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Results of Laminoplasty in Treatment of Multilevel Cervical Spinal Canal Stenosis

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ABSTRACT

Background: Cervical myelopathy is a prevalent neurological disorder resulting from compression of the cervical spinal cord, typically associated with degenerative changes in the cervical spine, particularly cervical spondylosis.
Cervical spondylotic myelopathy is the result of degenerative arthritic changes (spondylosis) in the cervical spine, which cause narrowing of the spinal canal (spinal stenosis) and eventually lead to compression of the spinal cord.
Spinal canal relief can be accomplished through either anterior or posterior surgical approaches. In cases involving multilevel disease, the majority of surgeons tend to favor the posterior decompression method.
Objective of the stud: to evaluate the clinical and radiological outcome of the laminoplasty preocedure.
Patients and Methods: This prospective research was conducted on a cohort of 20 patients diagnosed with multi level of cervical spondylotic myelopathy, confirmed both clinically and radiologically, who did not show improvement with conservative medical treatment. The patients underwent surgery at the spinal units of Mansoura University Hospitals and Manchester University Hospitals, UK, between January 2019 and December 2023. Patients were involved after providing verbal and informed consent.
Results: The mean value prior to surgery of modified Japanese Orthopedic Association (mJOA) score was 11.3 ± 1.24, which significantly improved to a mean post-surgery mJOA score of 13.8 ± 1.25. Additionally, the mean value prior to surgery Nurick's score was 3.07 ± 0.68, with a significant improvement postoperatively to a mean score of 1.67 ± 0.6.
Conclusion: Laminoplasty is increasingly recognized as a preferred management of multilevel cervical stenosis caused by CSM.
Keywords: Sagittal balance; Laminoplasty; Cervical myelopathy; Cervical spine surgery; Cervical stenosis.

INTRODUCTION

CSM is considered the leading cause of spinal cord-related disability in older individuals. CSM develops due to the degenerative narrowing of the spinal canal, leading to gradual, stepwise compression of the spinal cord. The extent and site of spinal cord compression differ, and it can be caused by ventral pathologies such as herniated discs and disc-osteophyte complexes, or by dorsal compression resulting from hypertrophy of the facet joints and ligamentum flavum. These alterations may be limited to a single level or extend across multiple levels. CMS is the leading cause of myelopathy in adults over the age of 55, resulting in progressive disability and a decline in quality of life [1].

CSM presents with various patterns of neurological deficits. Patients may exhibit a range of signs and symptoms, including paresthesia in the arms, gait disturbances, bilateral numbness, neck pain (often an early symptom), sensory impairments, bladder dysfunction, and lower extremity weakness with upper motor neuron (UMN) features. These clinical manifestations typically develop gradually, with a characteristic insidious onset and slow, stepwise progression [2].

Treatment options for CSM, particularly regarding the decision to operate and the timing of surgery, remain a subject of debate. These options encompass both conservative non-surgical approaches and surgical interventions. Conservative treatments typically involve cervical immobilization (using a brace or soft collar), refraining from engaging in high-risk activities and environments (including slippery surfaces, heavy lifting, contact sports and intense neck motions), along with pain management and physical therapy, is recommended [3, 4].

Currently, there is general agreement that a modified Japanese Orthopedic Association (mJOA) score of ≤12 serves as definitive indication for surgical intervention in patients with CSM. For those presenting with a mJOA score greater than 12, the decision to proceed with surgery should be made on a case-by-case basis. The timing of surgery is determined by the patient's specific clinical presentation. A rapid neurological decline necessitates more urgent intervention, while a stable deficit can be managed electively. When surgical intervention is deemed necessary, it is generally recommended to carry out the procedure within six months to one year of the initial onset of symptoms in order to maximize the likelihood of favorable outcomes [5,6].

The primary objectives in the management of CSM involve achieving adequate decompression of the neural structures and maintaining spinal stability is crucial to avert the progression of deformity and the potential worsening of neurological function. Selecting optimal interventional approach necessitates a thorough evaluation of the patient's clinical symptoms and radiographic findings. The surgical approach for patients with CSM must be personalized and thorough. The development of an optimal surgical plan relies on several factors, including the patient's pathology, neurological condition, underlying medical issues, assessment of risks associated with the procedure, and the surgeon's expertise and proficiency with particular techniques significantly influence the success of the procedure [7, 8].

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This study was conducted in Mansoura University Hospital Spinal Unit and Manchester University Hospitals, Spinal Unit to evaluate the clinical outcome, radiographic changes (increase in canal diameter) and adverse events in patients with multilevel cervical spinal canal stenosis who have undergone posterior pressure alleviation with laminoplasty.

PATIENTS AND METHODS

This prospective study included 20 patients diagnosed with multilevel cervical spondylotic myelopathy, confirmed radiologically and clinically, who had not shown improvement with conservative medical management. The surgeries were performed on patients at the spinal units of Mansoura University Hospitals and Manchester University Hospitals, UK, from January 2019 to December 2023.

All patients had cervical laminoplasty through the posterior approach of the neck.

The patients included in our study satisfied the following inclusion: -

- Age over 40 years
- CSM resulting from multi-segmental spinal stenosis (involving two or more segments).
- Non kyphotic cervical spine curve.
- Lack of response to conservative and medical treatments
- No prior history of cervical surgery.
- Medically deemed suitable for surgery
- Compliance of the patient to the required follow-up.

Ethical Committee approval:

The study was done after being accepted by the Research Ethics Committee, Mansoura University Hospital. All the patients provided written informed consents prior to their enrolment. The consent form explicitly outlined their agreement to participate in the study and for the publication of data, ensuring protection of their confidentiality and privacy. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

Statistical analysis of data: The collected data were organized, tabulated and statistically analyzed using statistical package for social sciences (SPSS) version 22 (SPSS Inc, Chicago, USA), running on IBM compatible computer. For qualitative data, frequency and percent distributions were calculated. For quantitative data, mean and standard deviation (SD) were calculated P value <0.05 was considered significant.

The Chi-square test, Fisher's exact test, and unpaired Student's t-test were used as appropriate to analyze the preoperative demographic characteristics, clinical presentations (pre-operative NDI, mJOA, Nurick's, and VAS scores), and clinical outcomes (post-operative complications and NDI, mJOA, Nurick's, and VAS scores).

RESULTS

The mean value prior to surgery of modified Japanese Orthopedic Association (mJOA) score was 11.3 ± 1.24, which significantly improved to a mean post-surgery mJOA score of 13.8 ± 1.25. Additionally, the mean value prior to surgery Nurick's score was 3.07 ± 0.68, with a significant improvement postoperatively to a mean score of 1.67 ± 0.6.

In the study cohort, the most prevalent presenting symptom was neck pain, observed in all 20 patients, followed by a sensation of heaviness in the upper and lower limbs, which affected 13 patients (Figure 1).

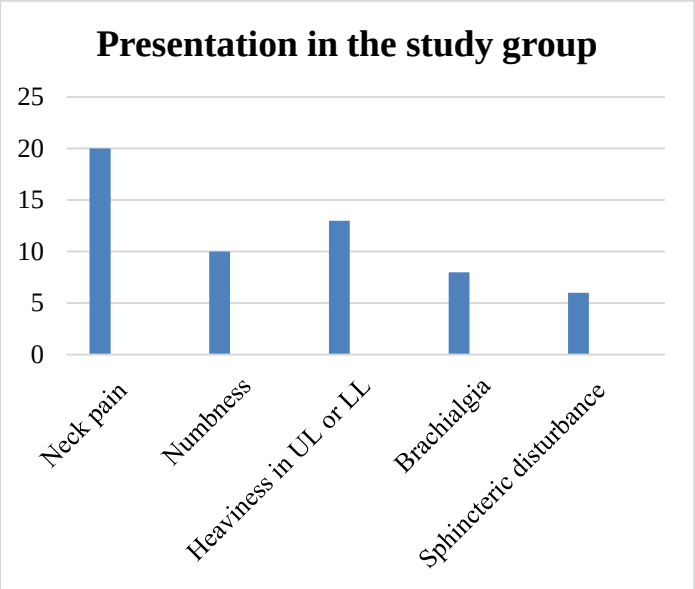

Figure (1): Presenting symptoms in the study group

Motor deficits affecting the upper limbs were present in all examined patients (100%). Deficits affecting both the upper and lower limbs were seen in 75% of the cases, while a positive Babinski sign was present in 55% of the patients (Table 1).

Table (1): Showing the clinical signs in the study group

Signs	No.	%
UL Weakness	20	100 %
UL and LL weakness	15	75 %
Sensory disturbance	5	25 %
Spasticity	11	55 %
Hyperreflexia	14	70 %
Positive Babinski sign	11	55 %
Positive Hoffmann reflex	3	15 %
Ankle clonus	7	35 %

Preoperative mean neck pain score on the VAS (Figure 2) was 6.07 ± 1.18 which was improved to a mean of 5 ± 1.03 at one year and preoperative mean upper limb pain score was 5.8 ± 1.47 which has improved to a mean of 3 ± 1.31 at one year follow up.

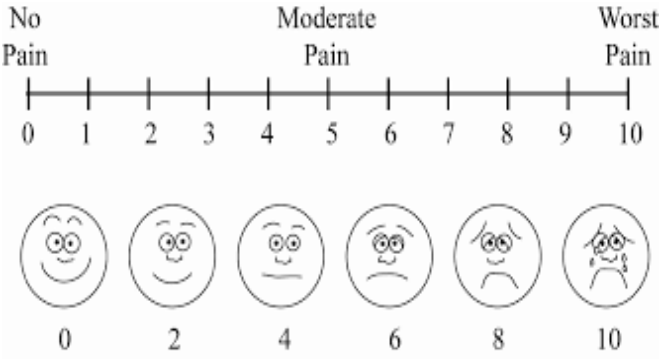

Figure (2): Visual analogue score; zero is no pain and ten is the worst pain

The preoperative average Neck Disability Index (NDI) score was 27.07 ± 5.26, while the overall post-operative average disability score on the NDI was 16.27 ± 5.13. There was statistically significant improvement in NDI after one year.

Complications observed in this study encompassed one instance of instrumentation failure (5%), the patient presented with severe radiculopathy and mild weakness, along with a fracture on the hinged side of the laminoplasty, causing neural compression. necessitating revision surgery. This involved the removal of the plate and the insertion of lateral mass screws. Furthermore, there was one instance of a superficial infection (5%) and one case of dural tear (5%). Throughout the study period, none of the patients experienced deep infections, progression of myelopathy at the final evaluation (as all reported weakness in both groups was temporary and resolved upon follow-up), vascular injuries, hematomas, or mortality.

Operative duration: The mean duration was 142 ± 27.06 minutes in the study group with max time 200 min of and minimum time of 110 min.

In our study, the average preoperative C2-7 Cobb's angle was 9.42° ± 6.1°, with a subsequent improvement in the mean postoperative C2-7 Cobb's angle at the 1-year follow-up, which was 9.2° ± 4.43°. This difference was found to be statistically insignificant.

In our study, outcome scores using Odom's criteria were excellent in 4 patients (20%), good in 11 patients (55%), fair in 4 patients (20%) and poor in one patient (5%).

Fair and poor results were observed in the 60-69 age group and in patients with pre-op diagnosis of DM and hypertension.

Table (2): Post-op Odom's Criteria

Odom's Criteria	No of patients	
	No.	%
Excellent	4	20%
Good	11	55%
Fair	4	20%
Poor	1	5%

DISCUSSION

Various posterior surgical approaches have been outlined for the management of cervical myelopathy. Traditionally, laminectomy was considered the preferred treatment. This procedure offers a direct decompression and consistent symptom relief [9]. However, a significant proportion of patients experience complications resulting from instability resulting from the removal of the posterior structures [10, 11]. Adverse events associated with laminectomy include neurological decline, post-laminectomy kyphosis and segmental instability. To mitigate these issues, fusion procedures are often incorporated to enhance biomechanical stability. Several studies have shown that the addition of posterior fusion effectively reduces risk of post-laminectomy instability [12, 13].

Laminoplasty is another surgical approach for treating CSM. It was introduced to minimize considerable risk of problems linked to other surgical methods, including anterior decompression with fusion and laminectomy, either with or without posterior fusion [14, 15].

Darryl Lau *et al.* performed retrospective cohort study involving 145 patients, of whom 44 underwent laminectomy with fusion and 101 underwent laminoplasty. Among the 145 patients, 96 (66.2%) reported preoperative neck pain. Neck pain was the most prevalent presenting symptom in our study group, affecting all 20 patients (100%), followed by feeling of weight in both the lower and upper limbs in 13 patients (86.7%). Additionally, six patients (9%) presented with sphincteric disturbances [16].

In retrospective study by **Wei Du *et al.***, most commonly reported sign was hyperreflexia, observed in 25 of the 36 patients who underwent laminoplasty (69.4%). Upper limb weakness was the second most commonly observed sign, affecting 22 of the 36 patients (61.1%). Additionally, 9 of the 36 patients (25%) who underwent laminoplasty exhibited the Babinski sign [17].

In a retrospective study by **Lili Yang *et al.*** , 75 patients underwent laminoplasty, with the average operative time being 145.07 ± 27.13 minutes [18].

These findings are consistent with our own results concerning operative duration and support the notion that laminoplasty is a time-efficient procedure compared to laminectomy and fusion. This can be particularly beneficial for elderly patients with comorbidities that limit their tolerance for prolonged

anesthesia. Additionally, longer operative times may increase the risk of infection [11].

Fehlings *et al.* reported that patients who underwent laminoplasty showed a mean improvement of 3.49 in the mJOA score. This improvement was significantly greater in laminoplasty group compared to laminectomy with fusion group, with scores of 3.49 and 2.39, respectively ($p = 0.0069$) [19]. These findings are consistent with our results.

Darryl Lau *et al.* found a decrease in the postoperative Cobb's angle (8.8°) compared to the preoperative Cobb's angle (10.9°) in laminoplasty group [16].

CONCLUSION

Laminoplasty is gaining popularity as management for multilevel cervical stenosis caused by CSM. This approach reduces the potential adverse events often seen with other surgical methods, such as graft and fusion-related problems, postoperative kyphosis and instability, along with the morbidity linked to anterior approaches. While laminoplasty presents several benefits, it is not without potential adverse events, such as difficulties with laminar closure, axial neck pain, nerve root palsies, loss of cervical motion and alignment. Despite these risks, laminoplasty continues to be a highly effective option for patients with multilevel cervical stenosis.

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