

CORRELATION BETWEEN CERVICAL SAGITTAL ALIGNMENT AND FUNCTIONAL CAPACITY IN CERVICAL SPONDYLOSIS

CORRELAÇÃO ENTRE ALINHAMENTO SAGITAL CERVICAL E CAPACIDADE FUNCIONAL NA ESPONDILOSE CERVICAL

CORRELACIÓN ENTRE ALINEACIÓN SAGITAL CERVICAL Y CAPACIDAD FUNCIONAL EN LA ESPONDILOSIS CERVICAL

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ABSTRACT

Objective: To correlate the radiographic parameters of sagittal cervical alignment with quality of life and functional capacity in patients with cervical spondylosis under conservative treatment. **Methods:** This is an observational and prospective study in patients with cervical spondylosis under conservative treatment and without indication for surgery. The 52 patients included were divided into three groups: axial pain, radiculopathy, and cervical myelopathy. The radiographic parameters considered were cervical lordosis (CL), cervical sagittal vertical axis (CSVA), T1 slope (TS) and the discrepancy between TS and CL (TS-CL). Quality of life and functional capacity were evaluated by the Neck Disability Index (NDI) questionnaire. Pain was assessed by the Visual Analogue Scale (VAS). The correlation between the radiographic parameters and the clinical scores was evaluated by the Pearson correlations coefficient. **Results:** There was no difference in cervical radiographic parameters between the three groups. In the total of the sample, the mean value of the CSVA was 17.8° (±8.3°), CL, 22.4° (± 8.8°); TS, 29.3° (±6.6°), and TS-CL, 7.0° (±7.4°). Significant inverse correlation ($r = -0.3$, $p = 0.039$) was observed between NDI and CL, but there was no significant correlation between CL and VAS. CSVA ($p = 0.541$), TS ($p = 0.287$) and TS-CL ($p = 0.287$) had no significantly correlated with NDI or VAS. **Conclusion:** Considering patients with cervical spondylosis not candidates for surgery, the only sagittal parameter that correlated with functional capacity was LC. In these patients, the correlation between cervical alignment and quality of life needs to be better characterized.

Keywords: Spondylosis; Neck pain; Lordosis; Postural balance; Quality of life.

RESUMO

Objetivo: Correlacionar os parâmetros radiográficos do alinhamento sagital cervical com qualidade de vida e capacidade funcional em pacientes com espondilose cervical em tratamento conservador. **Métodos:** Trata-se de um estudo observacional e prospectivo em pacientes com espondilose cervical e sem indicação de cirurgia. Os 52 pacientes incluídos foram divididos em três grupos: dor axial, radiculopatia e mielopatia cervical. Os parâmetros radiográficos considerados foram lordose cervical (LC), eixo vertical sagital cervical (EVSC), ângulo de inclinação de T1 (AIT1) e discrepância entre inclinação de T1 e lordose cervical (AIT1-LC). A qualidade de vida e a capacidade funcional foram avaliadas por meio do questionário Neck Disability Index (NDI). A dor foi avaliada pela Escala Visual Analógica (EVA). A correlação entre os parâmetros radiográficos e os escores clínicos foi avaliada pelo coeficiente de correlação de Pearson. **Resultados:** Não houve diferença nos parâmetros radiográficos cervicais entre os três grupos. No total da amostra, a média do EVSC foi de 17,8° (± 8,3°); da LC, 22,4° (± 8,8°); do AIT1, 29,3° (± 6,6°) e da AIT1-LC, 7,0° (± 7,4°). Observou-se correlação inversa significativa ($r = -0,3$, $p = 0,039$) entre NDI e LC, mas não houve correlação significativa entre LC e EVA. EVSC ($p = 0,541$), AIT1 ($p = 0,287$) e AIT1-LC ($p = 0,287$) não tiveram correlação significativa com NDI ou EVA. **Conclusão:** Considerando pacientes com espondilose cervical não candidatos à cirurgia, o único parâmetro sagital cervical que se correlacionou com capacidade funcional foi LC. Nesses pacientes, a correlação entre o alinhamento cervical e qualidade de vida precisa ser mais bem caracterizada.

Descritores: Espondilose; Cervicalgia; Lordose; Equilíbrio postural; Qualidade de vida.

RESUMEN

Objetivo: Correlacionar los parámetros radiográficos de la alineación sagital cervical con calidad de vida y capacidad funcional en pacientes con espondilosis cervical en tratamiento conservador. **Métodos:** Se trata de un estudio observacional y prospectivo en pacientes con espondilosis cervical i sin indicación de cirugía. Los 52 pacientes incluídos fueron divididos en tres grupos: dolor axial, radiculopatía y mielopatía cervical. Los parámetros radiográficos considerados fueron lordosis cervical (LC), eje vertical sagital cervical (EVSC), ángulo de inclinación de T1 (AIT1) y discrepancia entre AIT1 y LC (AIT1-LC). La calidad de vida y la capacidad funcional fueron evaluadas mediante el cuestionario Neck Disability Index (NDI). El dolor se evaluó por la Escala Visual Analógica (EVA). La correlación entre los parámetros radiográficos y los escores clínicos fue evaluada por el coeficiente de correlación de Pearson. **Resultados:** No hubo diferencia en los parámetros radiográficos cervicales entre los tres grupos. En la muestra total, la media de EVSC fue de 17,8° (± 8,3°); de LC, 22,4° (± 8,8°); del AIT1, 29,3° (± 6,6°) y de la AIT1-LC, 7,0° (± 7,4°). Se observó una correlación inversa significativa ($r = -0,3$, $p = 0,039$) entre NDI y LC, pero no hubo correlación significativa entre LC y EVA. EVSC ($p = 0,541$), AIT1 ($p = 0,287$) y AIT1-LC ($p = 0,287$) no tuvieron correlación significativa con NDI o EVA. **Conclusión:** Considerando pacientes con espondilosis cervical no candidatos a la cirugía, el único parámetro sagital cervical que se correlacionó con capacidad funcional fue LC. En estos pacientes, la correlación entre la alineación cervical y la calidad de vida debe ser mejor caracterizada.

Descriptores: Espondilosis; Dolor de cuello; Lordosis; Balance postural; Calidad de vida.

Study conducted at the Hospital do Servidor Público Estadual de São Paulo, São Paulo, SP, Brazil.

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INTRODUCTION

The cervical region is the spinal segment with the most mobility, in addition to being responsible for support of the weight of the head, and is susceptible to a series of pathologies associated with significant compromise to quality of life and functional disability.^{1,2} Physiologically, the cervical segment functions in lordosis and changes to this curvature are commonly observed in patients with cervical pathologies.²⁻⁵

Loss of the sagittal alignment of the spine is well-established as a determinant of pain and functional disability in adults.⁶⁻⁸ The correlation between sagittal imbalance, represented by a plumb line from C7 (sagittal vertical axis), and compromised quality of life, represented by worse scores obtained from questionnaires, has been demonstrated by various studies, as well as by better postoperative clinical results obtained when alignment is restored.⁹⁻¹¹ It has also been shown that in addition to the analysis of overall sagittal alignment, i.e., of the sagittal vertical axis, the pelvis plays a fundamental role in spine alignment, functioning as a tool to compensate for the loss of overall sagittal alignment and also correlating with quality of life indicators.^{8,12,13}

Recently, the importance of the sagittal alignment of the cervical segment of the spine has been demonstrated, and that deformity of the cervical spine is associated with pain, functional disability, and even the severity of cervical myelopathy.^{1,2,14-17} Standing out among the radiographic parameters most used to evaluate cervical alignment are cervical lordosis (CL) as defined by the Cobb method, based on lines parallel to the lower terminal plates of C2 and C7;¹⁸ the cervical sagittal vertical axis (cSVA), measured by the perpendicular distance between a plumb line drawn from C2 and the posterior-superior aspect of the vertebral body of C7;² and the discrepancy between the T1 slope (TS) and cervical lordosis (CL), calculated by the arithmetic expression TS-CL, which, according to some authors, acts as the cervical equivalent to the discrepancy between pelvic incidence and lumbar lordosis for the lumbar spine.¹⁹

Even though the correlation between such radiographic parameters of cervical sagittal alignment with quality of life and postoperative outcomes in patients submitted to surgical treatment is well-established,^{15,20,21} there is a scarcity of evidence in the literature of any correlation between cervical sagittal parameters and loss of quality of life or functional disability in patients in conservative treatment. Thus, the objective of this study is to evaluate and correlate radiographic parameters of cervical sagittal alignment with quality of life and functional disability indicators in patients with cervical spondylosis in a conservative outpatient treatment regimen who are not candidates for surgical treatment.

METHODS

This is an observational, prospective study, approved by the Institutional Review Board (IRB) of the responsible service (opinion no. 1.445.245). Participating in the study were patients attended at the outpatient spine pathology clinic of the same service, all having filled out the Informed Consent Form approved by the IRB. Individuals over 18 years of age with a diagnosis of cervical spondylosis undergoing a conservative treatment regime and who were not candidates for surgery were included. Individuals with spinal pathologies other than spondylosis (such as neoplasias, trauma, and congenital deformities), prior spine surgeries, patients with neurological disease, psychiatric conditions that compromise their understanding of the study, and patients who were indicated or opted for surgical treatment of their cervical spine condition were excluded. The patients were divided into three groups by clinical profile: Axial pain, Radiculopathy and Cervical myelopathy.

Lateral total spine radiographs of the patients were taken in a standing position with their eyes fixed on the horizon. Only exams that permitted adequate visualization from the base of the skull to the first thoracic vertebra (T1) were considered. The digitalized images obtained were analyzed using Surgimap Spine software (Nemaris Inc., New York, USA) to measure the following radiographic parameters of cervical sagittal alignment: cervical lordosis (CL), cervical sagittal vertical alignment (cSVA), the angle of inclination of T1 (TS), and the difference between the T1 inclination and the cervical lordosis (TS-CL), as illustrated in Figure 1.

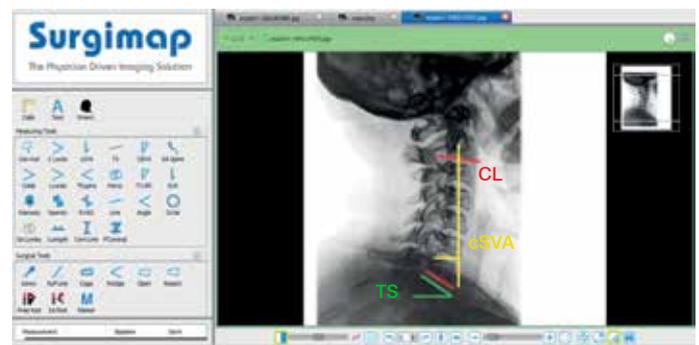


Figure 1. Example of a digitalized image with measurements of the radiographic parameters of interest (cSVA, TS, and CL) using Surgimap Spine software (Nemaris Inc., New York, USA).

Quality of life and disability were evaluated using the Neck disability index (NDI) questionnaire translated and validated for the Portuguese language.²² For the evaluation of the intensity of cervical axial pain, the Visual analog scale (VAS) was used, graded from 0 to 10, where 0 equals the absence of pain and 10 the strongest pain the patient has ever felt.²³

Statistical analysis was performed using STATA 11 SE software. The normality of the variables was tested by the Shapiro-Wilk test and the correlation analysis was tested by calculating the Pearson correlation coefficient. The comparison of the radiographic parameters between the patients with axial pain, radiculopathy, or myelopathy was conducted by means of the ANOVA test. A significance level of 5% was considered, therefore the results with a value of p lower than 0.05 were considered to be statistically significant.

RESULTS

The study included 52 patients with an average age of 60 years, ranging from 24 to 84 years of age with a standard deviation of 12 years. The sample was made up of 38 female patients (73%) and 14 male patients (27%). Of the total number of patients analyzed, 43 (82.7%) were classified as Axial Pain, 3 (5.8%) as Myelopathy, and 6 (11.6%) as Radiculopathy. Taking the total sample into account, the average cSVA was $17.8^\circ (\pm 8.3^\circ)$, the average CL, $22.4^\circ (\pm 8.8^\circ)$; the average TS, $29.3^\circ (\pm 6.6^\circ)$, and the average TS-CL difference, $7.0^\circ (\pm 7.4^\circ)$. Comparing the cervical sagittal alignment parameters in terms of classification by diagnosis, no significant difference was found for any of the parameters studied. (Table 1)

Table 2 shows the study of correlation between the radiographic parameters and the age of the patients of the study. There was a correlation with the cSVA ($r = 0.3$) and the TS ($r = 0.3$), both of them weak, but statistically significant ($p = 0.04$ and $p = 0.03$, respectively) and a moderate statistically significant correlation ($r = 0.04$, $p < 0.001$) with the CL. There was no statistically significant correlation between age and TS-CL. Considering the radiographic cervical sagittal alignment parameters among themselves, there was a moderate correlation ($r = 0.4$, $p = 0.004$) between the cSVA and the TS and between the CL and the TS ($r = 0.6$, $p < 0.001$). (Table 3)

Table 1. Values of the cervical sagittal parameters according to each diagnosis.

	Diagnosis				p
	Average axial pain (SD)	Average myelopathy (SD)	Average radiculopathy (SD)	Average for total sample (SD)	
cSVA (mm)	17.8 (7.8)	21.4 (13.0)	16.7 (10.4)	17.9 (8.17)	0.723
CL (degrees)	22.8 (8.5)	23.7 (13.0)	18.7 (11.9)	21.8 (8.4)	0.296
TS (degrees)	29.0 (6.5)	23.3 (6.7)	29.3 (7.5)	28.7 (6.9)	0.409
TS-CL (degrees)	6.2 (7.1)	10.7 (2.9)	10.7 (10.2)	6.9 (7.5)	0.265

The analysis of the intensity of cervical axial pain in the patients, through the VAS, showed an average of 6.8 (± 2.5), considering the total sample. The study of the correlation of the VAS with the cervical sagittal alignment parameters, illustrated in Table 3, did not show any significant correlation of cervical pain with any radiographic parameter ($p > 0.05$). The average score obtained for the NDI questionnaire, considering the total sample, was 39.1 (± 16.5), ranging from 8 to 84. Table 4 shows the correlation of the NDI score with the radiographic cervical sagittal alignment parameters. There was an inverse correlation of weak intensity ($r = -0.3$), though statistically significant ($p = 0.039$), between the CL and the NDI. (Figure 2) There was no significant correlation between the NDI and any of the other radiographic parameters considered.

Table 2. Correlation of the cervical sagittal parameters with age.

Variable	Age	
	Correlation coefficient (r)	p
cSVA (mm)	0.3	0.04*
CL (degrees)	0.4	<0.001*
TS (degrees)	0.3	0.03*
TS-CL (degrees)	-0.2	0.09

* = values with statistical significance ($p < 0.05$).

Table 3. Values of the correlations (r) between the variables studied.

Variables	Age	cSVA (mm)	CL (degrees)	TS (degrees)	TS-CL (degrees)	EVA	NDI
Age	-	0.3*	0.4*	0.3*	-0.2	0.0	-0.1
cSVA (mm)	0.3*	-	0.1	0.4*	0.2	0.0	0.1
CL (degrees)	0.4*	0.1	-	0.6*	0.0	0.0	-0.3*
TS (degrees)	0.3*	0.4*	0.6*	-	0.2	0.0	-0.2
TS-CL (degrees)	-0.2	0.2	-0.7*	0.2	-	0.0	0.2
VAS	0.0	0.0	0.0	0.0	0.0	-	0.4*
NDI	-0.1	0.1	-0.3*	-0.2	0.2	0.4*	-

* = values with statistical significance ($p < 0.05$).

Table 4. Correlation of the NDI with cervical sagittal parameters.

	NDI	
	Correlation coefficient (r)	p
cSVA (mm)	0.1	0.541
CL (degrees)	-0.3	0.039*
TS (degrees)	-0.2	0.287
TS-CL (degrees)	0.2	0.142

* = values with statistical significance ($p < 0.05$).

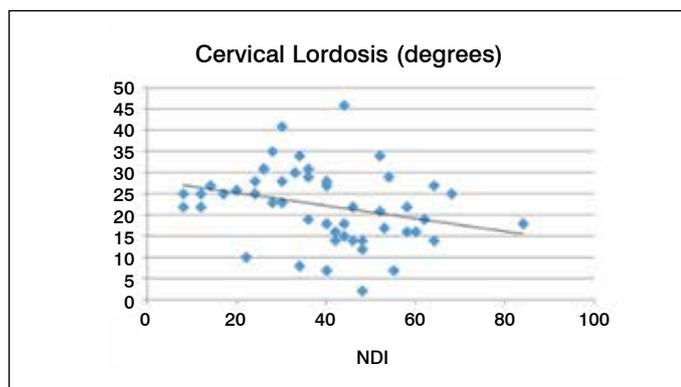


Figure 2. Correlation between the NDI and cervical lordosis.

DISCUSSION

In the past few years, various studies have tried to correlate spinal sagittal alignment parameters to quality of life, both after surgical procedures and in individuals who did not undergo surgery.²⁴⁻²⁶ More recently, there has been an increase in the number of studies demonstrating that there is also an important correlation between the postoperative outcomes of spine interventions and sagittal parameters.^{15,20,27} However, studies that correlate cervical sagittal parameters with quality of life indicators in patients who were not submitted to surgical treatment are extremely rare. This study analyzed the correlation of these radiographic parameters with indicators of quality of life and functional ability in a sample of patients with cervical spondylosis without an indication for surgical treatment or who opted not to undergo surgical treatment.

Tang et al.¹⁵ demonstrated the cSVA as an independent predictor of functional outcomes in patients submitted to posterior spinal arthrodesis. Thereafter, the cSVA was associated with worse severity of cervical myelopathy.¹⁶ In this study, there was no evidence of a correlation between the cSVA and quality of life, although the sample was made up of patients with no indication of surgical treatment or who had opted out of surgery. In addition, only 5.8% of the patients included had a diagnosis of myelopathy.

Our study results showed a significant inverse correlation between the CL and the NDI: the higher the value of the CL, the lower the value obtained from the NDI, i.e., the better the functional ability of the patient. In a recent study, Iyer et al.²⁸ analyzed the correlation between radiographic sagittal alignment parameters and quality of life in the preoperative period in patients awaiting surgical procedure. An inverse correlation was observed between the CL and the NDI, in that an increase in the CL was also associated with lower NDI values, similar to what was observed in our study. However, in their study, Iyer et al.²⁸ divided the patients into two groups – myelopathy and radiculopathy – and there was a significant correlation between the radiographic parameters and the NDI in the patients with myelopathy, but not in the patients with radiculopathy. Again, the vast majority of the patients in our study were classified as suffering from axial pain and radiculopathy (94%), and the minority with myelopathy.

The correlation between the cervical sagittal alignment parameters themselves has been demonstrated in recent studies,^{1,21,29} as well as the role of the cervical-thoracic junction in cervical sagittal alignment, similar to what occurs in alignment of the thoracolumbar spine in correlation to the pelvis.^{2,13} The correlation between the TS and the CL, showing that the amount of CL is influenced by the inclination of the upper plateau of T1 (TS), has been published in the literature^{21,29,30} and was also evident in our study. A significant correlation between the TS and the cSVA was also confirmed, which indicates the important role of the inclination of T1 for all cervical sagittal alignment, as previously demonstrated in the literature.^{2,29,30}

This study also showed the effect of aging on cervical sagittal alignment. As seen in the results obtained, the TS, the CL, and the cSVA tend to increase with age. Yukawa et al.³⁰ published similar results and argued that with age the spine tends to assume positive sagittal alignment, increasing the TS. In order to maintain the ability to look forward, the cervical spine has an increase in the value of cervical lordosis.

The main limitation of this study was the small case series and also the fact that few cases were included (15.3%) that could be classified as patients with “cervical spine deformity”, according to the criteria of the recently published classification system for cervical deformity.³¹ The fact that very few of the patients in the sample did not have indicators for a diagnosis of deformity and that the study only included patients who were not candidates for surgical treatment or who opted for non-surgical treated may suggest that the patients without criteria for deformity are more favorable to non-surgical treatment than patients with cervical spine deformity.

It seems incontestable that cervical alignment is a direct indicator of functional outcomes and of the quality of life following cervical spine arthrodesis and that the existence of a well-established correlation

between radiographic cervical alignment parameters and quality of life has been demonstrated in patients with myelopathy and cervical spine deformity. However, in patients with cervical spondylosis presenting axial pain and radiculopathy, without myelopathy and without deformity, this correlation has not been well-established.

CONCLUSIONS

Considering a sample of patients with cervical spondylosis without indications for surgical treatment or who opted for non-surgical

treatment, the only radiographic cervical spine alignment parameter that was correlated with quality of life was cervical lordosis. In these patients, presenting axial pain and radiculopathy, without myelopathy and without deformity, the correlation between cervical alignment and quality of life need to be better characterized.

All authors declare no potential conflict of interest related to this article.

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