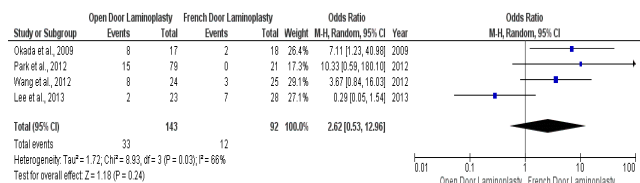


Figure 4: Forest plot showing the pooled odds ration in complication events of procedures treatment of the Japanese Orthopaedic Association (JOA) score for Open-door laminoplasty versus French-door laminoplasty

Figure 4 the complications events in ODL and FDL there was no significant difference, (OR = 2.62; 95% CI: 0.53 to 12.96; p = 0.24).

## Discussion

The results showed significant higher postoperative Japanese Orthopaedic Association (JOA) score in open-door laminoplasty (ODL) than French-door laminoplasty (FDL) (weighted mean

difference [WMD] = 0.71; 95% confidence interval [CI]: 0.35 to 1.07; p < 0.05). The outcome of procedures treatment of multilevel cervical myelopathy revealed cervical lordotic angle in ODL and FDL there was a significant difference; the ODL group were significantly lesser than the FDL group. The recovery rate in ODL and FDL, there was a significant difference; the ODL was shown to be significantly higher than FDL (p < 0.05).

Cervical laminoplasty has been the preferred surgical treatment for cervical compressive myelopathy cases. Its main purpose is to decompress the spinal cord by increasing the diameter of the spinal canal. The two most commonly used approaches are the open-door and French-door types, each with its pros and cons.

Hirabayashi first described a single door open laminoplasty technique in 1981, using groove creation between the lamina and articular facets of one side. This technique may cause the lamina to recover back to its original position due to failure in the attachment of the open side or the presence of fracture on the hinged side. Many researchers have published several modifications to the Hirabayashi technique to solve this problem. One is combining spinous processes grafts such as bony spacers, enhanced by titanium plates and screws [4], [11], [12].

The French-door laminoplasty, on the other hand, offers a symmetrical decompression by creating an opening in the midline of spinous processes and hinges on both laminae. Bilateral troughs are created on each lamina, thus creating a “French door” which allows the spinal cord to move posteriorly [2], [5], [12].

According to previous research over this procedure, the difference over the neurological and functional outcome is not significant [13], [14], [15]. Another research also found that the functional outcome of ODL was better than FDL [8], [10], [12]. Axial canal expansion and lordotic angle postoperative were better achieved by ODL than FDL [7], [14], [16]. The complication postoperatively was higher in ODL than FDL [15], [16].

Based on our recent analysis, the main results based on the comparison between open-door and French-door laminoplasties are that open-door laminoplasty is superior to French-door laminoplasty concerning higher recovery outcome. This reflects the efficacy of the surgical approaches in decompression of the spinal cord. But the complication rate is still higher, i.e. intraoperative blood loss and postoperative axial pain that possible from damage to the spinous process ligament-muscle complex, damage to posterior roots of C3-7 spinal roots, damage of the suture for facet joint capsule, decrease in the cervical lordotic angle and move range and long-term immobilization of neck [4], [15].

Others have suggested that French-door laminoplasty is more beneficial than open-door



laminoplasty for patients with multilevel cervical compressive myelopathy to minimise postoperative complications such as C5 palsy in patients with asymmetrical ossification of the posterior longitudinal ligament (OPLL) [7], [10], [14], [15]. This may be because French-door creates a wider spinal canal to allow more space for the spinal cord to expand.

In this analysis, open-door laminoplasty was found to be inferior to the French-door type when considering cervical lordotic angle and recovery rate. Others have suggested that French-door laminoplasty is more beneficial than open-door laminoplasty in preventing postoperative kyphosis [7].

In particular, the range of motion extension is significantly decreased in the open-door laminoplasty group. This may be due to excessive enlargement of the spinal laminae in open-door laminoplasty, which may negatively affect the results. Greater expansion of the spinal canal is easier by open-door laminoplasty than by French-door laminoplasty. Although future studies are required to ascertain the effectiveness of spinal canal expansion, according to the literature, it seems that open-door laminoplasty better enables effective spinal canal enlargement as compared with French-door laminoplasty.

These results suggest that neither cervical laminoplasty approach is superior based on the postoperative radiological data and complication rate. But open-door laminoplasty was shown to provide a higher functional outcome and recovery rate compared with French-door laminoplasty.

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