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# Cervical continent-content and myelopathy: proposal for a new classification

## *Contenido-continente cervical y mielopatía: propuesta para una nueva clasificación*

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**Keywords:**
myelopathy, content, continent, Nurick scale.

***Palabras clave:***
*mielopatía, contenido, continente, escala de Nurick.*

## ABSTRACT

**Introduction:** degenerative cervical myelopathy (DCM) is the most common cause of spinal cord dysfunction. It can lead to progressive disability and paralysis due to chronic compression of the spinal cord. **Objective:** perform a new classification according to the diameter of the cervical canal measured in millimeters and its correlation with the Nurick scale of the patient. **Material and methods:** observational, retrospective, transversal and descriptive study, from January 01, 2019 to December 31, 2019 at the ISSEMyM Ecatepec Medical Center, State of Mexico, Mexico. **Results:** in an effort to propose a new classification, the Nurick scale grade was used and a one-way analysis of variance (ANOVA) was performed to associate the grade to the scale, which was highly significant ($p < 0.001$). **Conclusion:** we propose this "SOSA" grading system to measure the cervical spinal canal on a sagittal T2-weighted MRI.

## *RESUMEN*

***Introducción:*** *la mielopatía cervical degenerativa (MCD) es la causa más común de disfunción de la médula espinal. Puede provocar discapacidad progresiva y parálisis debido a la compresión crónica de la médula espinal.* ***Objetivo:*** *realizar una nueva clasificación según el diámetro del canal cervical medido en milímetros y su correlación con la escala de Nurick del paciente.* ***Material y métodos:*** *estudio observacional, retrospectivo, transversal y descriptivo, del 01 de enero de 2019 al 31 de diciembre de 2019 en el Centro Médico ISSEMyM Ecatepec, Estado de México, México.* ***Resultados:*** *en un esfuerzo por proponer una nueva clasificación, se utilizó el grado de la escala Nurick y se realizó un análisis de varianza (ANOVA) de una vía para asociar el grado a la escala, siendo altamente significativa ($p < 0.001$).* ***Conclusión:*** *proponemos este sistema de clasificación "SOSA" para medir el canal espinal cervical en una resonancia magnética ponderada en T2 sagital.*

## INTRODUCTION

Degenerative cervical myelopathy (DCM) is the most common cause of spinal cord dysfunction.[1] It can lead to progressive disability and paralysis due to chronic compression of the spinal cord.[1,2] The incidence and prevalence of degenerative

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causes of spinal myelopathy are estimated to be as low as 41 and 605 per million in North America.[3] Hospitalizations have been estimated at 4.04 per 100,000 person years, and surgical rates appear to be increasing.[3] The incidence of cervical spondylotic myelopathy (CSM), ossification of the posterior longitudinal ligament (OPLL), ossification of the ligamentum flavum (OLF), and degenerative disc disease (DDD) in the general population varies, is significantly influenced by location geographic and ethnic origin, with the highest prevalence reported in East Asian countries.[4]

Non-traumatic and degenerative forms of cervical myelopathy represent the most common cause of spinal cord impairment in the elderly population.[3,5] The main problem is the propensity for degenerative changes that cause stenosis of the spinal canal, leading to compression of the spinal cord and eventually lead to disability due to the development of myelopathy.[3]

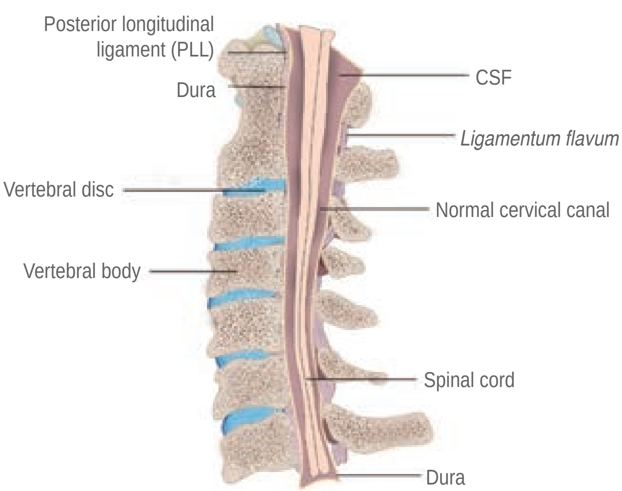
With repeated use of everyday life, periods of trauma, overuse, and other environmental factors, intervertebral discs (IVDs) begin to degenerate, disrupting the load-bearing and load-transfer functions of the intervertebral joint.[5,6] As a result, there is increased stress on the joint, cartilage end plates, and hypermobility in adjacent segments.[5,6] The unequal pressure forces exerted on the vertebrae as a consequence of these structural changes are thought to promote the formation of osteophytic spurs in a process of adaptive remodeling aimed at stabilizing an unstable spinal segment.[7] These changes include structural disc failure (eg, annular tears, bulging or herniation, and/or additional loss of disc height), osteophyte formation, and ligament hypertrophy and calcification.[8,9]

Pathophysiologically, symptomatic degenerative cervical myelopathy (DCM) may result from static compression of the spinal cord, spinal malalignment leading to impaired cord tension and vascular supply, and repeated dynamic injury due to segmental hypermobility.[3] The resulting chronic ischemic injury, in conjunction with mechanical stretch, has been found to activate some key biological events and cause neural degeneration.[10]

**A**

Continent

| Cervical spinal canal formed by: |
|---|
| - Vertebral body, intervertebral disc<br>- Posterior longitudinal ligament<br>- Yellow ligament *(flavum)*<br>- Facet joint, among others |




**B**

Contents

| Spinal cord, nerve<br>Roots, vascularity<br>Cerebrospinal liquid |
|---|

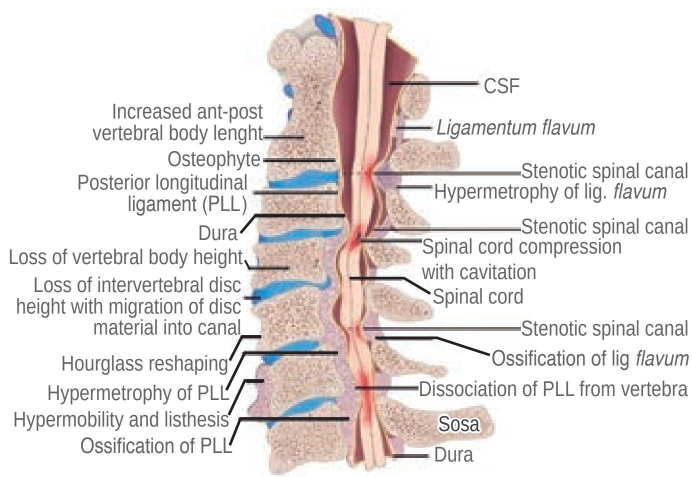



**Figure 1: A)** Structures that make up the normal cervical content-continent. **B)** Degenerative pathological processes that result in reduction of the continent, affecting the content.
CSF = cerebrospinal fluid. PLL = posterior longitudinal ligament.

**Table 1:** Nurick scale.

| |
|---|
| Degree 0: signs or symptoms of root involvement, but no evidence of spinal cord disease |
| Degree I: signs of spinal cord disease, but no difficulty walking |
| Degree II: slight difficulty walking that does not interfere with work activity |
| Degree III: difficulty walking that interferes with work activity or the ability to do all household chores |
| Degree IV: able to walk alone with the help of another person or with the aid of a walker |
| Degree V: in a chair or in bed |

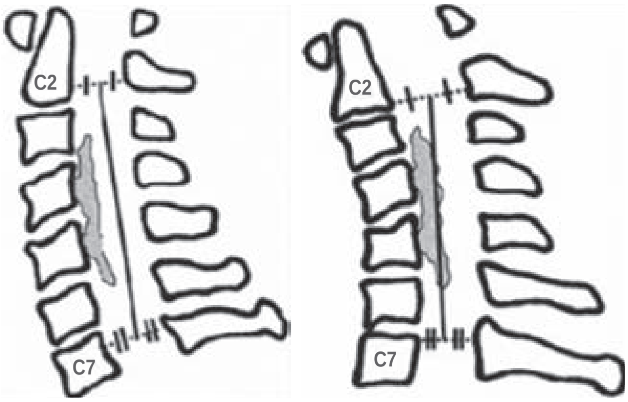



**Figure 2:** K line representation.

Cervical myelopathy is induced by static factors (space available for the spinal cord), dynamic factors (range of intervertebral movement) or a combination of both.[11] Within the static factors we cite in this work the content and container, and its implications direct towards the cervical spinal cord due to the degenerative changes between each one *(Figure 1)*, documented by a simple T2-weighted magnetic resonance study in sagittal section.

There are currently several systems for classifying disease severity at presentation. The 2 most commonly used are the Nurick scale and the Japanese Orthopedic Association (JOA) scale for the classification of cervical myelopathy *(Table 1)*.[4]

The Research Committee for Ossification of Spinal Ligaments (part of the Japanese Ministry of Health, Labor and Welfare) established a commonly used classification system for OPLL.[11,12] This system classifies OPLL into 4 types: 1. continuous, a long lesion extending over several vertebral bodies; 2. segmental, one or more separate lesions behind the vertebral bodies; 3. mixed, a combination of the continuous and segmental types; and 4. circumscribed, mainly located posterior to a disc space.

Another widely cited system is the K line classification. The K line *(Figure 2)* was originally described by Fujiyoshi et al. as a straight line connecting the midpoints of the spinal canal at C2 and C7 on a neutral lateral radiograph.[13] A patient is classified as having K (-) line if the OPLL extends beyond the K line and as K (+) line if the OPLL does not.

The diagnosis of DCM requires a careful history and physical examination to identify signs and symptoms of myelopathy and rule out alternative diagnoses; the clinical findings must be correlated with the magnetic resonance findings.[1]

The current literature indicates that 23-54% of patients initially receiving nonoperative treatment require surgical intervention within a mean follow-up of 29-74 months, suggesting that structured nonoperative care does not produce lasting effects.[14] Traditionally, the primary goal of surgical intervention for DCM was to maintain current neurologic status and prevent further deterioration. However, evidence from the last decade suggests that surgical decompression may improve neurological function. To date, the AOSpine CSM North America (CSM-NA)25 and AOSpine CSM International (CSM-I) studies are the largest prospective investigations of clinical outcomes after decompressive surgery for DCM. Both studies demonstrated that surgery significantly improves long-term neurological function (assessed using the mJOA scale and the Nurick grading system), disability (assessed using the NDI), and health-related quality of life.[15]

The central principle of surgical intervention is to relieve mechanical compression on the cervical spinal cord. Additionally, surgery may involve a fusion to rebuild and stabilize the spine and restore cervical alignment. Anterior, posterior, or combined surgical approaches may be used to achieve the goals of surgery. Anterior surgical procedures include anterior cervical discectomy and fusion, anterior cervical corpectomy and fusion, and combined (hybrid) discectomy-corpectomy constructs.[16] Subsequent surgical procedures are usually laminectomy with instrumented fusion and laminoplasty.[17]

We suggest a simple, practical and reproducible classification system based on simple T2-weighted magnetic resonance imaging in sagittal section, where the narrowest diameter of C2-C7 is the one considered for this measurement *(Figure 3)*. We propose that these measurements are always correlated with Nurick, as well as to individualize each patient for their correct treatment.

## MATERIAL AND METHODS

This is an observational, retrospective, transversal and descriptive study, in the period January 01, 2019 to December 31, 2019. Records and studies of cervical magnetic resonance, patients operated on or in cervical surgery protocol for stenotic cervical canal of origin were reviewed. degenerative with or without myelopathy in the spine surgery service, at the ISSEMyM Medical Center, Ecatepec, Mexico State, Mexico. Once the data was collected, a database was structured in the Excel program for Mac 2015, Version 15.13.3 (Microsoft). The qualitative variables were described with distributions of frequencies and percentages; while the quantitative variables used measures of central tendency and dispersion. The results will be presented in tables and graphs for the final research report at this Medical Center. The universe of work was all adult patients with a diagnosis of stenotic cervical canal of degenerative origin with or without myelopathy, operators or undergoing surgery protocol in the Vertebral Column Surgery service of the ISSEMyM Ecatepec Medical Center in the State of Mexico from January 1, 2019 to December 31, 2019. The inclusion criteria for the study were Patients 18 years of age or older, patients who have a cervical magnetic resonance imaging study, diagnosis of degenerative narrow cervical canal, patients operated on or undergoing surgical protocol for degenerative narrow cervical canal, patients with evaluation of the scale Nurick preoperative and postoperative; the exclusion criteria were patients with a stenotic cervical canal of traumatic origin; and the elimination criteria were patients in the non-degenerative cervical spine surgery protocol, patients operated on for the non-degenerative cervical spine. The statistics used were descriptive. The discrete or qualitative variables, which for the present work are presented in frequency and respective percentage. For the contrast of continuous variables, ANOVA (one-way analysis of variance) was applied. To compare the different scales, the t-student parametric contrast statistic was used for independent samples. Data processing was carried out with the statistical package for the social sciences (SPSS Ver.23.0). Statistically significant figures were those associated with a p-value $< 0.05$. Contingency tables and bar graphs are presented in frequency and percentage. As well as histograms of continuous variables and trend line graphs.

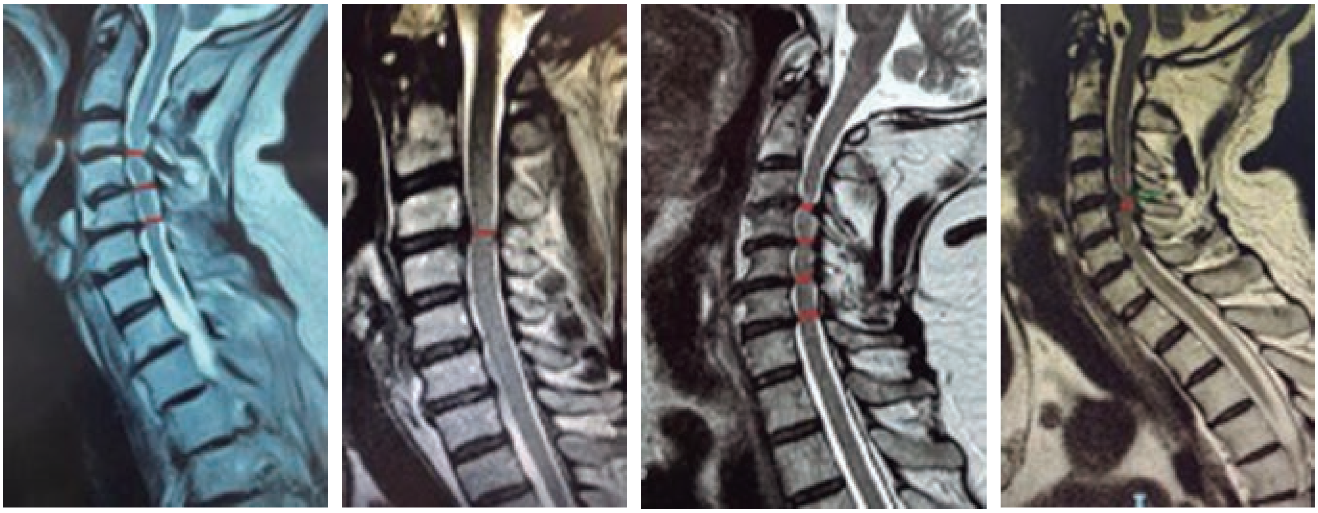


**Figure 3:** Examples of measurement of the cervical spinal canal: simple magnetic resonance imaging of the cervical spine weighted in T2 in sagittal section.

## RESULTS

It is an observational cohort study, in which a review of the records and cervical magnetic resonance studies was carried out at the ISSEMyM Ecatepec Medical Center, patients operated on or undergoing cervical surgery protocol for stenotic cervical canal of degenerative origin with or without Myelopathy. The sampling was for convenience, the study was carried out in a period from January 01, 2019 to December 31, 2019 at the ISSEMyM Ecatepec Medical Center, Mexico. They constituted the total sample (N = 35), whose average age was 56 ± 9.735 years, and according to the Kolmogorov-Smirnov criterion, said variable is normally distributed (statistical = 0.075, df = 335, Sig. = 0.200) *(Figure 4)*.

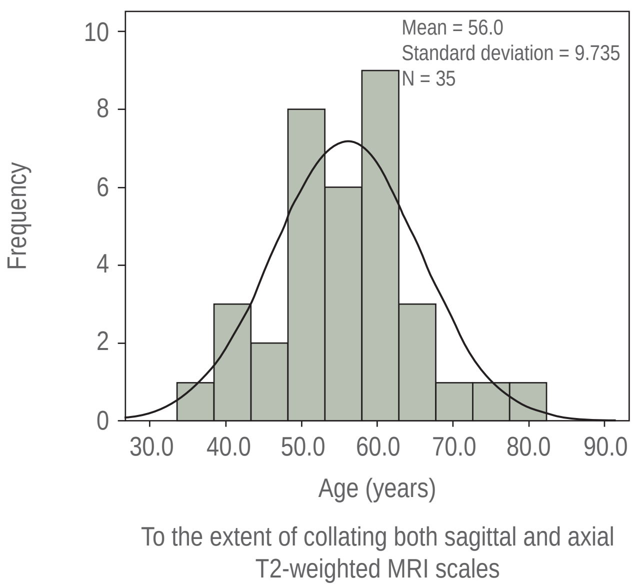



**Figure 4:** Age distribution.
MRI = magnetic resonance imaging.

To the extent of collating both sagittal and axial T2-weighted MRI scales. The correlation statistic (r-Pearson) r = 0.993 was initially executed, obtaining a high value of the coefficient of determination (r2 = 0.987), that is, 98.7% of the data of the variables share variation, the statistical significance is very highly significant ($p < 0.001$) which indicates a relevant change. The values are somewhat similar or similar. In addition, the parametric test statistic for related samples t-Student was used to contrast the average values of both SAGITTAL (mm) and AXIAL (mm) scales, providing a mean difference of -0.302, a small difference, since the ratio indicators 0.2, 0.5 and 0.8 are small medium and large according to methodological indications of the absolute value, in this case the discrepancy is between small and medium. The effect in favor of the SAGITAL (mm) scale is an average value 7.99 ± 0.40 slightly higher than the AXIAL (mm) with 8.29 ± 0.38. (t-Student = -0.542, df = 68, Sig. = 0.590). There is no statistical relevance, which infers that the null hypothetical approach is accepted; the values obtained by both scales are homogeneous. Confidence intervals at 95% are observed.

In an effort to propose a new classification, the grade of the Nurick scale was used, and a one-way analysis of variance (ANOVA) was performed to associate the grade to the scale. (F = 22.263, Sig. = 0.000), being very highly significant ($p < 0.001$) *(Table 2)*.

The modal value for the SAGITTAL scale (mm) was in grade II of "slight difficulty walking" in 11 participants (31.4%), providing an average value of 9.06 ± 0.4 mm.

In a chair or in bed 2 (5.7%) with a mean of 5.47 ± 0.5 mm and 5.82 ± 0.4 mm respectively for SAGITTAL

**Table 2:** ANOVA of SAGITTAL measurements (mm) according to Nurick scale.

| Nurick scale | N | Mean ± standard deviation | F | p |
|---|---|---|---|---|
| Grade | | | 22.263 | 0.000* |
| 0. No evidence of disease | — | — | | |
| I. Without difficulty to walk | 5 | 11.83 ± 0.9 | | |
| II. Light difficulty to walk | 11 | 9.06 ± 0.4 | | |
| III. Difficulty to walk | 8 | 7.25 ± 0.3 | | |
| IV. Needs help to walk | 9 | 5.77 ± 0.2 | | |
| V. Dependent of chair or in bed | 2 | 5.47 ± 0.5 | | |
| Total | 35 | 7.99 ± 0.4 | | |

* Very highly statistically significant ($p < 0.001$).

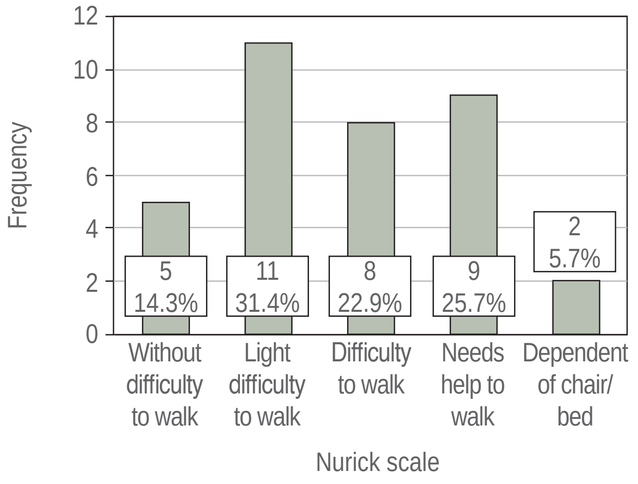



**Figure 5:** Nurick scale frequency.

**Table 3:** SOSA classification.

| | |
|---|---|
| 0 | NCC 18-16 mm without myelopathy |
| 1 | NCC 15-13 mm without myelopathy |
| 2a | NCC 12-11 mm without myelopathy |
| 2b | NCC 12-11 mm with myelopathy |
| 3a | NCC 10-7 mm without myelopathy |
| 3b | NCC 10-7 mm with myelopathy |
| 4 | NCC 6 mm or less with myelopathy |

NCC = Narrow Cervical Canal.

**Table 4:** SOSA + Nurick scale.

| | |
|---|---|
| 1 + N (0) | NCC Mild. Clinical and radiological surveillance |
| 2a + N (0) | NCC Moderate. Moderate risk of myelopathy. Clinical and radiological surveillance |
| 2b + N (I-V) | NCC Moderate. Surgical treatment |
| 3a + N (0) | NCC Severe. High risk of myelopathy. Surgical treatment |
| 3b + N (I-V) | NCC Severe. Urgent surgical treatment |
| 4 + N (I-V) | NCC Critical. Urgent surgical treatment |

NCC = Narrow Cervical Canal. N = Nurick.

(mm). No grade 0 No evidence of disease Nurick scale *(Figure 5)*.

## DISCUSSION

Cervical degenerative disease in the ISSEMyM Ecatepec Medical Center was found in patients of the 6th decade of life, who are still in productive stages both socially and economically, for which it is of the utmost importance to detect in a timely manner the reduction of the spinal canal with or without myelopathy and give targeted treatment for the same. We propose this "SOSA" classification system to measure the cervical spinal canal on a sagittal T2-weighted MRI *(Table 3)*.

Correlate it with the Nurick clinical scale to guide us definitively towards conservative and/or surgical treatment of the cervical spinal canal with or without myelopathy *(Table 4)*.

When analyzing the 35 patients in question with this classification, a SOSA 0 was found: 0 Patients, SOSA 1: 0 patients, SOSA 2a: 5 patients, SOSA 2b: 0 patients, SOSA 3a: 0 patients, SOSA 3b: 19 patients and SOSA 4: 11 patients.

As the Spinal Continent decreases, it directly affects the content, which was clinically represented in our patients with myelopathy and/or radiculopathy.

## CONCLUSIONS

The purpose of this research work was to find a simple way to classify the cervical content-continent and its involvement in myelopathy, with a radiological study and an authorized clinical scale to guide us towards the definitive treatment to follow.

Finding that as the spinal continent decreases, it directly affects the content, which was clinically represented in our patients with myelopathy and/or radiculopathy.

For the choice of the approach route and the type of surgery to be carried out, each patient, number of levels affected and the surgeon's expertise, among others, will have to be individualized. The greater the degree of narrowing of the continent, we find more clinical representation due to myelopathy due to content involvement.

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