International Journal of Neurosurgery
2022; 6(2): 77-83
http://www.sciencepublishinggroup.com/j/ijn
doi: 10.11648/j.ijn.20220602.18
ISSN: 2640-1940 (Print); ISSN: 2640-1959 (Online)

Efficacy of Posterior Cervical Laminectomy and Fixation Technique Using High Speed Drill in Cervical Myelopathy

Ahmed Nagaty*, Ahmad Elsabaa, Mohamed Helmy Abd Elshafouk

Department of Neurosurgery, Ain Shams University, Cairo, Egypt

Email address:

Ahmednagaty@med.asu.edu.eg (Ahmed Nagaty), Ahmed.abdelrhem@med.asu.edu.eg (Ahmad Elsabaa), Mhelmyneuro83@gmail.com (Mohamed Helmy Abd Elshafouk)

*Corresponding author

To cite this article:

Ahmed Nagaty, Ahmad Elsabaa, Mohamed Helmy Abd Elshafouk. Efficacy of Posterior Cervical Laminectomy and Fixation Technique Using High Speed Drill in Cervical Myelopathy. *International Journal of Neurosurgery*. Vol. 6, No. 2, 2022, pp. 77-83.
doi: 10.11648/j.ijn.20220602.18

Received: September 7, 2022; **Accepted**: September 26, 2022; **Published**: October 11, 2022

Abstract: This study aims to assess the efficacy and accuracy of a technique for posterior cervical decompression and fixation using high speed drill for posterior laminectomy and anatomical lateral mass screws placement. *Background:* Posterior cervical decompression through laminectomy is a well-known approach for surgical management of multiple levels cervical spondylosis with myelopathy, and ossification of the posterior longitudinal ligament (OPLL). Posterior decompression with lateral mass fixation helps to improve the clinical symptoms of those patients, in addition to improvement of their cervical curvature and range of motion. *Methods:* This is a retrospective study conducted from February 2019 to January 2021 included 30 patients with cervical myelopathy that underwent multiple levels posterior cervical laminectomy and lateral mass fixation using high speed drill. The primary outcomes measured in our study were Visual Analog Score (VAS) of neck pain and upper limbs pain, Japanese Orthopedic Association (JOA) score for assessment of cervical myelopathy for all those patients with comparison of preoperative and postoperative values up to 12 months after surgery. Secondary parameters assessed were perioperative complications, duration of surgical procedures, operative blood loss and hospital stay. *Results:* The included 30 patients in our study were 18 males (60%) and 12 females (40%), with mean age of 65.77 ± 5.056 years. Laminectomy and anatomical lateral mass screws placement using high speed drill approach showed average operative time of 119.83 ± 13.676 minutes, and minimal blood loss with mean 95.83 ± 14.389 ml. As regards VAS, our results showed marked improvement of postoperative VAS of neck pain 2.53 ± 0.73 and postoperative VAS of upper limbs 1.73 ± 0.828 at 12 months follow up in comparison to preoperative VAS values of neck pain 6.17 ± 1.51 and upper limbs 9.03 ± 0.85 with highly significant statistical difference value ($P < 0.001$). In addition, there was significant improvement of Postoperative JOA score 15.06 ± 1.36 in comparison to preoperative values 9.56 ± 1.43, also with highly significant statistical difference ($P < 0.001$). *Conclusion:* Posterior cervical decompression and fixation using high speed drill for Laminectomy and Anatomical lateral mass screws placement is an effective method for management of cases of cervical myelopathy with Favorable outcomes observed at 12 month follow up, with optimum operative time and minimal blood loss. However, a multicenter comparative study with long term follow-up is highly recommended.

Keywords: Cervical Myelopathy, Lateral Mass Fixation, Cervical Laminectomy, High Speed Drill

1. Introduction

Cervical myelopathy is a common and frequently occurring disease caused by many pathological factors. Multisegmented canal stenosis is considered the most important factor for development of myelopathy, it is a degenerative disease produced by many causes such as OPLL, multiple levels disc prolapses, ligamentum flavum hypertrophy, articular processes hyperplasia, thus leading to disorders of nerve roots and spinal cord in the form of compression and ischemia [1-3].

For cases of multiple levels cervical spinal stenosis, due to known complications of the anterior surgical approach as

inadequate decompression and poor long-term effect, posterior approach is always preferred. It aims to decompress and enlarge the spinal canal through hemilaminectomy, total laminectomy or decompression laminoplasty, but without disturbing the stability of the cervical vertebra. Posterior fusion and fixation may be the optimal approach in patients who require multilevel decompression, particularly if the construct requires an extension to the upper cervical or thoracic spine, sometimes to the occiput [4, 5].

Posterior cervical decompression through laminectomy and lateral mass fixation by screws and rods was initially developed to keep expansion of the spinal canal after surgery and prevent recurrence of stenosis, to improve perfusion of the spinal cord which indirectly helps in its decompression, and to achieve much improvement of the cervical spine range of motion and curvature. This approach is considered an ideal surgical method for the management of patients with multiple levels cervical spinal canal stenosis, and it proofs effectiveness in improving the clinical efficacy of those patients [6–8].

Lateral mass fixation is proved to be safer approach in comparison with cervical pedicle screws and other cervical fixation techniques, with low co-morbidities and a higher success rate. So, it is a reliable approach and one of the best methods for posterior cervical fixation [9, 10].

Although well-designed randomized clinical trials are lacking in this subject, the existing literature suggests that operative intervention reliably arrests the progression of myelopathy and may lead to functional improvement in most patients. The success of operative procedure is dependent on a comprehensive evaluation of the individual patient's clinical and radiographic characteristics [11].

In this study, we aimed to assess the efficacy posterior decompression through laminectomy and anatomical lateral mass screws placement using high speed drill in patients with cervical myelopathy, and to evaluate their clinical outcomes.

2. Patients and Methods

This is a retrospective study included thirty patients with cervical myelopathy, underwent surgeries for posterior decompression through laminectomy and anatomical lateral mass screws placement using high speed drill, in the period from February 2019 to January 2021.

The protocol of our study obtained an approval from the research ethics committee of our institute, faculty of medicine at Ain Shams University. Being a retrospective study, patients´ consents for participation in the study and for publication were not applicable.

All the included patients in our study were assessed as regards Visual Analog Score (VAS) of neck pain and upper limbs pain, Japanese Orthopedic Association (JOA) score [1] for assessment of cervical myelopathy for all those patients with comparison of preoperative and postoperative values during the follow up period that reached one year after surgery. In addition, other parameters were assessed as perioperative complications, duration of surgical procedures, operative blood loss and hospital stay.

2.1. Inclusion Criteria

1) Patients with Cervical myelopathy that didn't respond to at least 6 months of conservative management.
2) Multiple levels spondylosis (four levels or more).
3) Preserved cervical lordosis or with straightened cervical curve.
4) Patients with complete documented contact, clinical and radiological data, and completed minimum 11 months follow up.
5) No age or gender restriction.

2.2. Exclusion Criteria

1) Patients with incomplete documented data.
2) Patients with radiculopathy only with no myelopathic signs.
3) Less than four levels affected.
4) Reversed cervical curvature.
5) Association of other cervical pathologies (e.g., Fractures, infection, etc...).
6) Recurrent cases.

2.3. Preoperative Evaluation

2.3.1. Clinical Evaluation

All patients were submitted to full medical history and neurological assessment and general examination. Preoperative evaluation of neck pain and upper limbs pain severity was conducted according to the Visual Analogue Scale (VAS). While assessment of weakness and spasticity due to cervical myelopathy was assessed by Japanese Orthopedic Association (JOA) to be compared with postoperative data.

2.3.2. Radiological Evaluation

All patients were submitted for plain radiographs to assess the cervical lordotic curve, multi-slice Computed Tomography (MS CT) scan of the spine to evaluate the bony components of cervical spine, and to detect the presence of osteophytes or ossified posterior longitudinal ligaments. Magnetic Resonance Image (MRI) cervical spine was mandatory for all included patients assess the neural tissue compromise, intervertebral disc affection and ligaments integrity.

2.3.3. Outcome Measures

Data were collected from patients' medical records of our hospital including the immediate post-operative period then at 3, 6, and 12 months postoperative. Patients' documented data included: assessment of pain score using VAS, disability using ODI, operation time, operative blood loss and hospital stay. Postoperative radiological evaluation was performed by plain radiographs (AP and lateral) and CT scan to assess screws' position and decompression of the spinal canal.

2.4. Operative Procedure

All Patients were operated in prone position with head fixation by Mayfield. A linear midline posterior cervical incision was used over the targeted levels, followed by

bilateral subperiosteal muscle separation till full identification of the spinous processes, laminae, and facet joints. Lateral mass screws were applied anatomically (free handed without C- Arm that used only for level identification before screws application), by identification of the entry point just inferomedial to midpoint of the lateral mass targeting a superolateral trajectory (30 degrees cranially and 20 degrees laterally). The entry point was then drilled using bone cutting 2-mm bit of a high-speed drill with its handle based on the spinous process of the level below and directed parallel to the targeted facet, then tapping of drill hole was done with a 3.5-mm tap, followed by insertion of 3.5 mm diameter and 14 mm length poly-axial screws. After application of lateral mass screws, laminectomy for all levels was done through one piece removal using high speed drill to thin out the laminae bilaterally, also microscope was used for better visualization during laminectomy and removal of the ligamentum flavum for adequate exposure and decompression of the dura. Lastly, the rods were applied followed by hemostasis and closure in layers with submuscular drain.

Figure 1. *Preoperative MRI.*

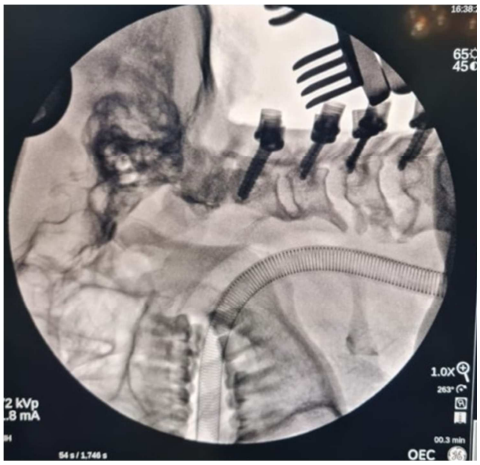

Figure 2. *Intraoperative single C-Arm image after anatomical application of lateral mass screws.*

Figure 3. *Intraoperative image showing one piece laminectomy after decompression using high speed drill.*

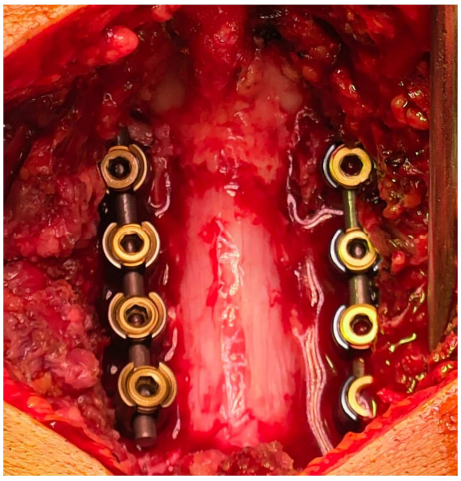

Figure 4. *Intraoperative image for exposed posterior cervical dura after laminectomy and ligament removal with apparent applied lateral mass fixation system.*

3. Results

Our retrospective study reported 30 patients diagnosed with cervical myelopathy with four levels or more of spondylosis, that underwent posterior laminectomy and lateral mass fixation using high speed drill. There were 18 males (60%) and 12 females (40%) with mean age at time presentation 65.77 ± 5.056 (58-77) years. As regards the number of decompressed levels, 4 levels of laminectomy (C3-C4-C5 and C6) were done in 24 cases (80%), while 5 levels were decompressed in 6 levels only (20%). (Table 1).

Table 1. *Demographic data and no. of decompressed levels.*

No. of cases		**30 (100%)**
Age/ years		65.77 ± 5.056
Sex	Male	18 (60%)
	Female	12 (40%)
No. of decompressed levels (Laminectomies)	4	24 (80%)
	5	6 (20%)

Statistical analysis of the perioperative data showed that the operative time ranged from 100 min to 150 min with mean value 119.83±13.676 min, while blood loss during operation showed average of 95.83±14.389 (75-120) ml. As regards hospital stay; our results demonstrated a range from 2 days (21 cases 70%) to 6 days (1 case 3.3%). In addition, a highly significant statistical difference (P<0.001) was seen in the relation between operative time and hospital stay, as

increasing the operation time was associated with more hospital stay and vice versa. (Figure 5).

Follow up period ranged from 11 to 14 months with mean 13.27±0.651. The perioperative data including operative time and blood loss, hospital stay and follow up period is summarized in (Table 2).

Table 2. *Perioperative data.*

Parameter	Mean ± SD
Operative time/ minutes	119.83±13.676
Operative blood loss/ ml	95.83±14.389
Hospital stay/days	3.61 ±0.704
Follow up period/months	13.27±0.651

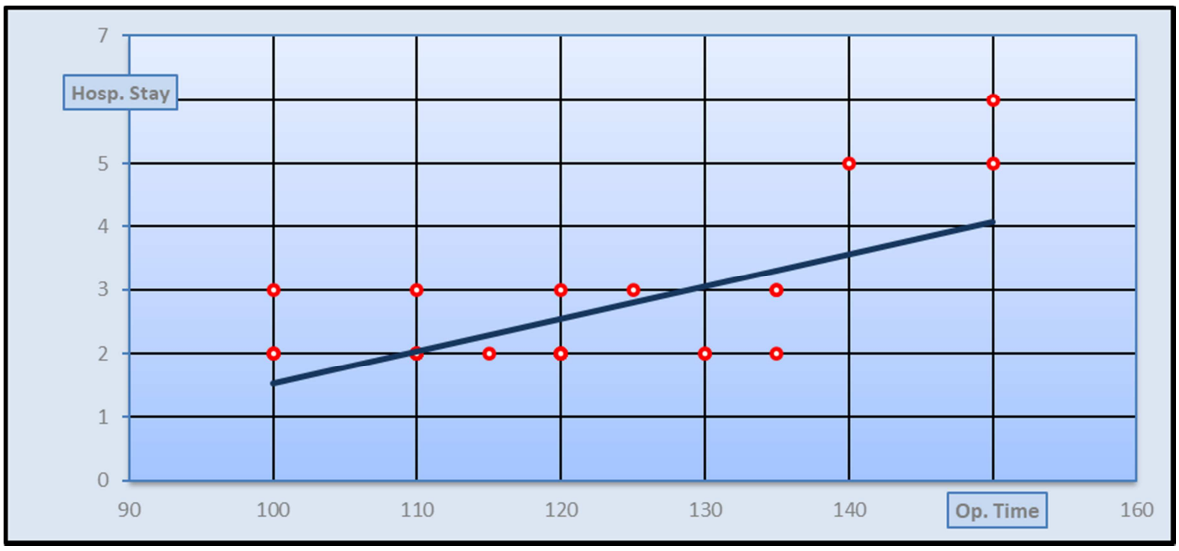

Figure 5. *Significant correlation between op. time & hospital stays.*

Our results showed marked improvement of postoperative VAS of neck pain 2.53±0.73 at 12 months follow up in comparison to preoperative VAS values 6.17±1.51 with highly significant statistical difference (P<0.001). In addition, postoperative VAS of upper limbs 1.73±0.828 at 12 months follow up showed a highly significant difference in comparison to preoperative VAS values of upper limbs pain 9.03±0.85. As regards (JOA) score, there was a significant improvement in the Postoperative JOA 15.06±1.36 in comparison to preoperative values 9.56±1.43, also with highly significant statistical difference (P<0.001). (Figures 6 & 7).

Intra-operative complication was reported in our study, as 3 cases (10%) had dural tear that occurred during laminectomy procedure. All these cases were managed intraoperative by direct suturing of the dura with application of muscle graft, while no postoperative C.S.F collection or leak was detected in 2 cases of them. Only one case had postoperative C.S.F leak and Lumbar drain was inserted for 3 days; this patient needed a longer hospital stay period reached 6 days. No other postoperative complications were detected in our study.

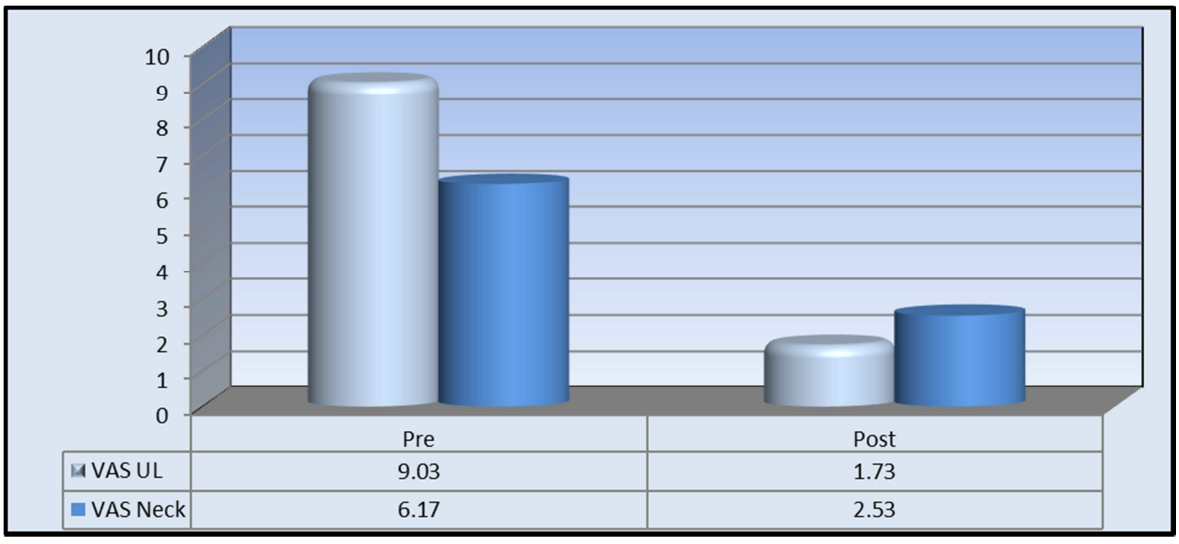

Figure 6. *Preoperative and Postoperative VAS.*

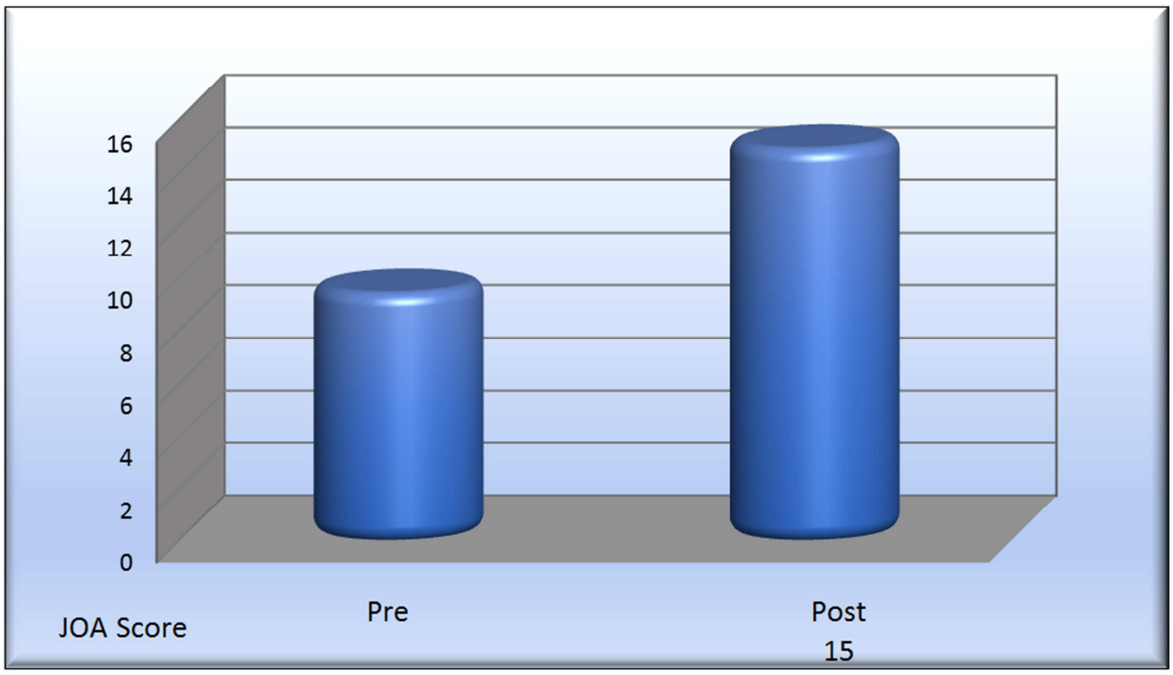

Figure 7. *Preoperative and Postoperative JOA Score.*

4. Discussion

Although, variable surgical techniques and approaches in spinal instrumentation for the management of cervical myelopathy have evolved over the last years, lateral mass fixation has world widely gained popularity among spine surgeons with low morbidity and satisfactory outcome [12, 13]. Decompression of the stenotic cervical spinal canal through posterior cervical laminectomy combined with lateral mass fixation can reduce the incidence of spine instability or even postoperative cervical kyphosis and maintaining the curvature of the cervical vertebra [14].

Lateral mass spinal fixation is a safe and effective stabilization technique that can achieve improvement in myelopathy with low morbidity and acceptable outcomes in terms of neck pain and mobility, in addition to better prevention of postoperative deformity than that with laminectomy alone [15].

As regards the operative technique, many screws entry points and trajectories have been described for cervical sub axial lateral mass fixation, Roy- Camille introduced an entry point for the screw in the midpoint of the lateral mass with a direction perpendicular to the posterior aspect of the cervical spine and 10 degrees outwards, while Magerl suggested a starting point 2-3 mm medial and superior to the midpoint of the lateral mass with angulation 30 degrees superiorly and 25 degrees laterally. Anderson's entry point is 1 mm medial to the midpoint of the lateral mass with angulation 30-40 degrees up and 10 degrees laterals. An et al proposed angulation of the screw 15-18 degrees superiorly and 30-33 degrees laterally, with an entry point 1 mm medial to the center of the lateral mass. As for Pait et al, they divided the lateral mass into four quadrants with the preference of the upper outer quadrant for screw insertion to avoid neurovascular injury. Finally, Sekhon used Anderson's starting point but with angulation 25 degrees laterally and superiorly [16–21].

In our study, Lateral mass screws were applied anatomically (free handed without C- Arm that used only for level identification before screws application), by identification of the entry point just inferomedial to midpoint of the lateral mass targeting a superolateral trajectory (30 degrees cranially and 20 degrees laterally). The entry point was then drilled using bone cutting 2-mm bit of a high-speed drill with its handle based on the spinous process of the level below and directed parallel to the targeted facet. This technique showed to be safe and easy without any screws related complications in all included patients.

As regards spinal decompression technique, recent meta-analysis reported that laminectomy with fusion and laminoplasty had similar results regarding the loss of cervical lordosis. In Liu et al meta-analysis, laminoplasty and laminectomy with fusion were both nearly similar techniques as regards spine biomechanics. In addition, muscles wide dissection, ligamentous structures transection, and spinal cord decompression through removal or opening of lamina, led to improvement of symptoms in both techniques, which proved that they were effective. Another study conducted by Phan et al, concluded that Laminectomy with lateral mass fusion and laminoplasty lead to equivalent clinical improvement and loss of lordosis. The authors included that there is no evidence to support laminoplasty over Laminectomy with fusion in the treatment of multi-level cervical myelopathy; however, the relative complication rates between the two approaches demonstrated that the total complication rate in Laminectomy with lateral mass fixation was around twofold higher than that of Laminoplasty. It was

associated with significantly higher nerve palsy complications and trended towards higher reoperation rates [22, 23].

In our study, all included patients were documented to have preoperative preserved cervical lordosis or with straightened cervical curve. All underwent laminectomy for targeted levels through one piece removal using high speed drill to thin out the laminae bilaterally before its removal for safer and faster bony decompression with facet preservation Also microscope was used for better visualization during laminectomy and removal of the ligamentum flavum for adequate exposure and decompression of the dura. This technique helped in preservation of the cervical curvature as preoperative status during the follow up period.

A recent study by Singrakhia et al, showed that patients undergo posterior laminectomy with lateral mass fixation for multisegmented cervical myelopathy have good functional and neurological outcomes due to wide surgical exposure, adequate decompression of spinal cord, well placed lateral mass screws, good fusion of bone graft, and avoidance of screws related complications. These factors help to maintain alignment of the cervical spine and prevent its reverse and occurrence of kyphosis. The most important factors to achieve favorable clinical outcome are adequate decompression and maintenance of cervical alignment, which prevent micromotion of cervical spine that always led to continuous irritation of the compromised cord and delay of the neurological recovery [24].

A systematic review, published in 2009, included 11 studies on posterior cervical laminectomy with fusion surgery done for patients with cervical myelopathy, reported improvement of neurologic function in 70% to 95% of those patients with recovery of around 50% of their deficit in JOA score. Similar results were obtained in a more recent meat-analysis study, that showed improvement of patient outcomes mainly JOA score through posterior cervical decompression and fusion for myelopathy [17, 25].

Our results showed marked improvement of clinical and functional outcome, as postoperative VAS of neck pain, VAS of upper limb pain, and JOA score showed highly significant improvement in comparison to preoperative values with average operative time and minimal blood loss.

In a meta-analysis done by Youssef et al, sub-axial posterior cervical decompression and fixation pooled rates of revision and complications were lower in this meta-analysis in comparison to other rates calculated from variable documented databases. Many Postoperative complications may be expected after extensive muscle detachment and retraction needed in posterior cervical fixation surgery, such as: axial pain, infection, C5 palsy that may result from stretching of the C5 spinal nerves during manipulation of the spinal cord after laminectomy, and transient postoperative neurologic deterioration that some surgeons might not have discussed with their patients who are potential candidates for Posterior Cervical decompression with fixation surgery [25].

The intra-operative complication that reported in our study was Dural tear that occurred during laminectomy procedure in 3 cases and managed intraoperatively. No other postoperative complications were detected in our study.

The present study confirms that posterior cervical decompression and fixation using high speed drill for laminectomy and anatomical lateral mass screws placement is an effective method for management of cases of cervical myelopathy with Favorable outcomes, but there are some limitations in our study being a single arm retrospective study that was done in a single institute, in addition, patients' allocation was not at random but according to surgeon preference, and the sample size is small and lacked long-term follow-up. So, multicenter comparative study with long-term follow-up is recommended to establish the obtained results.

5. Conclusion

Posterior cervical decompression and fixation using high speed drill for Laminectomy and Anatomical (free handed) lateral mass screws placement was found in our study to be of excellent value as an effective method for management of cases of cervical myelopathy. This technique showed favorable outcomes observed at 12 month follow up, with optimum operative time and minimal blood loss. However, a multicenter comparative study with long term follow-up is highly recommended.

Conflicts of Interest

The authors declare that they have no competing interests.

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