



Original Article

Interaction of demographic factors with the results of the surgery for degenerative disease of the cervical spine: a retrospective evaluation[☆]



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ABSTRACT

Objective: Degenerative disease of the cervical spine is a frequent source of intermittent neck pain, where the predominant symptom is axial neck pain. The indications for surgical treatment are reserved for the cases where the conservative treatment has not relieved the symptoms or the patient presents progressive neurological impairment. The objective of this study was to evaluate the prognostic factors involved in patients submitted to surgical treatment of the cervical spine.

Methods: The study analyzed data from patients submitted to cervical spine surgery between July 2011 and November 2015 ($n = 58$). The evaluated data included smoking habits, hypertension, diabetes, overweight, surgical technique, and number of levels of fusion. The primary outcome was defined as pain and the secondary outcomes were quality of life and disability. **Results:** A statistically significant difference was found between baseline and the 12-month post-operative results regarding pain in favor of non-hypertensive patients ($p = 0.009$) and discectomy plus instrumentation ($p = 0.004$). There was also significant difference between the results of neck disability in favor of non-hypertensive patients ($p = 0.028$) and patients with body mass index lower than 25 kg/m^2 ($p = 0.005$). There was no significant interaction between any analyzed data and the quality of life score results.

Conclusions: Non-hypertensive patients, those with body mass index lower than 25 kg/m^2 , and those submitted to discectomy combined with arthrodesis of the cervical spine are the most benefited by cervical degenerative disease surgery.

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Interação dos dados demográficos com os resultados da cirurgia da doença degenerativa da coluna cervical: uma avaliação retrospectiva

R E S U M O

Palavras-chave:

Vértebras cervicais/cirurgia
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Objetivo: A doença degenerativa da coluna cervical é uma fonte frequente de dor cervical intermitente, na qual os sintomas predominantes são dor axial cervical. As indicações para cirurgia são reservadas para os casos de falha do tratamento conservador ou com sintomas neurológicos progressivos. O objetivo deste estudo foi avaliar os fatores prognósticos dos pacientes submetidos ao tratamento cirúrgico da coluna cervical.

Métodos: O estudo avaliou os pacientes submetidos à cirurgia da coluna cervical entre julho de 2011 e novembro de 2015 (n = 58). As variáveis de comparação avaliadas foram tabagismo, hipertensão, diabetes, sobrepeso, técnica cirúrgica aplicada e número de níveis de artrodese. O desfecho primário foi definido como dor e os desfechos secundários foram qualidade de vida e disfunção.

Resultados: Encontramos diferença estatisticamente significativa entre os escores de dor de base e aos 12 meses após a cirurgia, favorável aos pacientes sem hipertensão arterial sistêmica (p=0,009) e aos submetidos à discectomia com instrumentação (p=0,004). Também houve diferença estatisticamente significativa na avaliação da disfunção da coluna cervical: o resultado foi mais favorável para os pacientes sem diagnóstico prévio de hipertensão (p=0,028) e para os pacientes com IMC menor do que 25 kg/m² (p=0,005). Não se observou evidência de interação significativa entre os dados avaliados e os resultados do questionário de qualidade de vida.

Conclusões: Os pacientes não hipertensos, com índice de massa corpórea menor do que 25 kg/cm² e submetidos à artrodese combinada à discectomia, são os mais beneficiados com o procedimento cirúrgico da doença degenerativa da coluna cervical.

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Introduction

The degenerative changes of the spine are anatomical adjustments to the continuous stress of compression and distraction on the spine structures.¹⁻³ During this adaptation process, some tissue changes are remarkable, such as calcification of ligaments and formation of osteophytes. In the cervical spine, osteophytes formed in the end plates and joint faces represent the bone elements that cause compression, whereas disc protrusion, yellow ligament or hypertrophic joint capsules may aggravate or initiate the compression by soft tissues.³ The prevalence of patients with a degenerative disc disease is uncertain, as in an asymptomatic population the presence of radiographic signs of degeneration of the cervical spine can reach 80%.⁴⁻⁶ When symptoms are present, its progression to more severe cases is highly variable and poorly defined.⁷

Degenerative diseases of the cervical spine are frequent causes of intermittent cervical pain in adult and elderly patients, with the predominant symptom being axial cervical pain, which originates from the degeneration of the discs, vertebral plateaus, facet joints or the growth of osteophytes.¹⁻³ Frequently, there is an association with neurological symptoms. Magnetic resonance imaging is indicated for these patients.^{2,8} Most cases of degenerative cervical spine disease, or cervical radiculopathy respond to conservative treatment, which consists of postural advice, changes in daily life activities, cervical immobilizations, isometric exercises and

medication.^{1,2,8} Indications for surgical treatment are reserved for cases in which pain has not been solved with conservative treatment, or when there is progression of neurological deficits.^{1,2,8,9}

Depending on the disease presented by the patient, two principles are sought after through surgical treatment: decompression and fusion (also known as arthrodesis).^{1,2,7,10} Decompression is indicated in cases in which degenerative changes cause direct neural compression. The fusion, on the other hand, is indicated in cases that present instability or loss of mechanical integrity of the cervical spine. This procedure may also have beneficial effects on compressive symptoms, through appropriate distraction applied in the segment, especially in cases where there is foraminal stenosis.^{1,10}

There are questionnaires and scales for the evaluation of pain, dysfunction and quality of life, specific and non-specific, which can be used to evaluate the effectiveness of the treatment. One study evaluated the Visual Analog Scale for Pain (VAS), the Neck Disability Index (NDI), the 12-item Short-Form Health Survey (SF-12) and the EuroQol Health Survey (EQ-5D) for the evaluation of 61 patients with cervical radiculopathy submitted to discectomy and anterior arthrodesis.¹¹ In this study, Parker et al. defined the minimum variations necessary for an important clinical difference between the evaluations.¹¹

Regarding the selection of the appropriate patient for a certain surgical procedure, some predictors of good and poor outcomes are described, including: age, presence of comorbidities, results prior to indication of surgery on quality of

life scales, presence of neurological symptoms, and even psychosocial factors.^{12,13} Anderson et al.¹² concluded that the factors of greater clinical relevance for poor results were the use of preoperative weak analgesics, and the help of some type of financial assistance by the patient due to incapacity caused by the cervical disease. The same study showed that the factors related to good results were advanced age, high preoperative NDI and occupation in profitable jobs.¹³

The objective of this study was to evaluate the prognostic factors of patients submitted to cervical spine surgical treatment.

Material and methods

Study design and setting

This is a cross-sectional study that evaluated the database between July 2011 and November 2015 of patients undergoing surgery for the treatment of cervical spine degenerative diseases in a private quaternary hospital in São Paulo, Brazil. During this period, 90 surgeries were performed to treat cervical spine degenerative disease. The study was sent to and accepted by the Ethics and Research Committee (number 49217515.6.0000.0071).

Inclusion and exclusion criteria

Inclusion criteria: (1) adults of 18 years or above, with indication for surgery of the cervical spine for stenosis, with or without myelopathy or cervical hernia; (2) submitted to surgical treatment; (3) with no contraindication to general anesthesia; (4) with an understanding of the Portuguese language and after accepting a written consent form so to complete the questionnaires.

Exclusion criteria: patients with (1) spine fractures; (2) scoliosis; (3) congenital deformities of the spine; (4) spine tumors; (5) spinal infection; (6) previous surgery on the cervical spine; (7) inability to participate in the follow-up (due to inability to read or complete the required forms).

Patients' demographic data

The following data were collected based on each patient's medical record,

- Age (in years).
- Gender (female or male).
- Weight, height and BMI (in kg, m and kg/m², respectively).
- Previous adjuvant therapies (physiotherapy, acupuncture, hydrotherapy or GPR).
- Previous diagnosis of hypertension.
- Previous diagnosis of diabetes.
- Previous diagnosis of fibromyalgia.
- Smoking or smoking habits.
- Alcoholism or habit of drinking alcoholic beverages.
- Surgical technique applied (simple discectomy or discectomy with fusion).

The data used for analysis and comparison of the results were smoking, hypertension, diabetes, overweight (IMC > 25), clustering (surgical technique applied) and number of levels of fusion.

The sample analyzed consisted of 58 patients submitted to surgery for the treatment of degenerative diseases of the spine. Data from the 32 other patients' records were insufficient for statistical analysis or were not found. One of the patients did not respond to the EVA and NDI questionnaires, so these two variables had a total N of 57 patients. Surgeries occurred between July 2011 and November 2015. The body mass index (BMI) ranged from 20.7 to 42.0 kg/m², with an average of 27.3 kg/m² (SD = 4.60 kg/m²). Most patients (89.7%) underwent cervical fusion surgery. These operations, involving anterior fusion, used at least one plaque, four screws and one cage, two screws and a cage were added for each additional level of fusion. The remaining procedures (10.3%) were simple posterior discectomy, without the need for implants. As for comorbidities and social data, 41.4% were hypertensive, 12.1% were diabetics, 13.8% were smokers, there were no cases of alcoholism or patients with fibromyalgia.

Evaluated outcomes

The primary outcome was pain, assessed by visual analog scale (VAS) ranging from zero to 10 (zero, pain absence and 10 maximum pain).^{14,15} Secondary outcomes were: (1) a quality of life scale was assessed, measured by the questionnaire EQ-5D¹⁶ validated for the Portuguese language¹⁷; (2) the Neck Disability Index¹⁸ validated for the Portuguese language.¹⁹

The visual analog scale used was the numerical one, which ranges from zero to 10, zero being the absence of pain, and 10 the most severe pain. Thus, 1-3 was considered mild pain, 4-6, moderate pain, and 7-10, severe pain.¹⁵

The EQ-5D used was the EQ-5D-3L, which consists of two columns, one of which describes the five dimensions evaluated: (1) mobility; (2) self-care; (3) usual activities; (4) pain/discomfort; (5) anxiety/depression. The second presents the analog scale, consisting of three levels for each dimension, ranging from "no problem to perform" to "disability", associated with a grade of 1-3, respectively.¹⁶ The final result is a sequence of 5 digits, with figures from 1 to 3, which should be analyzed together with a table that shows the respective score results, which can vary from -0.594 to +1 (unit value), to the point that the results lower than or equal to zero indicate significant disability.

NDI consists of 10 sections that assess daily activities and pain. These sections are divided into groups of activities and followed by six statements that express progressive levels of functional disability, with values from 0 to 5. This questionnaire presents good internal and temporal consistency, but may have its reliability questioned in patients who do not drive, because there is a section of questions specifically directed at the act of driving.¹⁸ The final value of this score is a sum of the scores from 0 to 5, given by the patient to each of 10 questions, totaling from 0 to 50 points, and then expressed as a percentage. They range from 0 (no disability) to 100%

(complete disability).^{18,19} In the event that there are questions left blank, the result obtained is divided by the total number of questions answered and then this value is multiplied by 100.¹⁹

The scores obtained during the postoperative follow-up visits were compared with the pre-operative scores, and the variations of at least 2.6 points for the EVA score, 0.24 points for the EQ-5D and 17.3% for NDI were considered clinically significant, as suggested by Parker et al.¹¹

All of the aforementioned outcomes were evaluated pre-operatively and then at 1, 2, 3, 6 and 12 months of follow-up, depending on the attendance and commitment of each patient, which is also described and analyzed.

Statistical analysis

Qualitative variables were described by absolute frequencies and percentages, and the numerical ones by summary measures such as average, standard deviation, median, interquartile range, minimum and maximum values.²⁰

The influence of interest factors in the variation of the score scales throughout the follow-up was evaluated by generalized estimation equation models, considering the correlation between the measurements of the same patient in the different moments of evaluation (preoperative and with 1, 3, 6 and 12 months of follow-up).

The models for the EVA and NDI scales were adjusted with negative binomial distribution, and for the EQ-5D scale the normal distribution was used. Multiple comparisons were corrected by the Bonferroni method.

The results of the models were presented in tables and graphs by adjusted average values and confidence intervals of 95%.

These analyzes were performed with the help of the SPSS software (SPSS Inc. Released 2008. SPSS Statistics for Windows, Version 17.0, Chicago: SPSS Inc.) and a level of significance of 5% was considered.^{21,22}

Results

A model of generalized estimation equations (GEE) was adjusted, considering the evaluations of VAS, NDI and EQ-5D throughout the follow-up and the different demographic states of the patients.

Main outcome – pain visual analogical score (VAS)

There was a statistically significant difference between the pre and postoperative scores at 3, 6 and 12 months in the assessment of the presence or absence of SAH, which was more favorable for patients without previous diagnosis of hypertension ($p = 0.009$), as described in Table 1.

In addition, the average VAS for non-hypertensive patients (4.4 points) compared to the average preoperative values (7.3 points) were also clinically significant, according to the study by Parker et al.,¹¹ which considered the minimum variation of 2.6 points in the VAS. On the other hand, the hypertensive patients varied in average only 1.1 points between the

Table 1 – Estimate averages and confidence interval of 95% for VAS scale scores in pre- and post-evaluations according to the diagnosis of hypertension.

Evaluation	Hypertension	
	No (n=33)	Yes (n=24)
Pre	7.3 [6.4; 8.1]	6.1 [4.8; 7.3]
1 month	2.7 [1.5; 4.0]	4.8 [3.5; 6.2]
3 months	2.3 [1.2; 3.5]	4.4 [3.3; 5.4]
6 months	4.8 [3.6; 5.9]	3.5 [2.1; 4.9]
12 months	4.4 [3.0; 5.8]	5.0 [3.7; 6.3]
Effect of interaction	0.009	

preoperative and the 12-month postoperative evaluation, from 6.1 to 5 points.

There was a statistically significant difference between the pre and postoperative scores at 3, 6 and 12 months in the comparison between the procedures of simple discectomy and discectomy with instrumentation, it was more favorable for patients who underwent discectomy in addition to instrumented fusion ($p = 0.004$), as described in Table 2. This evaluation, however, was not clinically significant, when comparing pre and postoperative averages, according to the minimum variation considered.

No evidence of significant interaction was observed between the following data and the evaluations of EVA throughout the follow-up, that is, there was no evidence that the variation in EVA scores depends on smoking habits ($p = 0.569$), diagnosis of diabetes ($p = 0.076$), overweight with BMI higher than 25 kg/m² ($p = 0.381$), or number of levels of fusion ($p = 0.151$).

Secondary outcome – dysfunction Neck Disability Index (NDI)

There was a statistically significant difference for NDI between pre and postoperative scores at 3, 6 and 12 months in the assessment of the presence or absence of hypertension, it was more favorable for patients without previous diagnosis of hypertension ($p = 0.028$), as described in Table 3.

There was also a statistically significant difference for NDI between the pre and postoperative scores at 3, 6 and 12 months in the evaluation of the presence or not of

Table 2 – Estimate average and confidence interval of 95% for VAS scale scores in pre- and post-evaluations according to the type of surgery.

Evaluation	Clustering	
	Decompression (n=6)	Fusion (n=51)
Pre	5.0 [2.4; 7.6]	6.9 [6.2; 7.7]
1 month	5.1 [3.5; 6.8]	3.6 [2.5; 4.7]
3 months	2.3 [0.3; 4.2]	3.6 [2.7; 4.5]
6 months	2.5 [1.2; 3.7]	4.6 [3.5; 5.6]
12 months	5.2 [3.6; 6.8]	4.5 [3.4; 5.6]
Effect of interaction	0.004	

Table 3 – Estimate average and confidence interval of 95% for VAS scale scores in pre- and post-evaluations according to the diagnosis of hypertension.

Evaluation	Hypertension	
	No (n=33)	Yes (n=24)
Pre	21.2 [17.7; 24.7]	21.7 [18.0; 25.5]
1 month	15.6 [12.1; 19.1]	15.3 [10.4; 20.2]
3 months	11.5 [8.0; 14.9]	17.2 [12.9; 21.6]
6 months	14.6 [10.8; 18.5]	13.0 [9.0; 17.1]
12 months	11.2 [6.7; 15.8]	15.5 [11.5; 19.5]
Effect of interaction	0.028	

Table 4 – Estimate average and confidence interval of 95% for NDI scale scores in pre- and post-operative evaluations according to the level of BMI.

Evaluation	BMI	
	<25 kg/m ² (n=21)	≥25 kg/m ² (n=36)
Pre	19.0 [15.3; 22.7]	22.8 [19.4; 26.2]
1 month	17.4 [14.2; 20.7]	14.1 [10.0; 18.2]
3 months	13.9 [9.9; 18.0]	14.6 [10.8; 18.3]
6 months	15.1 [10.2; 20.0]	13.2 [9.8; 16.7]
12 months	9.8 [5.2; 14.4]	15.1 [10.9; 19.3]
Effect of interaction	0.005	

overweight; it was more favorable for patients with BMI lower than 25 kg/m² ($p=0.005$), as described in Table 4.

The outcomes described above did not reach clinically significant NDI variation according to the study by Parker et al.,¹¹ which should be at least 17.3%.

There was no evidence of significant interaction between the following data and NDI assessments during follow-up, i.e., there is no evidence that variation in NDI scores depends on smoking habits ($p=0.791$), diagnosis of diabetes ($p=0.918$), clustering ($p=0.374$), or number of levels of fusion ($p=0.388$).

Secondary outcome – EuroQol (EQ-5D) questionnaire regarding quality of life

There was no evidence of significant interaction between the data assessed and the results of the EuroQol quality of life questionnaire throughout the follow-up, that is, there was no evidence that the variation in the EuroQol scores depends on the smoking habit ($p=0.115$), diagnosis of diabetes ($p=0.721$), or SAH ($p=0.423$), overweight with BMI over 25 kg/m² ($p=0.444$), clustering ($p=0.087$), or number of levels of fusion ($p=0.884$).

Discussion

In general, surgery for degenerative cervical spine disease by discectomy with or without anterior fusion, apart from the evaluation stratified by demographic data, showed short- and long-term improvement in our evaluation. On the other hand, when the patients were stratified into subgroups, differences

between the outcomes were found, but a greater understanding of the complex physiopathology of the degenerative disc disease is still necessary to find the real causes for these events.

In a recent study, Murray et al. compared the surgical outcomes of patients with degenerative cervical spine, and no differences among the results of the statistical analysis were found in the results for pain or quality of life among the different demographic aspects: gender, age, ethnicity, smoking, BMI, surgical level or previous treatment, which contrast with some results of the present study.²³

The combined analysis of our results with the current literature suggests that surgery for degenerative cervical spine disease has good results in short and long terms but presents statistically significant differences among demographic groups, which may guide the choice of the patient who will have good results and possibly avoid or postpone unnecessary surgery, and patients who will have less significant results in the late postoperative period.

Our study concluded that all patients are benefited to some degree with surgery for degenerative cervical spine disease, but those who are overweight, who undergo simple decompression or who have a previous diagnosis of hypertension are the ones who have the least improvement in pain or quality of life. Other operative techniques under development may further improve this paradigm, but new longitudinal and prospective clinical studies are still necessary to better evaluate the outcomes and possible complications. Current studies show little statistical difference in the outcome of pain or dysfunction when compared to discectomy procedures with fusion, and discectomy with arthroplasty, in order to maintain segment mobility.²³⁻²⁵ New forms of outcome evaluation and questionnaires are also under development and validation to reach increasingly accurate conclusions about subjective and individual data rather than a shallow comparison of radiographic results that may not faithfully express patient satisfaction.²⁶

Study limitations

A weak point of the retrospective studies that should be taken into account is the fact that patients are not randomly selected for each type of treatment, and that there is also no possibility of blinding, which results in non-homogeneous groups. The study sample was relatively small; in addition, many patients did not respond to all questionnaires on their return. Another selection bias is revealed at the level of health care in which the Albert Einstein Israelite Hospital is, attending mostly private or health plan patients, which limits the diversification of cases. Some decisive factors that led to the conduct of the procedure were disregarded by the method, such as presence of instability or preoperative facet arthritis, which would need to be evaluated, for example, from imaging tests and usually indicate anterior cervical fusion.

Virtues of the study

The easy access to the patient's medical records database, anonymously for the patient, with questionnaires previously

filled out by the nursing team, allows us to make adequately safe conclusions to write a historical cohort study such as the present one. The results may help predict better long-term results from demographic data, which should be associated with the surgeon's experience.

Conclusion

In the sample studied, smoking habits, previous diagnosis of diabetes, or the number of levels of fusion do not influence the prognosis of cervical spine surgery, in terms of pain, quality of life and dysfunction. On the other hand, patients with hypertension were less favored in relation to pain and dysfunction. In addition, overweight patients, defined as BMI greater than 25 kg/m², did not achieve a significant improvement in dysfunction as those with BMI lower than 25 kg/cm². Patients who underwent discectomy with fusion had better pain scores after 12 months than those submitted to simple discectomy alone. Therefore, non-hypertensive patients with a BMI lower than 25 kg/cm² and submitted to combined fusion with discectomy seem to be more favored with the surgical procedure for degenerative cervical spine disease.

Conflicts of interest

The authors declare no conflicts of interest.

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