

Anterior and Posterior Approach Results for Treatment of Cervical Myelopathy in the Elderly: A 10-Year Experience in a Mexican Institution

Mauricio Daniel Sánchez-Calderón¹, María Elena Córdoba-Mosqueda^{1*}, José Ramón Aguilar-Calderón¹, Carlos René Domínguez-Herz², Diego Ochoa-Cacique¹, Daniel Alejandro Vega-Moreno¹, Victor Andrés Reyes-Rodriguez³, Ulises García-González¹, Abraham Ibarra-de la Torre¹, Rodrigo Efraín Hernández-Reséndiz⁴

¹Department of Neurosurgery, Hospital Central Sur de Alta Especialidad de Alta Especialidad de PEMEX, Periferico sur 4091, Fuentes del Pedregal, Tlalpan, México City, México

²Department of Neurosurgery, Hospital Regional de Alta Especialidad "Centenario de la Revolución Mexicana" ISSSTE Cuernavaca, Palo Escrito, Emiliano Zapata

³Department of Neurosurgery, Hospital Central Norte PEMEX, Mexico City, México

⁴Department of Neurosurgery, Hospital Ángeles Clínica Londres, Mexico City, Mexico

Email: md.sanchez.neurocirugia@gmail.com, *dramaelenacmosqueda@gmail.com, jcalderon02@yahoo.com,

saludneurologica@hotmail.com, diego2doc@gmail.com, d2206_@hotmail.com, neurovican@hotmail.com,

ulises.med@gmail.com, abraham_ibarra2017@outlook.com, drrodrigoehr@gmail.com

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Abstract

Introduction: Degeneration of the cervical spine (CDSD) prevalence is nearly 90% by the 7th decade. This is the first research that compares the outcomes between the Anterior Approach (AA) and Posterior Approach (PA) to cervical myelopathy (CM) in the elderly. Materials and Methods: A retrospective observational study of electronic health records at the Hospital Central Sur de Alta Especialidad (HCSAE), PEMEX from January 2010 to May 2020 with patients older than 60 years submitted to cervical surgery. For the analysis we elaborated two groups according to the surgical approach: AA vs PA; we analyzed the trans-operative behavior, the immediate outcome, and after 3 months, 6 months, and 1 year. Results: As a total of 145 patients, the prevalence of CM in elderly was the 63.8% with a median age of 69 (64 - 75) years. We found statistical differences in strength outcome only in the P3m (p =0.011), for sensitivity we found major prevalence of affection in the PA group. We didn't report a significant difference in the Neck Disability Index (NDI) at all measures, but the PA presented a major incapacity. The Nurick scale results were significant in all stages (p < 0.05); and presented improvement compared with presurgical period (p < 0.001). **Discussion**: Patients show significant improvements in outcome measures with either anterior or posterior surgery. Both approaches are highly efficacious in preventing neurologic deterioration and in most cases improve neurological function with appropriate postoperative management like rehabilitation, pain management, and psychological support. **Conclusion**: The patients submitted to surgical medullary decompression presented a favorable outcome despite the age and the higher prevalence of comorbidities; whereby we favor the surgical treatment in all patients in a case-to-case selection to generate a positive impact on functional outcomes.

Keywords

Cervical Spine, Surgical Approach, Elderly, Cervical Myelopathy, Cervical Degenerative Spine Disease

1. Introduction

Degeneration of the cervical spine is part of the natural process of aging, with 30% of the population showing degeneration in the 4th decade and 90% by the 7th decade. The most common cause of spinal cord dysfunction in the elderly population is cervical myelopathy (CM), surgery is the primary treatment reporting excellent outcomes in the general population, but there are scarce publications to review the outcomes in the Mexican and Latin-American elderly population [1] [2].

In 1972, Nurick described a six-grade system based on the "difficulty in walking" and postulated that the established disability in CM occurs early in the disease and barely progresses [3].

The optimal management strategy for CM secondary to a cervical degenerative spine disease (CDSD) remains controversial because of the natural history of the disease and the degree of neurological progression [4].

Elderly patients with CM often present with a multilevel disease, the literature considers the treatment with laminoplasty rather than anterior fusion in case of failure of the conservative therapy [5]. This is the first research that describes and compares the outcomes between the Anterior Approach (AA) and Posterior Approach (PA) to treat CM in the elderly in the Mexican population [6].

Surgical Approaches

• Anterior Approach (Figure 1)

AA is the most anatomical technique with minimal collateral soft tissue damage, the indications are clear in spinal pathology between C3 and T1 with the affection in the anterior components of the spine (disk herniation, vertebral osteophytes).

The technique requires a supine position with a slight hyperextension of the head and exposition of the cervical region. The incision is paramedian and can

be transverse, oblique, or longitudinal; followed by dissection of subcutaneous tissue and cervical fascia to expose the vertebral bodies. If it is necessary, the surgeon can realize the discectomy and medullary decompression [7].

• Posterior Approach (Figure 2)

This technique is for multisegmental (2 or more) spine levels with degenerative changes and ossification of the posterior longitudinal ligament (OPLL).

The surgical position of the patient is prone, using a Mayfield head clamp or a horseshoe headrest and a slight flex of the cervical spine. This procedure requires a midline incision, dissection, and a detachment of the muscles from the respective spinous process, taking care of lateral dissection because of the trajectory of the vertebral artery.

Posterior to the exposure of vertebral laminae, the following step is to dissect the interlaminar ligament and the laminoplasty or laminectomy to decompress the cervical canal.

The contraindications for this approach are in cases of instability and with diseases of the anterior structures [7].



Figure 1. A 67-year-old man with a history of hypoesthesia of both arms and severe cervicalgia; (a) sagittal T2 Magnetic Resonance Image (MRI) with cervical canal stenosis at C3C4 with medullary compression; (b, c) trans-operative pictures of C3C4 after discectomy and adequate decompression; (d) postoperative Computed Tomography (CT) scan with evidence of prosthesis position and adequate spinal canal caliber.



Figure 2. A 60-year-old man with walking instability, cervicalgia, and previous anterior arthrodesis; showing in sagittal T2 MRI (a) spinal canal stenosis; (b, c) trans-operative images of laminae and dura-mater after decompression; (d) postoperative sagittal MRI showing posterior decompression of spinal canal.

2. Materials and Methods

A retrospective search of electronic health records at the Hospital Central Sur de Alta Especialidad, PEMEX (HCSAE), from January 2010 to May 2020. We selected the cases using the code M500—Myelopathy secondary to the degenerative process of an intervertebral disk from the International Classification of Diseases (ICD-10). For this study, the inclusion criteria were:

- Subjects older than 60 years.
- Myelopathy secondary to degenerative disease.
- Follow-up at 1 year.
- Subjects submitted to surgical treatment previously accepted consents.

We excluded patients with myelopathy secondary to different etiology than degenerative, for example traumatic, infectious, tumors, etc. Also, we removed patients with an incomplete follow-up at 1 year, and those who followed conservative management.

Statistical Analysis

Demographic data were reported as median, range, frequency, and prevalence. We elaborated 2 groups according to the surgical approach: AA vs PA; and analyzed the trans-operative behavior, the immediate outcome, and after 3 months (P3m), 6 months (P6m), and 1 year (P1y) with the following variables:

- Complications: Defined as all the trans-operative and postoperative undesirable events that impact directly in patient evolution and they could be classified by type: neurological (CSF fistulae, laryngeal nerve lesion, nerve roots lesion), systemic (infection, esophageal lesion, hypertension, arrhythmias), related to anesthesia (delirium).
- Neck Disability Index (NDI)—The NDI is an international classification for disability related to CM. This scale has 10 items, seven related to activities of daily living, two related to pain, and one item related to concentration. Each item is scored from 0 to 5 and the total is expressed as a percentage. Higher scores correspond to greater disability [8].
- Nurick Scale: Table 1 describes the clinical criteria of the Nurick scale. This scale grades myelopathy and patients' performance. For the analysis, we dichotomized the results in <3 or ≥3 according to the severity of myelopathy [3].
- Sensitivity: The term "affected" refers to symptoms during the evolution and follow-up in the patients, characterized by dysesthesia, hypoesthesia, altered proprioception, agraphaesthesia, and absence of two-point discrimination.
- Strength: The International scale of Daniels (see Table 1) describes the grade of affection at muscular strength. For this study, we took dichotomized the results as severe results <3 and mild ≥3 [7].

For the analysis between groups, we performed a Mann-Whitney U test for quantitative variables, and a chi-square test for categorical. The analysis of the results in each approach was realized with Friedman Test for quantitative parameters and Cochran's test for categorical values.

	Nurick Scale				
Grade	Characteristics				
0	Signs or symptoms of root involvement but without evidence of spinal cord disease				
1	Signs of spinal cord disease but no difficulty in walking				
2	Slight difficulty in walking which does not prevent full-time employment				
3	Difficulty in walking which prevents full-time employment or the ability to do all housework, but which is not so severe as to require someone else's help to walk				
4	Able to walk only with someone else's help or with the aid of a frame				
5	Chair bound or bedridden				
	Daniel's Scale				
Grade	Definition				
0	Absence of muscular contraction				
1	Visible or palpable muscular contraction without any movement.				
2	Movement of the extremity without defeating gravity				
3	Movement against gravity				
4	Movement against gravity and resistance diminished strength				
5	Normal strength				

 Table 1. Nurick and Daniel's scales.

Calculations were conducted using IBM SPSS 27.0 statistical analysis software, with the significance threshold set at P < 0.05.

The study design conformed to the Declaration of Helsinki and local regulations; patients signed their informed consent for admission and surgery and for reporting their results and data.

3. Results

We found 145 patients with the inclusion criteria, representing a prevalence of 63.8% of the cases with cervical myelopathy in the HCSAE. **Table 2** presents the demographic and general characteristics of our sample. The age of presentation was 69 (64 - 75) years, and masculine was the most prevalent gender.

Laterality of the symptoms with more prevalence was bilateral, presented in 60.7% of our sample. The median number of affected levels was 2 (1 - 3), being C5C6 the most prevalent (40%) followed by C4C5 (36.8%) and C3C4 (21.6%).

For the first treatment, 92.4% of the patients started with conservative treatment like physical therapy and non-steroid anti-inflammatory drugs (NSAIDs) without a significant remission of symptoms; becoming candidates for surgical management.

The comorbidities with major frequency were systemic blood hypertension (51%), Diabetes mellitus type 2 (29%) and urologic diseases (10.3%). Other comorbidities (psychiatric diseases, cardiopathies, nephropathies, neuropathies, cancer, rheumatoid arthritis, osteoporosis, hematologic disorders, and gastropathy) presented a prevalence of less than 5% per each one.

	n (%)
Gender	
Feminine	56 (38.6)
Masculine	89 (61.4)
Laterality	
Left	31 (21.4)
Right	26 (17.9)
Bilateral	88 (60.7)
Levels	
C2C3	1 (0.7)
<i>C3C4</i>	55 (37.9)
C4C5	88 (60.7)
<i>C5C6</i>	98 (67.6)
<i>C6C7</i>	43 (29.7)
<i>C7T1</i>	3 (2.1)
Initial Treatment	
Conservative	134 (92.4)
Surgical	11 (7.6)
Comorbidities	
Systemic Blood Hypertension	74 (51.0)
Diabetes Mellitus type 2	42 (29.0)
Urologic	15 (10.3)
Others	41(28.3)

Table 2. Demographic characteristics (n = 145).

3.1. Characteristics of the Groups and Perioperative Results (Table 3)

The median age of presentation was significantly older in the PA group (U = 1697.00, p = 0.008) with 71 (67 - 77.5) years. Masculine was the most prevalent gender in both approaches. However, we found a statistical difference between groups ($x^2(1) = 7.533$, p = 0.006). The median time of the symptoms did not present a significant difference between groups (U = 2275.00, p = 0.823), neither the number of affected levels (U = 2286.00, p = 0.847).

We reported a surgical time of 210 (156 - 240) minutes for AA and 150 (120 - 180) minutes for PA where we appreciated a notable difference (U = 1275.50, p = 0.001) between them. Surgical bleeding (U = 2027.00, p = 0.203) and the median length of hospitalization (U = 2129.500, p = 0.455) did not present a significant difference between both groups.

Twenty-two patients presented complications, being more prevalent in AA, without a statistical difference against PA ($x^2(1) = 1.261$, p = 0.261). In Figure 3, we present the different frequencies of the complications, those related to the anesthesia management and the CSF leak prevailed in AA, and in PA the Delirium.



Figure 3. Surgical complications.

Table 3. General and Surgical variables of Anterior and	Posterior groups ($n = 145$).
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	Anterior Approach (n = 97)	Posterior Approach (n = 48)	р
Age	69 (63 - 673.5) years	71 (67 - 77.5) years	0.008*
Gender			0.018*
Feminine	44 (45.4%)	12 (25%)	
Masculine	53 (59.6%)	36 (75%)	
Evolution time	5 (3 - 16) years	5 (2 - 17) years	0.823
Number of levels	2 (2 - 2)	2 (2 - 3)	0.847
Surgical Variables			
Surgical time	210 (156 - 240) min	150 (120 - 180) min	0.001*
Bleeding	150 (90 - 250) cc	200 (100 - 300) cc	0.203
Days of hospitalization	6 (4 - 11) days	5 (4 - 10) days	0.455
Complications	17 (17.5%)	5 (10.4%)	0.261

*Statistical significative.

3.2. Outcome Results (Table 4)

In the variable of strength, we found a significant difference between the approaches in the presurgical period ($x^2(1) = 9.003$, p = 0.003) and at P3m ($x^2(1) = 6.501$, p = 0.011). IP ($x^2(1) = 3.682$, p = 0.055), P6m ($x^2(1) = 0.096$, p = 0.757) and P1y ($x^2(1) = 9.758$, p = 0.384) did not show a statistical difference. Both groups presented a statistical improvement in strength (AA: $x^2(4) = 51.203$, p < 0.003)

0.001; PA: $x^2(4) = 4.926$, $p \le 0.001$) and no clinical deterioration compared with the presurgical stage.

In both approaches, the patients showed a significant sensitivity improvement compared with the presurgical state (AA: $x^2(4) = 91.051$, p < 0.001; PA: $x^2(4) = 15.094$, p = 0.005), however; we found differences in measures at P3m ($x^2(1) = 6.638$, p = 0.010), P6m ($x^2(1) = 13.658$, p = 0.001), and P1y ($x^2(1) = 11.065$, p = 0.001), with a major prevalence of the affection in the PA group.

The difference in the median percentage index of NDI between groups was not significant (Presurgical: U = 2040.00, p = 0.225; IP: U = 2287.50, p = 0.923; P3m: U = 2121.00, p = 0.422; P6m: U = 2262.00, p = 0.765; P1y: U = 2153.5, p = 0.394) presenting a major incapacity in the PA group.

	Anterior Approach (n = 97)	Posterior Approach (n = 48)	р
Strength (<3)	n (%)	n (%)	
Presurgical	21 (21.6)	22 (45.8)	0.003*
Immediate postsurgical	5 (5.2)	7 (14.6)	0.055
Postsurgical 3 months	3 (3.2)	7 (14.6)	0.011*
Postsurgical 6 months	3 (3.2)	2 (4.3)	0.757
Postsurgical 1 year	3 (3.2)	3 (6.3)	0.384
р	<0.001*	<0.001*	
Sensitivity (affected)	n (%)	n (%)	
Presurgical	66 (68)	37 (77.1)	0.259
Immediate postsurgical	53 (54.6)	32 (66.7)	0.166
Postsurgical 3 months	31 (32)	26 (54.2)	0.010*
Postsurgical 6 months	26 (26.8)	28 (58.3)	0.001*
Postsurgical 1 year	22 (22.7)	24 (50)	0.001*
р	<0.001*	0.005*	
NDI †	Index (range) %	Index (range) %	
Presurgical	30 (10 - 48)	24 (2.5 - 45)	0.225
Immediate postsurgical	12 (0 - 30)	12.5 (0 - 40)	0.923
Postsurgical 3 months	5 (0 - 11)	7.5 (0 - 24.5)	0.422
Postsurgical 6 months	2 (0 - 10)	0 (0 - 15)	0.765
Postsurgical 1 year	0 (0 - 5)	0 (0 - 10)	0.394
р	<0.001*	<0.001*	
Nurick (≧3)	n (%)	n (%)	
Presurgical	26 (26.8)	24 (50)	0.006*
Immediate postsurgical	27 (27.8)	25 (52.1)	0.004*
Postsurgical 3 months	27 (27.8)	25 (52.1)	0.004*
Postsurgical 6 months	18 (18.6)	17 (35.4)	0.026*
Postsurgical 1 year	12 (12.4)	16 (33.3)	0.003*
р	<0.001*	<0.001*	

Table 4. Presurgical and Follow-up results.

*Statistical significative, † Neck Disability Index.

There was a significant difference in the NDI results between the presurgical and postsurgical stages in each group (AA: $x^2(4) = 246.079$, p < 0.001; PA: $x^2(4) = 86.068$, p < 0.001). Post hoc analysis with Wilcoxon signed-rank tests was conducted with a Bonferroni correction, resulting in a significance level set at p < 0.010. We only found no significant differences between the P6m and P1y in the PA (Z = -1.472, p = 0.140), the rest of the values were statistically different between them.

The Nurick scale results showed a statistical difference during in all the stages (Presurgical: $x^2(1) = 7.647$, p = 0.006; IP: $x^2(1) = 8.208$, p = 0.004; P3m $x^2(1) = 8.208$, p = 0.004; P6m: $x^2(1) = 4.985$, p = 0.026; P1y: $x^2(1) = 9.055$, p = 0.003). Both groups presented an improvement compared with the presurgical period ($x^2(4) = 33-091$, p < 0.001).

4. Discussion

CM is one of the most common diseases in the elderly population, including almost 90% of patients in the seventh decade of life; it is more often in the male population (1.12:1, M:F). The symptoms are sensitive alterations, weakness, urine incontinence, and in the most severe cases, quadriplegia secondary to the stenosis of the spinal canal [9]. Our population has similar demographic aspects to those reported in the current literature.

The pathological changes in the spine during the elderly are a combination of disk herniations that occur because of dysfunction, instability, and spinal stenosis. These changes occur because of the late instability and early stabilization secondary to bony overgrowth, leading to disturbing with more frequency C6C7 (60%), followed by C5C6 (40%) and C4C5 (5%) [10]. In our series, the most affected levels were C4C5 and C5C6; C3C4 occupied third place, derived from the changes in motion at this level [6].

Conservative treatment includes physical therapies, including intermittent cervical traction, heat therapy, and medications; these therapies may offer symptomatic relief with NSAIDs, steroids, and/or muscle relaxants for neck pain or paresthesias. The recommendation is to start the conservative treatment in patients with mild CDSD [18]. The proportion of patients who converted to surgery after failed nonoperative care ranged from 4% to 40% during 3 of 7 years [5].

4.1. Approach Analysis

Based on the characteristics of each patient, the choice of the AA is in patients with normal to kyphotic alignment because PA may further cause kyphosis secondary to the destabilization. When an indirect decompression is warranted, the PA can be used. This approach is for patients with neutral or lordotic cervical spine alignment and is quite helpful in patients with multilevel compression and congenital stenosis, usually involving C3-C7. Posterior decompression provides the spinal cord with more space, moving away from the disk/bony ridges that are

compressing anteriorly [11] [12] [13].

In our study, we performed the AA for younger patients than the PA group. The international literature encourages the anterior techniques to treat younger patients and with less severe impairment and more focal cervical pathology, as we reported [14].

The results in the perioperative variables that we describe showed similar results to those in the international literature. Blood loss is higher in the PA because of a bigger muscle dissection. The literature reports a stronger association between the PA and the necessity of blood transfusion (1.38% AP, 7.20% PA) [14] [15].

Surgical time presents differences between the approaches. During the dissection, the AA demands more time for the vital structures that surrounded the incision, like the trachea, esophagus, carotid artery, jugular vein, and recurrent laryngeal nerve; in PA, the dissection involves only muscles and fascia minimizing the surgical time [9] [14].

Various studies have shown variations in outcomes after cervical spine surgery secondary to the patient's characteristics and surgical factors. Older patients were at greater risk of encountering several complications, and gender was a common risk factor depending on the complication.

Nationwide Inpatient Sample showed that older patients had a higher risk of complications, such as cardiac and respiratory complications. This study identified common non-infection complications and corresponding risk factors after selected cervical spine surgery. The cause of these complications is unclear. They may be related to anesthesia or opioid use, particularly since almost all patients undergoing common orthopedic and soft tissue surgical procedures had been previously found to receive opioids [16]. Despite the higher prevalence of comorbidities in the Mexican population, the frequency of postoperative complications presented in our sample was low, probably associated with perioperative management in our institution [17].

4.2. Functional Outcomes

• Strength

The rate of strength recovery in the postsurgical stages in our elderly patients could be secondary to the age-related changes in their spinal cord, including a decrease in γ -motor neurons, synaptic and dendritic elements, the number of anterior horn cells and number of myelinated fibers in the corticospinal tract and posterior funiculus; may have unassociated comorbidities that may impede their ability to perform the simple tasks, such as locomotor diseases (hip and knee osteoarthritis), sarcopenia, diabetic neuropathy, or urinary incontinence; have reduced physiological reserves and, as a result, are less tolerant to physical assault such as that represented by surgery [18].

Sensory deficit

Our data reports that the patients with PA decompression remained with

mild-to-moderate symptoms after 3 months of the surgery compared with AA. PA can produce progressive kyphosis, expansion of the OPLL, and indirect decompression of nerve roots and spinal canal, in the other side; the AA makes a direct decompression and resection of the OPLL with better long-term sensitivity outcomes [19].

• NDI

Patients submitted to cervical surgery presented significant improvement in their NDI index in all time intervals of follow-up, no matter the approach achieving almost the 100% after 5 years of follow-up [19]. When patients make improvements in pain and disability after spine surgery in the first three months; they are likely to continue to improve and have successful clinical outcomes in one year. Part of the therapy role is to maximize the long-term follow-up with reconditioning functional strength, mobility and postural control of the upper body. In addition, with therapy, patients can learn the most effective nonpharmacological pain management [20].

• Nurick scale

Although both surgical approaches for CM are effective in the elderly, these patients are less effective at translating neurological improvements into functional recovery (18). The differences presented in the measurements at each stage of the evaluation between the AA and PA approaches are because the PA has a major prevalence since the presurgical stage compared with the AA. However, both approaches presented a good recovery after 1 year of follow-up, coinciding with the conclusions of previous reports that both approaches are highly efficacious in preventing neurologic deterioration and in most cases improve neurological function [21].

5. Conclusions

International literature recommends realizing AA to treat multilevel CM in the elderly when involved in less than 3 surgical segments. PA may be the elective method for treatment multilevel (\geq 3) [15].

Adequate surgical decompression is necessary to get a favorable long-term outcome, however, is important to recognize the previous functional limitations related to comorbidities.

Appropriate perioperative management is crucial to get a satisfactory result. The selection of the approach should accord to the surgeon's abilities, the patient's characteristics, and the anesthetic support. The postsurgical management should include excellent rehabilitation, pain management, and psychological support.

Unlike the international literature reports predictors like comorbidities, age, duration, and severity of symptoms; we could determine that in this series all the patients submitted to surgical medullary decompression presented a favorable outcome despite the age and the higher prevalence of comorbidities in the Mexican population; whereby we favor the surgical treatment in all patients in a case-to-case selection to generate a positive impact on functional outcomes.

Limitations

The major limitation of this study is that the analysis was carried out retrospectively, limiting the selection of the approach to criteria and treatment of different surgeons. With this article, we want to encourage the scientific community to carry out future projects, eliminating these limitations.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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