Original Article

Cervical Hemilaminectomy in the Management of Degenerative Cervical Spine Myelopathy: Utilization and Outcome from a Neurosurgical Institution in Nigeria

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Abstract

Introduction: Hemilaminectomy is one of the surgical options for managing cervical spondylotic myelopathy. However, it has not gained the expected popularity. This paper aims to review the utilization of hemilaminectomy, the outcome, and complications observed among patients managed with the procedure for advanced multilevel degenerative cervical myelopathy. **Methods:** Retrospective longitudinal analysis was done at a neurosurgical hospital in Enugu, Nigeria, between years 2010 and 2019. The Study analyzed 46 patients that had cervical hemilaminectomy for multilevel degenerative cervical myelopathy. Excluded from the study were patients offered cervical hemilaminectomy for other indications including tumor and trauma. Patients were assessed by comparing preoperative, and follow-up modified Japanese Orthopedic Association (mJOA) score and Cobb lordotic angles. The minimum postoperative follow-up period was for 1 year. **Results:** The mean age was 61 (43–88) years; male-to-female ratio was 3.6:1. Symptoms duration ranged from 6 months to 10 years, and 31 (67.4%) patients had significant comorbidities. The average operation time was 2 h 36 min (0.5–3.0 h). The mean blood loss was 260 mL (100–800 mL). Right hemilaminectomy was done for 37 (80.4%) patients. The average preoperative and postoperative Cobb lordotic angles were 10.90° ± 2.4° and 9.98° ± 2.1°. The mean preoperative mJOA was 8.2 ± 1.4. On follow-up 1 year after surgery, the mean mJOA score was 12.2 ± 1.1 (P = 0.0001). The neurological recovery rate at 1-year follow-up was 50.5%. One patient each experienced a transient postoperative drop in neurology, postoperative respiratory distress, and surgical site infection. **Conclusion:** Cervical hemilaminectomy for multilevel degenerative cervical spine myelopathy has the potential to achieve clinically satisfactory neurological improvement without significantly compromising stability and other serious long-term complications.

Keywords: Cervical hemilaminectomy, degenerative myelopathy, Nigeria, outcome, usefulness

Introduction

The surgical management options for degenerative cervical myelopathy have evolved over the years and in the past few decades, more minimally invasive options are being explored.[1,2] Whatever technique is adopted, the basic aim is to improve the space available for the spinal cord with minimal disruption of cervical spine anatomy. Both anterior and posterior cervical approaches have been established depending on the technical analysis of the challenges of the planned surgery with varying postoperative outcomes and drawbacks.[3-5] However, concerns of progressive spinal instability, adjacent level degenerative spine disease, and postlaminectomy membrane formation add to the challenges faced by the neurosurgeon in the choice of surgical option for cervical spine decompression.[3,6] Whichever option is selected for the decompression of the cervical spine, the surgeon must make a surgical decision based on the approach that will properly decompress the neural tissues, address the cause of the cord compression, and preserve or tackle unstable spine segments.[7,8]

Hemilaminectomy is one of the options that can be utilized for the management of degenerative cervical spine myelopathy,

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and since cervical hemilaminectomy was initially described,[9] some other modifications of the procedure have been developed with the aim of maximizing the space gained for the spinal cord.[10-12] However, this procedure has not gained the expected popularity probably as a result of potential complications such as the risk of iatrogenic spinal cord injury.[12] Based on anatomical consideration, however, cervical hemilaminectomy procedure should be able to achieve satisfactory decompression of the cervical spinal cord while preventing the known challenges associated with classical laminectomy. The study center also utilizes a modified floating laminoplasty in appropriate cases.[13] Unfortunately, cervical hemilaminectomy is not often the neurosurgeon's first choice for cervical spine decompression despite these potential benefits. This paper aims to review the utilization of hemilaminectomy, the outcome and complications observed among the patients managed with the hemilaminectomy technique for advanced multilevel degenerative cervical myelopathy.

Methods

The study is a retrospective longitudinal analysis of patients that had cervical spine decompression surgery between years 2010 and 2019. The study was carried out at Memfys Hospital for Neurosurgery Enugu, South-East Nigeria. The inclusion criteria were patients with clinical symptoms and signs in whom magnetic resonance imaging (MRI) confirmed advanced multilevel cervical spine degenerative myelopathy for which surgery using modified cervical hemilaminectomy was performed. Those excluded from the study were non-Nigerians; patients offered cervical hemilaminectomy for nondegenerative cervical spine diseases including tumors and trauma. Also excluded were patients with kyphotic deformity of cervical spine based on imaging studies, focal cord compression, and patients that were offered instrumented cervical spine decompression. All patients were evaluated using clinical assessment and neuroimaging investigations including cervical MRI and X-rays. Some patients had computed tomography of the cervical spine as part of the diagnostic workup. The preoperative modified Japanese Orthopedic Association (mJOA) score for each patient was determined. The Cobb lordotic angles were also determined and recorded from the preoperative imaging investigations done for the patients. The surgeon's decision on the side (left or right) for the hemilaminectomy procedure followed the protocol of the study center, usually based on the handedness of the patient and the side of the body that had more motor weakness or sensory symptoms. The minimum postoperative follow-up period was for 1 year (up to 8 years). Follow-up MRI was recommended for patients that could afford it. Follow-up outcome was assessed using the mJOA score and plain radiographs obtained at 1 year following surgery.[14] The extent of neurological improvement was simply assessed by comparing the mean preoperative Japanese Orthopedic Association (JOA) score and the mean postoperative JOA score.

In the procedure of modified cervical hemilaminectomy, the center's protocol includes general anesthesia with endotracheal intubation. The patient is positioned prone for posterior cervical spine decompression and draped. Following a midline incision, the laminae of interest are exposed unilaterally, and the paraspinal muscles are retracted away. Bilateral exposure is done sometimes if contralateral interlaminar ligamentum flavum excision will be required. Caution is taken not to damage the supraspinous and interspinous ligaments. A multilevel hemilaminectomy is carried out starting with the cervical spine segment that has the least stenosis. Carefully, ligamentum flavum is excised along the span of the hemilaminectomy. In addition, the unit's protocol is to undercut the base of the spinous processes partially routinely and cautiously during the procedure. This improves the space available for the spinal cord [Figure 1]. Exit foraminotomy and lateral recess decompression are done as necessary using a size 1 Kerrison punch. When indicated, the hemilaminectomy is combined with contralateral interlaminar decompression through excision of the hypertrophied ligamentum flavum with exit foraminotomy while preserving the adjacent laminae. During closure, meticulous hemostasis is ensured. The paraspinal muscles are carefully hitched up to avoid loss of the space previously gained and the supraspinous ligament is attached at intervals to the ligamentum nuchae to minimize the risk of collapse of the remaining posterior spinolaminar complex. The rest of the wound is closed in layers using the standard protocol, and an active wound drain is left *in situ*. Patients are generally discharged 5–7 days postsurgery for outpatient follow-up and physiotherapy. Sutures are removed on postoperative day 14.

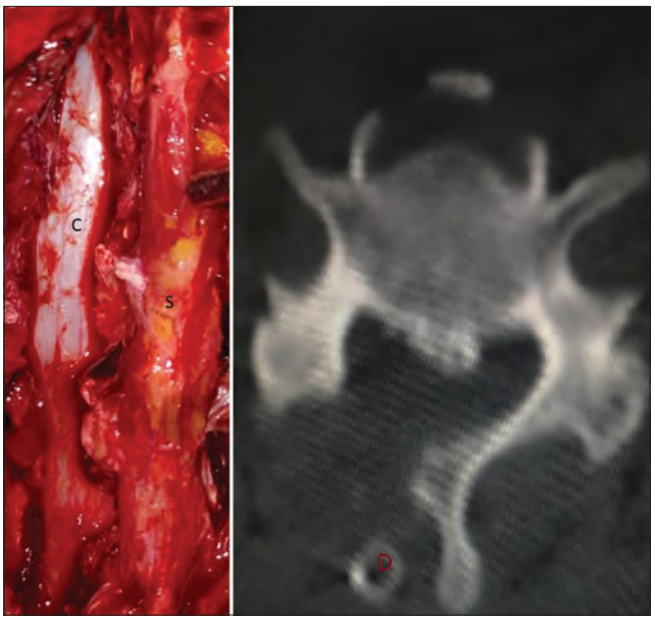

Figure 1: Intraoperative image (left) of a patient that had C3 to C6 right hemilaminectomy showing the decompressed cervical spinal cord. The postoperative axial cervical computed tomography scan bone window of the same patient (right) shows the bone defect and the space gained from the hemilaminectomy procedure

Results

A total of 46 patients were analyzed; 37 (80.4%) had right hemilaminectomy, the rest were on the left. The mean age was 61 years (range 43–88 years); male-to-female ratio was 3.6:1. The duration of symptoms ranged from 6 months to 10 years, and 31 (67.4%) patients had significant comorbidities. The average operation time was 2 h 36 min (0.5–3.0 h). The mean blood loss was 260 mL (100–800 mL) [Table 1].

The number of laminae involved in the hemilaminectomy was five in 21 (45.7%) patients, four in 11 patients (23.9%), two in 7 (15.2%) patients, three in 6 (13.0%) patients, and six in 1 (2.2%) patients [Table 2].

The average preoperative and postoperative Cobb lordotic angles were 10.90° ± 2.4° and 9.98° ± 2.1° (P = 0.0001) [Table 3]. However, in subgroup analysis, 24 (52.2%) patients had a lordotic angle of ≤10° on presentation, while 22 (47.8%) patients had an angle >10°. Fourteen (58.3%) patients with lordotic angle <10° presurgery had significant neck pain with the visual analog scale of >4 and none of these 14 patients reported worsening neck pain on follow-up.

The mean preoperative mJOA was 8.2 ± 1.4. On follow-up 1 year after surgery, the mean mJOA score was 12.2 ± 1.1 (P = 0.0001) [Table 4]. A total of 31 (67.4%) patients were admitted with mJOA score of ≤11, while 12 (26.1%) cases were admitted with mJOA score of 12–14. Only three (6.5%) of the cases operated on had a preoperative mJOA score of >14. Postsurgery, 16 (51.6%) cases admitted with mJOA score of ≤11 improved to at moderate and mild mJOA impairment scale, while the remaining 15 (48.4%) remained in the severe category although there was as high as 7-point improvement at 1 year. All the cases admitted with mJOA score >11 improved to the mild category after surgery [Table 5]. The neurological recovery rate at 1-year follow-up was 50.5%.

One patient experienced a transient postoperative drop in neurology, and another had postoperative respiratory distress necessitating overnight ventilation but these improved. One patient had a deep surgical site infection. There was no iatrogenic injury to the spinal cord or nerve roots intraoperatively. During the period of follow-up, there was no recorded neurological deterioration.

Table 1: Baseline characteristics of the patients

Parameter	Frequency
Total number of patients	46
Male to female ratio	3.6:1
Mean age (years)	61 (43-88)
Symptom duration	6 months-10 years
Side of surgery (right versus left)	37 versus 9
Average operation duration	2 h 36 min
Average estimated blood loss (ml)	260
Medical comorbidity (%)	31 (67.4)

Table 2: Number of hemi lamina involved in the decompression

Number of hemi lamina removed	Frequency (%)
2 levels	7 (15.2)
3 levels	6 (13.0)
4 levels	11 (23.9)
5 levels	21 (45.7)
6 levels	1 (2.2)
Total	46 (100)

Discussion

Anatomical advantage of hemilaminectomy

The cervical hemilaminectomy procedure could be regarded as a form of minimally invasive procedure in clinical practice.[12,15] This is because it is associated with minimal disruption of the anatomy of muscles and ligaments compared to other posterior decompression procedures. In addition, bone removal is limited to one side, sparing the laminae of the contralateral side, thereby helping to support spine stability.[16-18]

As observed in this study, the majority of the patients that were offered hemilaminectomy procedure had low preoperative lordotic angle but could not benefit from cervical spine implant surgery because of financial or other medical reasons. It is known from animal models that the posterior column offers some level of contribution to spine stability and should be preserved as much as necessary during spine decompression surgeries.[12] In patients at borderline risk of instability, recommendations are not clear.[19] However, the residual spine stability offered by the retained hemilaminae, spinous processes, posterior column ligaments, and muscle attachments in hemilaminectomy procedure may prevent a tilt to kyphotic instability. Hemilaminectomy decompression will serve as one of the choice procedures for such borderline cases, especially when such a patient is not being offered spine instrumentation procedure. Furthermore, hemilaminectomy being a less invasive procedure significantly preserves the

Table 3: Comparison of preoperative and follow-up lordotic angle using paired *t*-test and Wilcoxon paired statistics

			Paired *t*-test statistics					Wilcoxon test statistics	
Lordotic angle	Mean	SD	Mean	SD	*t*	df	*P*	*Z*	*P*
Follow-up cobb	10.90±2.4	8.0	−0.9±0.2	0.7	−9.8	45	0.000	−5.597	0.000
Preoperative cobb	9.98±2.1	8.1							

SD: Standard deviation

Table 4: Comparison of preoperative and follow-up modified Japanese orthopedic association using paired *t*-test and Wilcoxon paired statistics

			Paired *t*-test statistics					Wilcoxon test statistics	
Mjoa	**Mean**	**SD**	**Mean**	**SD**	***t***	**df**	***P***	***Z***	***P***
Follow-up mJOA	12.2±1.1	3.6	4.1±0.6	2.2	12.7	45	0.000	−5.823	0.000
Preoperative mJOA	8.2±1.4	3.8							

mJOA: Modified Japanese Orthopedic Association

Table 5: Sub-group analysis of preoperative and postoperative modified Japanese orthopedic association

Preoperative mJOA score		Postoperative mJOA score		
Grade	***n* (%)**	**0-11**	**12-14**	**15-17**
0-11	31 (67.4)	15	11	5
12-14	12 (26.1)			12
15-17	3 (6.5)			3
Total (%)	46 (100)	15 (32.6)	11 (23.9)	20 (43.5)

mJOA: Modified Japanese Orthopedic Association

range of motion in the cervical spine region compared with laminectomy and with a lower risk of postoperative spinal instability.[12] Instrumented laminectomy and laminoplasty may also reduce the risk of postoperative kyphotic deformity[8] but have more cost implications, more risk of axial neck pain, and reduced cervical spine range of motion when compared with hemilaminectomy and these may negatively affect the patient's quality of life.[20-23]

Consideration of side for the procedure

This study had more procedures involving the right side than the left. This is because part of the consideration in the choice of side for the hemilaminectomy is the handedness of the patient. Priority to the dominant hand is important to the team because adequate decompression will enhance long-term preservation of dexterity and indirectly impact the functional outcome of these patients. However, the decision on the side to operate on also considers the side of the body with worse neurological symptoms and signs, especially motor deficit. Furthermore, consideration is given to the side that has more radiculopathy which in turn may need more aggressive exit foraminotomy in addition to the cord decompression.

Follow-up results and complication rates

In the current study, the majority of the patients that had hemilaminectomy did not experience deterioration in neck pain after surgery even at borderline Cobb angle. Axial pain and instability, especially following the posterior approach for cervical spine surgeries, have been correlated to the extent of bone removal, disruption of nuchal ligaments, and cervical spine muscles.[24] A higher risk of axial pain has been reported following non-instrumented laminectomy and laminoplasty. These procedures are, therefore generally avoided in patients with significant preoperative axial pain.[25] The authors strongly recommend hemilaminectomy for patients with significant preoperative axial pain if instrumentation is not possible or affordable.

The extent of laminectomy is known to influence the cervical lordotic angle.[26] In this study, there was a slight decrease in the mean lordotic angle following surgery from 10.9° to 9.98°, but this was still statistically significant despite the relatively minimal extent of bone removal. In view of this, when multilevel decompression is planned, procedures such as classical laminectomy that involve more aggressive laminectomy should be discouraged as much as possible since this may predispose to more disruption of spine stability.[27]

The postoperative outcome may be influenced by the preoperative neurological condition of patients. However, despite the variable period of delay in presentation before surgery, the study recorded significant improvement in the follow-up result. The improvement in mJOA postsurgery is an indicator of the effectiveness of this procedure despite its limited invasiveness. Although most of the cases were admitted and operated-on with very poor mJOA, significant improvement was reported at 1-year follow-up. The functional improvement in mJOA is quite impressive and comparable to the findings from other decompression procedures. Karademir *et al*. observed a comparative level of improvement in mJOA between patients that had cervical spine decompression using hemilaminectomy or laminoplasty.[8] This means that all factors considered, hemilaminectomy achieves a comparable level of clinical outcome with the added advantage of enhanced spine stability.

One concern about the hemilaminectomy procedure is the risk of iatrogenic spinal cord injury which has been reported in the literature following different spine procedures.[12] This risk increases among patients with very tight stenosis. The authors, however, did not observe any iatrogenic spinal cord injury in this study although one patient had a transient drop-in neurological status post surgery. The authors' recommendation is to start the laminotomy laterally from the laminofacet groove and advance medially toward the spinous process, especially in very tight segments of the cervical spine. Furthermore, lateral recess decompression and aggressive ligamentum flavum excision should be delayed until after the completion of the laminectomies when more space would have been gained from the multilevel laminectomy. There are studies in the literature that have collaborated the good safety profile

of hemilaminectomy even for complex spine procedures including excision of cervical spine tumors.[18,28]

Another argument about hemilaminectomy is the extent of space gained for the spinal cord following this procedure, especially among individuals with background congenital canal stenosis. The authors prefer to use a modification of the procedure that allows undercutting of the base of the spinous process to further improve on the space gained.[12] Hemilaminectomy has been observed from previous studies to have a comparable result with laminoplasty procedures in terms of volumetric space gained among patients being managed for cervical spondylotic myelopathy.[11] In addition, the team routinely carries out meticulous lateral recess decompression, which is effective in clearing the spinal canal of the degenerate tissues that contribute to the canal stenosis with added the benefit of proper nerve root decompression. The reduced risk of spine deformity observed with hemilaminectomy enhances the confidence of the surgeon to do a little more aggressive facetectomy safely. With these measures, enough space has been gained from the author's experience and as reported in the literature[14] for procedures as tasking as extradural and intradural-extramedullary tumor excision. Even among patients with severe stenosis, a contralateral ligamentum flavum excision at the affected levels in patients with bilateral symptoms still helps the team to further achieve maximal decompression without sacrificing stability.

The complication profile following this procedure was relatively acceptable with no major postoperative complications. One patient had a transient drop in neurology and required ventilation because of respiratory distress following attempted extubation.

The study did not observe any clinical deterioration related to postlaminectomy membrane formation. This is believed to be partly because of the support provided by the limited lamina removal and the preserved posterior osteoligamentous complex. Furthermore, the caution observed to hitch-up muscle at the side that had hemilaminectomy during closure, meticulous hemostasis, and the routine use of active drain usually placed as deep as possible may have also contributed to the prevention of postlaminectomy membrane.

Another advantage of limited bone removal is the prevention of adjacent level accelerated degeneration.[21] As observed in the current study, there was no recorded clinical deterioration related to accelerated adjacent level degeneration even as some patients have been followed up for as long as 8 years. It is believed that the retained posterior osteoligamentous complex helps to slow down the rate of annulus disc degeneration since the extent of bone removal is known to correlate with the amount of stress on the disc annulus.[12]

The preserved posterior element apart from reducing the formation of adjacent level stenosis and instability also helps to minimize the risk of iatrogenic postoperative spinal cord compression when rigid dressing or cervical collar is applied over the wound postsurgery, contrary to what may be observed, especially in some cases of classical laminectomy and floating laminoplasty. Spring-back closure has been reported in some patients following floating laminoplasty and may lead to loss of the space gained from the surgical decompression.[29] The authors suggest further studies to compare Hemilaminectomy with other laminectomy options in the study environment.

Indications for hemilaminectomy

As shown in this study, the usefulness of hemilaminectomy cut across age groups. The procedure is an alternative option for middle-aged patients who ordinarily merited instrumentation but cannot afford the procedure considering its anatomical and clinical benefits to the patients in the long term. Although there is no established option as a gold standard for multilevel decompression,[30-32] hemilaminectomy has advantages over other non-instrumented options for spine decompression, which are more prone to the risk of postoperative kyphosis.[33,34] In this regard, the option of hemilaminectomy has been found to have comparable results with instrumented classical laminectomy or laminoplasty.[8,36]

The benefit of hemilaminectomy in clinical practice, especially among low-income populations is the reduced need for costly cervical spine instrumentation. This benefit is also more appreciated in elderly osteoporotic patients where implant usage is not feasible.

Surgeons are generally reluctant to carry out prolonged and aggressive surgical procedures on the elderly and patients with significant comorbidities because of the high surgical risk concerns.[35] However, the experience from the current study shows that the procedure of hemilaminectomy is associated with tolerable operation time and minimal intraoperative blood loss. This is particularly of benefit in the elderly where massive fluid shifts may result in significant hemodynamic challenges perioperatively. In the authors' opinion, the procedure of hemilaminectomy has a strong place in the choice of options for cervical spine decompression in the elderly.

Apart from the utilization of cervical hemilaminectomy for spine decompression in patients with cervical spondylotic myelopathy, the authors have used this access successfully for other indications including excision of extradural and intradural-extramedullary cervical spine tumors, decompression of spinal cord syringomyelia as well as for cervical decompression in patients with severe spinal cord edema and autonomic dysfunction following traumatic spinal cord injury. In the literature also, cervical hemilaminectomy has been used to manage pediatric patients requiring cervical spine procedures to minimize postlaminectomy-related spine deformities,[37,38] as well as for patients with calcified cervical disc herniation, cervical osteophytes, ossification of posterior longitudinal ligament, hypertrophic ligamentum flavum, and other lesions in the cervical spine causing myelopathy.[11,14,17,18,31]

Conclusion

Cervical hemilaminectomy for multilevel degenerative cervical spine myelopathy has the potential to achieve clinically satisfactory decompression and long-term functional improvement without significantly compromising stability. In addition to being less invasive, the procedure additionally preserves the anatomy of the cervical spine, minimizing the risk of kyphotic deformity, and other serious long-term complications.

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Conflicts of interest

There are no conflicts of interest.

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