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Laminectomy alone versus laminectomy with lateral mass screw fixation in the treatment of multisegment cervical spinal canal stenosis: a comparative analysis

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Abstract

Background Multisegment cervical canal stenosis is one of the most common causes of spinal cord dysfunction. Cervical laminectomy affords direct relief from dorsal stenosis, but many concerns were raised regarding its effect on spinal stability and cervical sagittal alignment. Laminectomy in conjunction with lateral mass screws is aiming to prevent recurrence of stenosis and to achieve much improvement of the cervical spine range of motion and curvature.

Objectives To compare the clinical and radiological outcome of laminectomy alone versus laminectomy with lateral mass screw fixation in the treatment of patients with multisegment cervical canal stenosis.

Patients and methods A retrospective study conducted on 46 patients with multisegment cervical canal stenosis who were treated between April 2018 and April 2021. Patients were divided into two groups. The 20 cases in group (A) underwent conventional laminectomies and the 26 cases in group (B) underwent laminectomies with lateral mass screw fixation. Operative complications, visual analogue scale (VAS), neurological functional recovery and cervical curvature changes were compared between the two groups.

Results Operative times in group A were significantly less than it was in group B ($P < 0.001$). The postoperative VAS scores in group B were significantly lower than those in group A ($P < 0.05$). No statistical differences in the modified Japanese Orthopedic Association score could be found between the two groups after surgery. Patients in group B in comparison with those in group A had good alignment of the cervical spine with maintenance of curvature index ($P < 0.001$).

Conclusions In multilevel cervical canal stenosis, internal fixation using lateral mass screws in conjunction with laminectomy can be of a considerable significance than laminectomy alone in improving the axial symptoms and ceasing further disease progression through stabilization of the cervical spine and maintaining the sagittal alignment.

Keywords Cervical stenosis, Laminectomy, Lateral mass, Myelopathy

Background

Multisegment cervical canal stenosis is a degenerative disorder caused by multiple factors such as multiple levels disc prolapses, ossified posterior longitudinal ligament (OPLL), hypertrophy of ligamentum flavum and facets hyperplasia. It is the most important factor for

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development of myelopathy through compression and/or ischemia of nerve roots and spinal cord [1, 2].

Surgical treatment aims to correct spinal compression, maintain sagittal alignment and stabilize the cervical spine. Multiple factors are important in determining the surgical approach best to be used including; the cervical sagittal alignment, location of the spinal cord compression, number of compressing segments and associated comorbidities [3, 4]. For multilevel cervical spinal stenosis, posterior decompressive surgery is often advocated as it can stop disease progression and improve functional outcome [5].

In the majority of cases with spinal cord compression, the course of the disease is gradually progressing. However, a few patients with myelopathy suffered rapidly progressive neurological deterioration, mainly with walking disorders. Early surgical decompression can achieve good neurological recovery, indicating a reversible condition [6].

Lateral mass screws have become the method of choice for posterior cervical spine stabilization in a variety of surgical indications. It results in a high rate of fusion and can provide equal or greater biomechanical stability when compared to anterior fixation techniques [7, 8]. Laminectomy with lateral mass screw fixation is an ideal surgical method in multilevel cervical canal stenosis aiming to prevent recurrence of stenosis and to achieve much improvement of the cervical spine range of motion and curvature [5].

When choosing the posterior approach, it remains controversial whether fusion as an adjunct to laminectomy is necessary. And the decision to fuse is mainly based on surgeon preference [9].

Therefore, in this study we tried to answer an important question; should lateral mass screws be used in conjunction with laminectomy in patients suffering multilevel cervical canal stenosis or it should be left for the surgeon's preference?

Aim of the work

This study aimed to compare the clinical and radiological outcome of laminectomy alone versus laminectomy with lateral mass screw fixation in the treatment of patients with multisegment cervical spinal canal stenosis.

Patients and methods

Study design and patients

A retrospective comparative study conducted on 46 patients treated for multisegment cervical spinal canal stenosis between April 2018 and April 2021; and comparing the clinical and radiological outcome after laminectomy alone (group A) versus after laminectomy with lateral mass screw fixation (group B). There was no

documented reason for assigning the patients to either operative method and the decision to use lateral mass screws was mainly based on the surgeon's preference.

Ethics approval

This study was approved by the local ethical scientific committee of our institution. IRB approval number and date is (2-2023.NEUS. 1-3). Being a retrospective study, patients' consents for participation in the study and for publication were not applicable.

Sample size estimation

Based on review of past literature Al Barbarawi et al. [10] who found that preoperative and postoperative neck disability score were 60% versus 20%. The least sample size calculated using Statistics and Sample size pro program V.6 is 46 participants. The power of study is 80% and confidence level is 95%. Sample size: 46 participants.

Inclusion criteria

In this study, we included patients who (1) were diagnosed with multilevel cervical spinal stenosis by Magnetic Resonance Imaging (MRI) and had relevant clinical symptoms, (2) didn't respond to at least 3 months of conservative management, (3) had posterior pathological cervical compression that encompasses 2 or more vertebral body segments in MRI, (4) had preserved cervical lordosis or with straightened cervical curvature, and (5) were treated with either laminectomy alone or laminectomy plus lateral mass screws fixation.

Exclusion criteria

We excluded all patients with; (1) previous cervical surgery, (2) incomplete follow-up information or (3) stated comorbidities in the register, including spinal trauma, spinal infection, rheumatoid arthritis, ankylosing spondylitis, neoplastic disease, cervical segmental instability, severe cardiac disease, and severe neurological disease.

Data collection

Data were collected from the patients' medical records of our department including; data on admission; immediate postoperative data; data on follow ups at 3, 6 and 12 months after surgery. All patients were submitted to full medical history, general examination and full neurological assessment. Preoperative evaluation of neck pain severity was conducted according to the VAS score. Assessment of weakness and spasticity due to cervical spondylotic myelopathy was done by the mJOA.

All patients were submitted for plain radiographs of the cervical spine to assess the cervical lordotic curve, Computed Tomography (CT) scan to detect the presence of osteophytes or OPLL and MRI to assess the neural tissue

compromise, intervertebral disc affection and ligaments integrity.

Operative procedure

All patients were operated under general anesthesia, in the prone position with head fixed in Mayfield. A posterior midline incision was made, and then electro-cautery was used to carry the incision deeply and to expose the spinous processes, laminae and lateral masses of the desired levels. Muscular sub-periosteal dissection was performed and self-retaining spreaders were installed.

In group (A): The spinous processes, laminae and the lateral masses were prepared. The decompressive laminectomy was done and the ligamentum flavum was removed.

In group (B): The lateral mass at each level was considered to be split into four quadrants. A cross was marked with mono-polar coagulation and the midpoint of the lateral mass was identified. The modified Magerl technique was used for screw insertion, where the entry point was 1–2 mm medial and 1–2 mm inferior to the midpoint of the lateral mass. The direction was 20° to 30° divergent from the midline and upwardly parallel to the superior facet joint. A 2.7 mm tap was used, and a 3.5 mm

diameter polyaxial screw was inserted. The usual screw length was between 10 and 14 mm. Rods of appropriate size were selected and bent to match the contour of the lateral masses and secured to the lateral masses by screws. Then laminectomy was done and the ligamentum flavum was removed.

In both groups, the wound was closed in anatomical layers and the patients were mobilized at the sixth post-operative hour. A cervical neck collar was used for 6 weeks.

Outcome measures

Clinical outcome measures included: (1) assessment of pain score using VAS score for neck pain [11] where the worst imaginable pain takes 10 points, while no pain takes 0 points, (2) assessment of disability and functional evaluation using the mJOA score [12] Table 1, and (3) assessment of operative related complications.

Radiological evaluation was performed by plain radiographs (AP and lateral views) to assess cervical curvature. The cervical curvature changes were evaluated by the cervical curvature index (CCI), where $CCI = (a1 + a2 + a3 + a4)/a \times 100\%$; this can be done by measuring the distance between the posterior lower margins of the C2

Table 1 The modified Japanese Orthopedic Association (mJOA) score

(1) Motor dysfunction of the upper extremities			
Unable to feed oneself			0
Unable to use knife and fork but can eat with spoon			1
Able to use knife and fork with much difficulty			2
Able to use knife and fork with slight difficulty			3
None			4
(2) Motor dysfunction of the lower extremities			
Unable to walk			0
Can walk on flat floor with walking aid			1
Can walk up and/or down stairs with handrail			2
Lack of stability and smooth gait			3
None			4
(3) Sensory deficit			
	Upper extremities	Lower extremities	Trunk
Sever sensory loss or pain	0	0	0
Mild sensory loss	1	1	1
None	2	2	2
(4) Bladder dysfunction			
Unable to void			0
Marked difficulty in micturition (retention)			1
Mild difficulty in micturition (frequency and hesitation)			2
None			3
Total score = 17			

and C7 plates, and it is named as *a*. Then, the vertical distances from the posterior lower margins of C3, C4, C5, and C6 to *a* are measured and named *a1*, *a2*, *a3*, and *a4* respectively. CT scan was used to assess screws' position and adequacy of decompression.

Statistical analysis

To tabulate and statistically analyze the results, SPSS V.22 (IBM Corporation, 1 Orchard Rd, Armonk, NY 10504, USA), and Microsoft Excel 2010 (Microsoft Corporation, One Microsoft Way Redmond, WA 98052-6399 USA) were used. The descriptive statistics included mean (\bar{x}), median, and standard deviation (SD). The count data were expressed as the rate and analyzed using the chi-square test (χ^2). Standard Student *t*-test (*t*) for paired samples was used for the comparison between different pre and postoperative means. *P* value ≤ 0.05 was considered statistically significant.

Results

In the current study of 46 patients with multisegment cervical canal stenosis, group A included 20 patients (43.5%) who were operated by laminectomy alone and group B included 26 patients (56.5%) who were operated by laminectomy with lateral mass screws fixation. As shown in Table 2, there were no statistically significant differences between the two groups in terms of age, gender, duration of symptoms, main complaint, systemic comorbidities, or decompressed segments where (all $P > 0.05$).

The mean operation time in group A was (90.17 ± 8.22) minutes, while the corresponding value in group B was (125.81 ± 8.96) minutes. A significant difference could be found ($P < 0.001$).

Neurological function evaluation using mJOA score between the two groups

As shown in Table 3, no significant differences could be found in the mJOA score between the two groups before surgery and at each time point after surgery ($P > 0.05$). Compared with the preoperative values, the mJOA score was significantly increased in both groups at 3, 6 and 12 months after surgery, with statistical significant differences ($P < 0.001$).

The VAS score between the two groups

As shown in Table 3, there were no significant differences in the VAS score between the two groups before surgery but at 6 and 12 months after surgery there were statistical significant differences ($P < 0.05$) where VAS scores were significantly decreased in group B. Compared with the preoperative values in group A, there were no significant differences in the VAS scores at each time point after surgery ($P > 0.05$) while in group B there were significant differences in the VAS scores at 6 and 12 months after surgery ($P < 0.05$).

The CCI % between the two groups

There were no significant differences in the CCI % between the two groups before surgery but at each time point after surgery there were statistical significant

Table 2 Comparison of the general data of patients in the two groups

Parameters	Group A (N=20)	Group B (N=26)	P value
Age in years (mean \pm SD)	59.71 \pm 3.03	59.59 \pm 2.35	0.281
Gender (male/female)	12/8	16/10	0.269
Symptoms duration in months (mean \pm SD)	11.16 \pm 2.26	11.25 \pm 2.55	0.314
Main clinical symptoms			0.462
Sensory disturbances	13/20	16/26	
Lower limb weakness	11/20	14/26	
DM	5/20	6/26	0.684
HTN	6/20	7/26	0.806
Decompressed levels			0.623
C 3–5	3	6	
C 3–6	4	6	
C 3–7	8	10	
C 4–7	5	4	
Operation time in minutes (mean \pm SD)	90.17 \pm 8.22	125.81 \pm 8.96	< 0.001*

Group A: patients underwent laminectomy alone; Group B: patients underwent laminectomy with lateral mass screw fixation

DM diabetes mellitus, HTN hypertension, C cervical

*Statistically Significant

Table 3 Comparison of neurologic functions, axial symptoms and curvature index between the two groups:

Parameters	Group A (N=20)	Group B (N=26)	P value
mJOA score			
Before surgery	7.95±2.83	8.15±2.88	0.812
3 months after surgery	10.10±1.88*	9.92±1.57*	0.731
6 months after surgery	11.55±1.60*	11.77±1.12*	0.600
12 months after surgery	13.05±1.19*	13.12±0.766*	0.832
VAS score			
Before surgery	3.15±1.6	2.81±1.38	0.446
3 months after surgery	3±1.29	2.73±1.25	0.48
6 months after surgery	2.95±1.23	2.31±0.88*	0.046
12 months after surgery	2.65±0.98	1.96±0.66*	0.011*
CCI %			
Before surgery	22.18±0.46	22.23±0.48	0.68
3 months after surgery	24.02±0.843*	19.86±0.633*	<0.001*
6 months after surgery	24.22±0.86*	19.38±0.623*	<0.001*
12 months after surgery	24.72±0.591*	18.27±0.527*	<0.001*

Compared with the preoperative level, * $P < 0.05$. Group A: patients underwent laminectomy alone; Group B: patients underwent laminectomy with lateral mass screw fixation

mJOA modified Japanese Orthopedic Association, VAS visual analogue scale, CCI % cervical curvature index

differences ($P < 0.001$) where CCI % was significantly improved in group B; this was shown in Table 3. Compared with the preoperative values, there were significant changes in the CCI % at each time point after surgery ($P < 0.001$) in the two groups; where in group (B) CCI % was significantly improved while in group (A) it was significantly lost. Figures 1 and 2 represent the pre and post-operative imaging examinations of two cases, one from each group.

Regarding the operative related complications between the two groups

In group (A), the incidence rate of C5 nerve root palsy was 20% (4/20), while in group (B), it was 7.69% (2/26), so a significant statistical difference was found between the two groups ($\chi^2 = 6.00$, $P = 0.014$).

Discussion

Cervical laminectomy affords direct relief from dorsal stenosis, allows the spinal cord to migrate dorsally away from the anterior compressive pathology and also improves cervical cord perfusion [13].

Many concerns were raised regarding the effect of this procedure on spinal stability and cervical sagittal alignment. The main drawback is cervical curvature loss and development of kyphotic deformity. Therefore it is

important to restore and maintain cervical curvature by placing the internal fixation during the operation [14]. In posterior cervical operations, the internal fixation using lateral mass screws is a powerful tool for the treatment of cervical spondylotic myelopathy [15].

In our study, patients in group A underwent cervical laminectomies without internal fixation, while patients in group B were treated with laminectomies plus lateral mass screws fixation. The results showed that; the operative times in group B were longer than it was in group A, and this is because of the time taken for lateral mass screws insertion. In both groups the neurological functions were significantly restored postoperatively in comparison to the preoperative neurological state. However, there were no significant differences in the mJOA scores at each time point after surgery between the two groups. This is because of laminectomy which solved the compression on the cervical spinal cord. These results are in accordance with the results in multiple previous studies [16–18].

The postoperative imaging data in our study showed that; group B patients achieved a better recovery in terms of their cervical curvatures, which were well maintained during follow-up visits; the cervical curvatures in group A patients were significantly lost. Multiple studies had similar results [17, 19, 20]. This can be attributed to loss of the attachment points of the posterior cervical muscles after wide laminectomy, so that the tensile stress of the cervical curvature is obviously weakened, and also the cervical curvature is gradually straightened and even kyphosis occurs. Liu et al. [5], in their study documented that, the physiological curvature of cervical spine was improved at 6 and 12 months after laminectomy plus lateral mass screw fixation and was statistically significant ($P < 0.05$).

Postoperative chronic neck pain is a common complication of traditional posterior cervical approach, which seriously affects the normal life of patients [21, 22]. In our study at 6 and 12 months after surgery, the VAS scores in group B were significantly less than they were in group A. And significant improvement in axial symptoms was found only in group B postoperatively when compared with the preoperative values. This can be attributed to multiple factors including; muscle or ligament injury, atrophy of posterior neck muscles, destruction of joint capsule, cervical curvature change or loss of cervical stability. Takeuchi et al. [23] also reported similar results.

In our study, dural tear had occurred in one case (5%) in group A and it was repaired intra-operatively, facet fracture had occurred in one case (3.84%) in group B and this level was skipped on the side of facet fracture.

The main postoperative complication was the C5 nerve root palsy which was more common in group A. this

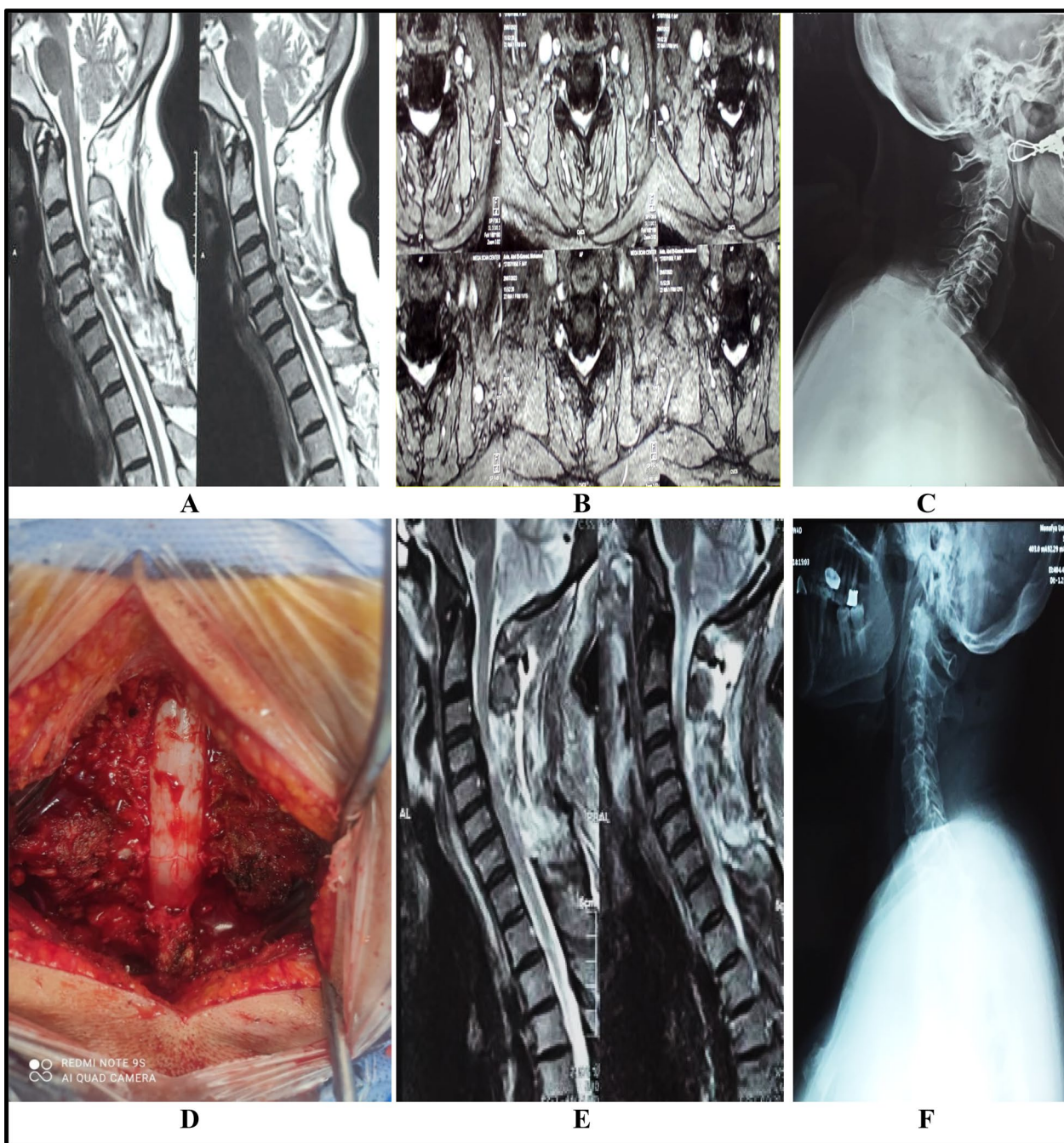


Fig. 1 A–F Female 63 years old in Group A, underwent cervical laminectomy. **A** Pre op. MRI sagittal T-2 showed multisegment cervical canal stenosis; **B** Pre op. MRI axial T-2 confirming the stenosis; **C** X-ray lateral view showed degenerative changes; **D** Intra operative photo showing spinal cord after laminectomy; **E** 3 months post op. MRI sagittal cuts showed sufficient spinal cord decompression; **F** 3 months post op. X-ray

complication was medically treated and settled gradually without any intervention in all cases. The explanation of C5 nerve root palsy is that, the backward drift of the spinal cord which occurred when the sagittal sequence of the cervical spine restores to lordosis, thereby significantly increasing the tension of the nerve root,

making the C5 nerve root excessively stretched and can be directed to ischemia and hypoxia [24].

Takeuchi et al. [23] also reported similar results where C5 nerve palsy was most likely to occur after a total laminectomy without internal fixation. Also, in a study conducted by Chang et al. [25] on 58 patients with multilevel

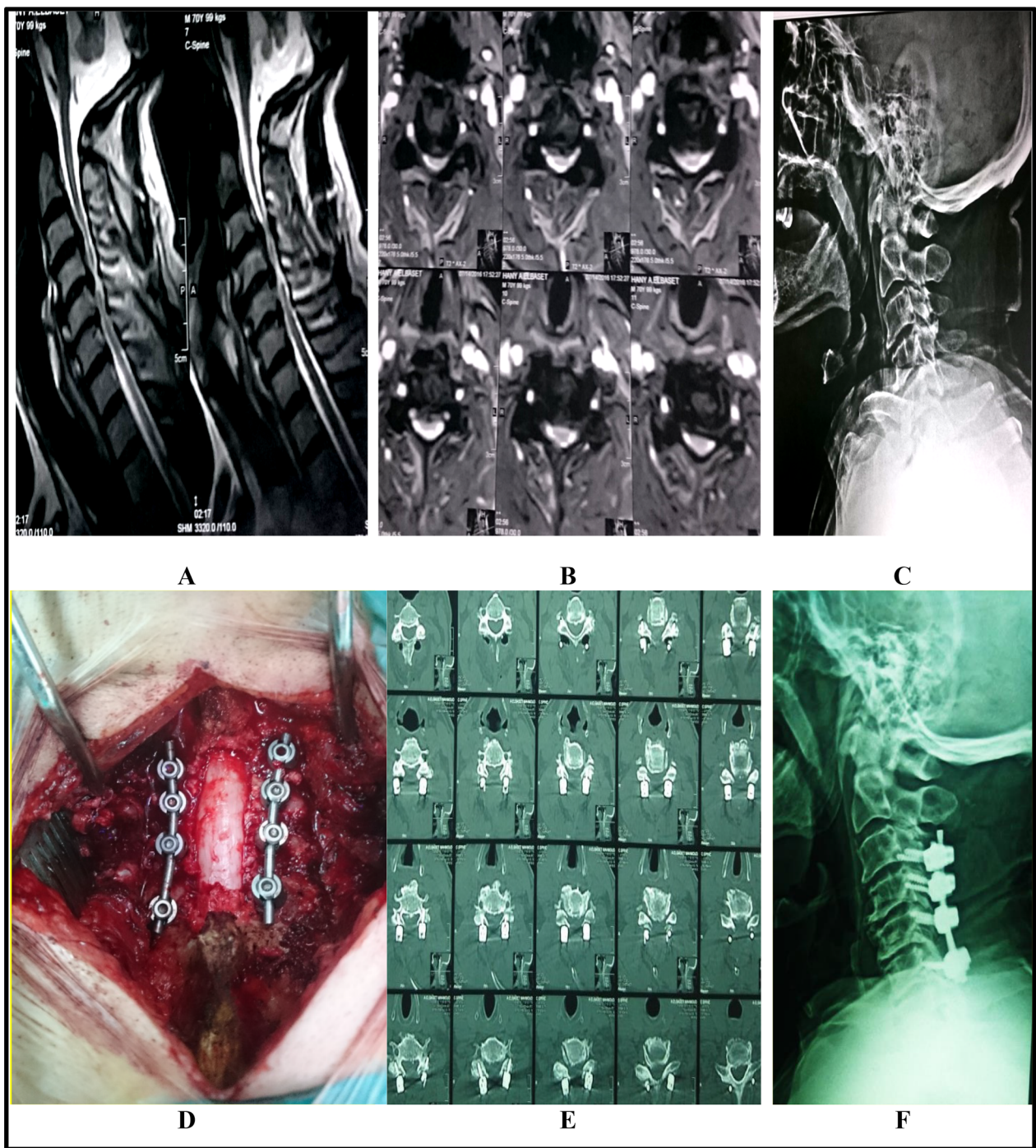


Fig. 2 A–F Male 64 years old in Group B, underwent cervical laminectomy with lateral mass screws. **A** Pre op. MRI sagittal T-2 showed multisegment cervical canal stenosis; **B** Pre op. MRI axial T-2 confirming the stenosis; **C** X-ray lateral view showed degenerative changes; **D** Intra operative photo showing spinal cord after laminectomy plus lateral mass screws; **E** 3 months post op. CT showed sufficient spinal cord decompression and accurate screws; **F** 3 months post op. X-ray

cervical myelopathy who underwent cervical laminectomy and fusion with lateral mass screws, four patients had C5 nerve root palsy. In the study of Huang et al. [26],

two patients had C5 nerve root palsy and it was settled gradually without any intervention. The incidence of C5 nerve palsy can be significantly reduced through the

decompression of the posterior wall of the C5 intervertebral foramen [19].

In summary, compared with laminectomy alone, laminectomy with lateral mass screws fixation has more advantages including; avoiding excessive backward drift of the spinal cord, restoring and maintaining the cervical curvature that can significantly reduce the occurrence of C5 nerve palsy and postoperative axial symptoms.

Study limitations

Limitations of our study come from its retrospective nature, relatively low number of participants and the fact that this wasn't a randomized controlled trial. Therefore, prospective, large-scale, multicenter clinical trials are needed to further validate our results.

Conclusions

In multilevel cervical canal stenosis, internal fixation using lateral mass screws in conjunction with laminectomy can be of a considerable significance than laminectomy alone in improving the axial symptoms and ceasing further disease progression through stabilization of the cervical spine and maintaining the sagittal alignment.

So, looking for halting late neurological deterioration, we are encouraging the use of lateral mass screws fixation in combination with laminectomy in treating myelopathy patients with multilevel cervical canal stenosis.

Abbreviations

VAS	Visual analogue scale
CT	Computerized topography
MRI	Magnetic resonance imaging
mJOA	Modified Japanese Orthopedic Association
OPLL	Ossification of posterior longitudinal ligament
CSM	Cervical spondylotic myelopathy

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Author contributions

All authors made a significant contribution to the work reported, whether that was in the conception, study design, execution, acquisition of data, analysis and interpretation; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agreed to be accountable for all aspects of the work.

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Availability of data and materials

All data and materials included in this work are available.

Declarations

Ethics approval and consent to participate

Our local Ethics Committee approved our study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests in this work.

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