

# PROGRESSION OF MYELOPATHY TREATED WITH CORPECTOMY, AUTOLOGOUS GRAFT AND PLATE

EVOLUÇÃO DA MIELOPATIA TRATADA COM CORPECTOMIA, ENXERTO AUTÓLOGO E PLACA

EVOLUCIÓN DE LA MIELOPATÍA MANEJADA CON CORPECTOMÍA, INJERTO AUTÓLOGO Y PLACA

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## ABSTRACT

**Introduction:** Cervical myelopathy is a degenerative pathology of spinal and/or root involvement. Caused by hypertrophy of the yellow ligament, osteophytes in the medullary canal and disc herniation. It affects the upper and lower motor neurons. The treatment of myelopathy diagnosed by magnetic resonance and electromyography consists of decompression by corpectomy. **Methods:** Autologous graft integration with cervical plate placement was evaluated in 31 patients, from January 1, 2013 to December 31, 2015. The procedure consisted of a Smith Robinson approach, anterior corpectomy, iliac crest autograft, anterior stabilization with cervical plate (Vectra, Synthes). Statistical analysis was performed with EPIINFO 3.5.1. **Results:** Age 64.6% (45-65 years), Sex: 41.9% (women), 58.1% (men). Segments treated: 38.7% (C5-C6), 35.5% (C4-C5), graft separation in sections <0.5 cm, sagittal, and <0.5 cm, axial at 12 months. Bleeding 61.3% (100-500 ml), 32.3% (501-100 ml), 6.5% (1,001-1,500 ml). Time 32.3% (> 249 min), 32.3% (121-180 min), 32.3% (181-240 min), 3.2% (91-120 min). **Discussion:** In this series, Querétaro is similar to other cities in the world with respect to sex, age, levels affected, number of complications, surgical time and bleeding, as well as graft integration in the evaluation at 12 months. **Conclusions:** Increased frequency in adult men, C4-C6 affected levels; **Complications:** recurrent laryngeal nerve injury, bleeding greater than 500 ml.

**Keywords:** Spinal cord diseases; Prognosis; Treatment outcome.

## RESUMO

**Introdução:** Cervical mielopatia é uma doença degenerativa do envolvimento da medula e/ou radicular. Causado pela hipertrofia do ligamento amarelo, osteófitos na medular canal e hérnia de disco. Ela afeta o neurônio motor superior e inferior. Tratar mielopatia diagnosticado por ressonância magnética e eletroneuromiografia é corpectomia descompressão completamente. **Métodos:** Foi estudada a integração de colocação de enxerto autólogo placa cervical em 31 pacientes, a partir de 01 de janeiro de 2013 a 31 de Dezembro de 2015. O procedimento foi abordar Smith Robinson, corpectomia anterior, crista íliaca auto-enxerto, a estabilização anterior com placa cervical (Vectra, Synthes). A análise estatística foi realizada com EPIINFO 3.5.1. **Resultados:** Idade 64,6% (45-65 anos) Sexo: 41,9% (mulheres), 58,1% (homens). segmentos tratados: 38,7% (C5-C6), 35,5% (C4-C5), cortes de separação de enxerto <0,5 cm, sagital e <0,5 cm, axiais em 12 meses. Sangramento 61,3% (100-500 ml), 32,3% (501-100 ml), 6,5% (1001-1500 ml). Tempo de 32,3% (> 249 minutos), 32,3% (121- 180 min), 32,3% (181-240 min), 3,2% (91-120 min). **Discussão:** Nesta casuística, Querétaro é semelhante a outras cidades do mundo com relação a sexo, idade, níveis afetadas, número de complicações, tempo cirúrgico e sangramento e integração dos enxertos na avaliação aos 12 meses. **Conclusões:** O aumento da frequência em homens adultos, níveis afetados C4-C6; ocorreram complicações: lesão do nervo laríngeo recorrente, sangramento mais de 500 ml.

**Descritores:** Doenças da medula espinal; Prognóstico; Resultado do tratamento.

## RESUMEN

**Introducción:** La mielopatía cervical es una patología degenerativa de compromiso medular y/o radicular. Causada por hipertrofia del ligamento amarillo, osteofitos en el canal medular y herniación discal. Afecta la neurona motora superior e inferior. El tratamiento de la mielopatía diagnosticada por resonancia magnética y electromiografía consiste en descompresión por medio de corpectomía. **Métodos:** Fue evaluada la integración de injerto autólogo con colocación de placa cervical en 31 pacientes, del 1 de enero del 2013 al 31 de diciembre de 2015. El procedimiento consistió en abordaje de Smith Robinson, corpectomía anterior, autoinjerto de cresta íliaca, estabilización anterior con placa cervical (Vectra, Synthes). El análisis estadístico se realizó con EPIINFO 3.5.1. **Resultados:** Edad 64,6% (45-65 años), Sexo: 41,9% (mujeres), 58,1% (hombres). Segmentos tratados: 38,7% (C5-C6), 35,5% (C4-C5), separación del injerto en cortes <0,5 cm, sagital, y <0,5 cm, axial a los 12 meses. Sangrado 61,3% (100-500 ml), 32,3% (501-100 ml), 6,5% (1.001-1.500 ml). Tiempo 32,3% (> 249 min), 32,3% (121- 180 min), 32,3% (181-240 min), 3,2% (91-120 min). **Discusión:** En esta casuística, Querétaro es similar a otras ciudades del mundo con respecto a sexo, edad, niveles afectados, número de complicaciones, tiempo quirúrgico y sangrado, así como la integración del injerto en la evaluación a los 12 meses. **Conclusiones:** Mayor frecuencia en hombres de edad adulta, niveles afectados C4-C6; complicaciones ocurridas: lesión del nervio laríngeo recorrente, sangrado mayor de 500 ml.

**Descriptores:** Enfermedades de la médula espinal; Pronóstico; Resultado del tratamiento.

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## INTRODUCTION

Myelopathy is a degenerative disease; its main symptom is neck pain, and its principal causes are spondylosis and radiculopathy. It starts with facet osteophytes and hypertrophy of the ligamentum flavum. An intervertebral disc joined to the osteophytes is referred to as a bone spur, a combination of folding of the intervertebral disc and osteophytes. In terms of age at onset, the disease usually presents at age 55 years or older.<sup>1</sup>

Spinal stenosis is categorized as either congenital, acquired, dynamic or functional, or combined (two or more types). Degenerative disc disease is one of the main causes of spinal stenosis.

Spondylosis is categorized in grades: grade I disc disease, grade II spondylosis, grade III spondylosis with restriction of the range of movement, IV spondylotic myopathy. It has a standard of progression.

Lateral stenosis may present by syndrome of the pedicles, in which the pedicles involved are thinner and shorter in their anterior-posterior configuration. Changes in the pedicles commonly contribute to narrowing of the spinal cord, decreased diameter in the coronal plane occurs, together with a reduction in interpedicular distance.

Common causes of acquired spinal stenosis include facet arthropathy, scoliosis, spondylolisthesis, disc bulging by the intervertebral space, protrusion, extrusion and migration of the free fragment. Less common causes are cysts, tumors and postoperative scarring.

The movements of hyperflexion and hyperextension can cause microtraumas and microvascular lesions of the spinal cord, even when the size of the spinal cord is normal, while a reduction in the size of the spinal cord increases the risk of contusion of the spinal cord. The principal mechanism of narrowing of the spinal cord is the impingement effect, which makes the patient vulnerable to herniation of the intervertebral disc, spondylosis, spondylolisthesis, thickening or folding of the ligament, and hypertrophy due to hypermobility of the adjacent segment.

## CERVICAL SPONDYLOTIC MYELOPATHY

### Prevalence

The segment most affected by spondylotic myelopathy is the cervical segment, as an entity secondary to disc herniation. This is common in patients aged over 50 years, and is the most common cause of spinal cord pathology and also the most common complication of cervical spondylosis.

### Pathological mechanism

Spinal compression secondary to spondylosis and central spinal stenosis can compromise blood flow in the spinal cord, leading to ischemia and spinal cord infarcts. The main mechanisms of cervical myelopathy in the presence of cervical spondylosis are (1) circumferential central narrowing of the spinal canal, (2) bony projections in the interior of the spinal canal (crests, spurs, and occupation of the canal by disc herniation), (3) changes in radicular circulation, and (4) chronic blockage of medullary flow.

The size of the spinal canal is the main predisposing factor in the development of spondylotic myelopathy. The posterolateral white matter is vulnerable to the presentation of negative effects of spinal cord compression, particularly in the corticospinal tract. An aqueous zone in the region of the cuneate fasciculus, the medial spinothalamic tract, and the corticospinal tract has been proposed as being susceptible to lesion and injury from hypoxia and ischemia. Autopsies reveal that patients with cervical myelopathy have preserved anterior spines, marked atrophy of the grey matter, degeneration of the lateral and posterior fasciculi, as well as of thinning myelin fibers, with changes in the white matter that suggest demyelination and remyelination processes. The degeneration of the medial portion of the posterior spine is very noticeable in lesions from severe compression.

## Clinical findings

The active global or segmental cervical range of movement is reduced secondary to changes of the soft tissues and hardening of the intervertebral disc associated with spondylosis.

The levels adjacent to moderate or severe spondylosis may exhibit compensatory hypermobility in flexion-extension radiographs. Cervical spondylosis can cause dynamic medullary compromise and the Lhermitte's phenomenon with a mild shock-like pain when moving the neck that extends uni- or bilaterally from the neck to the arms. Rotation combined with extension can cause the Lhermitte's phenomenon. The extensor plantar response is positive in many cases in these patients.

Cervical spondylosis at multiple levels with lateral stenosis may present with the reduction or absence of reflexes in the upper limbs and the preservation or increase of the reflexes in the lower limbs. In some cases, there may be hyperreflexia of the patellar reflex. Normal mandibular reflexes may help rule out compromise of the descending corticospinal tract. Abdominal reflexes may be decreased in cervical myelopathy, but are not related to spasticity of the lower limbs.

The common symptoms are deterioration of hand use (75%), changes in the sensitivity of the upper limbs (82.9%), and difficulty walking (80.3%). Cervical spondylotic myelopathy is characterized by a series of events with the following presentation: 1. spastic tetraparesis with numbness and hyperreflexia of the limbs; 2. spastic paraparesis with lesions below C6; 3. medium and moderate spastic tetraparesis of the deltoid muscles; 4. amyotrophic myelopathic hand with long-tract signs; 5. central cord syndrome secondary to spondylotic and traumatic myelopathy.

### Diagnostic imaging

The quantitative measurements of the cervical spinal canal in radiographs can help to identify congenital or acquired narrowing of the spinal canal. Radiographs do not always show osteophytic projections so in some cases requesting advanced imaging studies such as CT and MRI is indicated. The MRI is the most sensitive study for measuring changes in the spinal cord from stenosis secondary to acute or chronic lesions, especially in the T2 weighted mode, and contrast resonance can be used when diagnosis with conventional MRI is not clear. CT can help to evaluate bone lesions, but does not help to evaluate soft tissues or tumor lesions of the spinal cord. In addition, CT provides us with precise measurements of the spinal canal that reveal the clinical severity.<sup>1</sup>

### Folding and thickening of the yellow ligament

In adults, the ligamentum flavum is formed from fibers of yellow elastin (80%), fibers of type 1 collagen (20%) interposed between the elastin fibers, and several fusiform fibrocytes. The MRI offers a method for examining the spinal ligaments. The higher intensity of the signal of the ligamentum flavum versus the posterior longitudinal ligament in the weighted T1 mode or the gradient of the ultrasound images occurs because of its high elastin content. The ligamentum flavum extends laterally towards the fibrous portion of the joint capsule along the root in the lateral recesses and the intervertebral canal. Subsequently, a minimal hypertrophy of the ligamentum flavum can generate dorsal compression. The thickening of the ligamentum flavum can be identified in the axial and sagittal MRI projections. The average thickening of the ligamentum flavum of the lumbar spine is 3mm.<sup>1</sup>

Degenerative disc disease results in a loss of height causing rostrocaudal subluxation between the mobile segments of the spine. This loss of vertical height of the spine causes the folding of the ligamentum flavum. Hypertrophy of the ligamentum flavum can also be caused by an increase in mechanical stress in the affected region. The invasion of the spinal canal by the ligamentum flavum in the posterolateral plane can coexist with degenerative changes in the anterior spinal canal causing posterior longitudinal bulging of the ligament with disc herniation.<sup>1</sup>

Cervical myelopathy evolves acutely or subacutely, where one of the most frequent causes is the protrusion of the intervertebral disc and the pathology associated with cervical spondylosis.<sup>2</sup>

The surgical procedures adopted to decompress the cervical spinal cord basically consist of a laminectomy with or without the section of the denticulate ligament, the resection of the bony spurs protruding towards the anterior wall of the spinal canal.<sup>2</sup>

Symptoms presented in the physical examination include the Hoffman/Babinski sign, ataxia, hyperreflexia, clonus, and gait dysfunction not associated with other neurological pathologies.<sup>1</sup>

In some patients, a change in cervical lordosis may be observed, and the normal range is from 30-45°. Less than this is considered hypolordosis and more than this is considered hyperlordosis.<sup>3</sup>

The diagnosis is most often reached via simple magnetic resonance, and, in many cases, a reduction of the diameter of the spinal canal of less than 13mm is detected in the AP (anteroposterior) projections, measured from the osteophytic ridge to the anterior line of the ligamentum flavum in the axial image measured in the line where the diameter is the most reduced. Abnormalities in T2-weighted changes in the parenchyma are signs of medullary compression.<sup>1</sup>

### Treatment via anterior approach corpectomy plus autologous iliac crest and cervical plate graft

This is the treatment of choice used in patients with cervical myelopathy, and especially indicated in those patients with compression secondary to osteophytes in the spinal canal.<sup>4</sup>

The technique used is via anterior approach which stabilizes the anterior spine and in which the placement of a bone graft is performed in addition to the placement of a cervical plate that acts as a tension band or support.

The indication for placement of a cervical plate is to give support to a persistently unstable cervical spine, especially when there is a loss of vertebral body height due to vertebral compression or wedging. It is also indicated in vertebrectomies for medullary decompression.<sup>5</sup>

The 2.5mm profile VECTRA plate from SynthesSpine is a cervical plate used to stabilize the anterior cervical spine and its placement is indicated when decompressive vertebrectomies are performed.<sup>6</sup>

To classify the fusion of the graft, after the procedure, several markers are used: the degree of fusion, it is observed if there are trabeculae in more than 50% of the graft. Graft collapse, which is defined as a loss of more than 2 mm of the height of the vertebral body. If there is migration of the graft, which is considered positive if there is migration outside or inside the spinal canal.<sup>7</sup>

### Complications from anterior corpectomy and anterior plate placement

Delayed consolidation and pseudoarthritis are the main complications following multi-level corpectomies in which the probability of pseudoarthritis increases with the number of levels where the corpectomy is performed. In addition, early consolidation rates have been observed in patients where stabilization with graft and plate placement was performed, compared to patients in whom no plaque was placed.<sup>8</sup>

To determine the fusion of the autologous iliac crest graft in patients diagnosed with chronic cervical myelopathy, following anterior corpectomy and anterior cervical plate placement at 6 and 12 months at the Hospital General de Querétaro.

To know the frequency of chronic cervical myelopathy in patients by sex and by age at the Hospital General de Querétaro.

To quantify the surgical time and transoperative bleeding of patients diagnosed with chronic cervical myelopathy at the Hospital General de Querétaro.

## METHODS

Thirty-one patients diagnosed with chronic cervical myelopathy were evaluated clinically and radiographically at the Hospital General de Querétaro.

The inclusion criteria were a diagnosis of chronic cervical myelopathy reached clinically, radiographically, and via electromyography.

Exclusion criteria were chronic myelopathy secondary to acute traumatism, vertebral fractures, and tumors.

We obtained an informed consent from all study participants and the study was approved by the Institutional Review Board with registration number 304/17 -10-06 VI.

This descriptive longitudinal study was conducted with patients diagnosed with chronic cervical myelopathy who underwent anterior approach spine surgery at the Hospital General de Querétaro for medullary decompression via resection of the hypertrophic ligamentum flavum, osteophytes, and fibrosis, according to the diagnosis and with its confirmation during the surgery. The 2.5mm VECTRA plate by Synthes was used and fusion was confirmed by BRIVO CT 385 tomography at the Hospital General de Querétaro.

## RESULTS

We observed a greater frequency in male patients (58%) than in female patients (41.93%). The levels affected were C3-C4 in 2 patients (6.4%), C4-C5 in 11 patients (35.48%), C4-C5-C6 in 4 patients (12.9%), C5-C6 in 12 patients (38.7%), and C6-C7 in 2 patients (6.4%). (Table 1)

In the axial and sagittal computed tomography projections taken at 6 months, we observed gaps greater than 0.5 cm in 19 patients (61.29%). At 12 months, the number of gaps observed in the computed axial tomography scan was lower, only occurring in 4 patients (12.9%). (Table 2)

Transoperative bleeding ranged from 100-500 ml in 10 patients (32.25%), from 501-1000 in 10 patients (32.25%), and from 1001-1500 in 2 patients (6.45%). (Table 3)

**Table 1.** Levels affected.

Levels affected	Female	Male	Total
C3-C4	1	1	2
C4-C5	4	7	11
C4-C5-C6	2	2	4
C5-C6	6	6	12
C6-C7	0	2	2
Total	13	18	31
<b>Chi-square</b>		<b>Probability</b>	
2.0655		0.7237	

**Table 2.** Gap between the graft and the vertebral body at 6 months.

Levels affected	gap < 0.5 cm sagittal < 0.5 cm axial	gap > 0.5 cm sagittal < 0.5 cm axial	Total
C3-C4	1	1	2
C4-C5	5	6	11
C4-C5-C6	0	4	4
C5-C6	5	7	12
C6-C7	1	1	2
Total	12	19	31
<b>Chi-square</b>		<b>Probability</b>	
2.9964		0.5584	

**Table 3.** Bleeding ranges.

Sex	1001-1500 ml	100-500 ml	501-1000 ml	Total
female	0	7	6	13
male	2	12	4	18
Total	2	19	10	31
<b>Chi-square</b>		<b>Probability</b>		
2.9870		0.2246		

The mean time was 120 to 180 minutes in 10 patients (32.25%), from 181 to 240 minutes in 10 patients (32.25%), more than 249 minutes in 10 patients the shortest time group (91-120 minutes) was a single patient (3.22%).

## DISCUSSION

The population studied at the Hospital General de Querétaro is similar to those of studies conducted in other countries in terms of the sex, age, levels affected, number of complications, surgical time, and bleeding, as well as in terms of the integration of the autologous graft in the follow-up outpatient consultation held 12 months following the surgery.

## CONCLUSIONS

Cervical myelopathy is more common in male than in female patients, however we did not find statistically significant differences with  $p=0.6895$ . There was a statistically significant difference between the

gaps observed in the computed axial tomography scans of patients after 6 months (61.29%) versus 12 months (12.9%). Intraoperative bleeding ranged from 100 to 1500 ml in 99.77% of the patients. Bleeding was less than 1000 ml in 93.54% of the patients and only 6.45% had bleeds greater than 1000 ml.

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**CONTRIBUTION OF THE AUTHORS:** Each author made significant individual contributions to this manuscript. SS wrote the methods section, compiled the statistical tables, and contributed to the discussion and results sections. JT wrote the results section and contributed to the discussion section. JG prepared the conclusions based on the results. JC wrote the abstract and provided the translations.

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