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ANALYSIS OF CERVICAL SAGITTAL BALANCE IN PATIENTS NECK PAIN AND NO NECK PAIN

ANÁLISE DO EQUILÍBRIO SAGITAL CERVICAL EM PACIENTES COM E SEM CERVICALGIA

ANÁLISIS DEL EQUILIBRIO SAGITAL CERVICAL EN PACIENTES CON Y SIN CERVICALGIA

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ABSTRACT

Introduction: Sagittal balance was measured by Hardacker`s et al. using the occipital method COBB C1-C2, C2-C3, C3-C4, C4-C5, C5-C6, C6-C7 in a sample of asymptomatic patients without neck and shoulder pain. In other recent studies, measurements of cervical sagittal balance included several radiographic parameters. Objective: To compare the cervical sagittal balance in groups of patients with and without neck pain submitted to cervical radiography, with the upper limbs in flexion. Methods: This is a cross-sectional, quantitative, prospective, descriptive study with radiographic analysis of 50 adults aged between 30 to 70 years old. The group was divided into Group 1: without neck pain, and Group 2: with neck pain. All answered a questionnaire about age and the presence or absence of neck pain. Exclusion criteria were: inadequate X-Ray image, deformity or previous spine surgery, limited shoulder mobility, and individuals younger than 30 and older than 70. The radiographic parameters evaluated were: COBB, TIA (THORACIC INLET ANGLE), T1 SLOPE, NECKTILT, and COG-C7 with no neck pain. α = 5% (significance when $p < 0.05$). Results: The MANN WHITNEY nonparametric test showed no significant differences between Cobb GROUPS (p= 0.7452), T1 SLOPE GROUPS (p=0.1410), NECKTILT GROUPS (p=0.0852) and GROUPS THORACIC INLET ANGLE (p=0.1789). Conclusion: There was a significant difference only between COG-C7 GROUPS (cm) (p=0.0013). The analysis of the obtained data showed statistical significance in the variation in the COG-C7 groups. ***Level of Evidence II; Prospective comparative study.***

Keywords: Postural balance; Radiography; Neck pain.

RESUMO

Introdução: O equilíbrio sagital foi medido por Hardacker et al. usando o método occipital COBB C1-C2, C2-C3, C3-C4, C4-C5, C5-C6, C6-C7 em uma amostra de pacientes assintomáticos sem dor no pescoço e no ombro. Em outros estudos recentes, as medidas do equilíbrio sagital cervical incluíram vários parâmetros radiográficos. Objetivo: Comparar o equilíbrio sagital cervical em grupos de pacientes com cervicalgia e sem cervicalgia submetidos à radiografia da cervical, com os membros superiores em flexão. Métodos: Trata-se de um estudo transversal, quantitativo, prospectivo, descritivo, com análise radiográfica de 50 adultos, com idade entre 30 e 70 anos. O grupo foi dividido em Grupo 1: sem cervicalgia e Grupo 2: com cervicalgia. Todos responderam a um questionário sobre idade e presença ou não de dor cervical. Os critérios de exclusão foram: imagem inadequada, deformidade ou cirurgia prévia da coluna, mobilidade limitada do ombro e indivíduos com idade inferior a 30 e superior a 70 anos. Os parâmetros radiográficos avaliados foram: COBB, TIA (ANG THORACIC INLET), T1 SLOPE, NECKTILT e COG-C7 com e sem cervicalgia. α = 5% (significância quando $p < 0,05$). Resultados: O teste não paramétrico de MANN WHITNEY não mostrou diferenças significativas entre os GRUPOS Cobb (p= 0,7452), GRUPOS SLOPE T1 (p=0,1410), GRUPOS NECKTILT (p=0,0852) e GRUPOS TIA (p=0,1789). Conclusão: Houve diferença significativa apenas entre os GRUPOS COG-C7 (cm) (p=0,0013). A análise dos dados obtidos demonstrou significância estatística em relação à variação nos grupos COG-C7. ***Nível de evidência II; Estudo comparativo prospectivo.***

Descritores: *Equilíbrio postural; Radiografia; Cervicalgia.*

RESUMEN

Introcucción: El equilibrio sagital fue medido por Hardacker et al. utilizando el método occipital COBB C1-C2, C2-C3, C3-C4, C4-C5, C5-C6, C6-C7 en una muestra de pacientes asintomáticos sin dolor del cuello y hombros. En otros estudios recientes, las mediciones del equilibrio sagital cervical incluyeron varios parámetros radiográficos. Objetivo: Comparar el equilibrio sagital cervical en grupos de pacientes con y sin cervicalgia sometidos a radiografía cervical, con los miembros superiores en flexión. Metodos: Se trata de un estudio transversal, cuantitativo, prospectivo, descriptivo, con análisis radiográfico de 50 adultos, con edades entre 30 y 70 años. El grupo compartió el Grupo 1: Sin dolor del cuello y el Grupo 2: Dolor de cuello. Todos respondieron un cuestionario sobre edad, dolor de cuello o ausencia de dolor

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de cuello. Los criterios de exclusión fueron: imagen inadecuada, deformidad o cirugía previa de columna, movilidad limitada del hombro y menores de 30 años y mayores de 70 años. Los parámetros radiográficos evaluados fueron: Cobb, TIA (ANG TORACIC INLET), T1 SLOPE, NECKTILT y COG-C7 con y sin cervicalgia. α = 5% (significación cuando p < 0,05). Resultados: La prueba no paramétrica de MANN WHITNEY no mostró diferencias significativas entre los GRUPOS COBB (p=0,7452), GRUPOS T1 SLOPE (p=0,1410), GRUPOS NECKTILT (p=0,0852) y GRUPOS ANG TORACIC INLET (p=0,1789). Conclusión: Hubo diferencia significativa solo entre los GRUPOS COG-C7 (cm) (p=0,0013). El análisis de los datos obtenidos mostró significancia estática en relación a la variación en los grupos COG-C7. ***Nivel de Evidencia II; Estudio prospectivo comparativo.***

Descriptores: *Equilibrio postural; Radiografía; Dolor de cuello.*

INTRODUCTION

The sagittal balance and normative parameters of the cervicothoracic junction are established, and its normal parameters can guide the surgical correction of deformities in this vertebral segment.[1] It is based on the alignment between the vertebral segments.[2-4] It is a parameter evaluated by physical and radiographic examination and is an important study of spinal diseases and indications for surgical treatment.

Recently, the importance of cervical sagittal balance has been demonstrated, and its deformity is associated with, for example, pain, functional disability, and even the severity of cervical myelopathy.[3]

Sagittal balance was measured by Hardacker et al.[5] using the COBB C1-C2, C2-C3, C3-C4, C4-C5, C5-C6, C6-C7 occipital method in a sample of asymptomatic patients without complaints of the cervical spine and shoulder pain.[5] In other recent studies, measurements of cervical sagittal balance have included various radiographic parameters. These include the T1 slope or T1 tilt (T1 SLOPE), C1-C2 lordosis, C2-C7, the sagittal vertical axis (SVA), and the C7-T1 slope.[4,6,7]

Lee et al.[4] studied lateral cervical spine radiographs in 77 asymptomatic patients aged 21 to 50. The following parameters were evaluated: (1) thoracic entry parameters: thoracic inlet angle (TIA), T1 slope (T1 SLOPE), and neck tilt (NECKTILT); (2) cervical spine parameters: C2-C7 and C0-C7 angles. Iyer et al.[8] (2016) recruited 120 asymptomatic adults between 18 and 79 years old, excluding people with cervicalgia, and performed a cervical sagittal balance measurement.

The study aims to analyze the parameters used in evaluating cervical sagittal balance in patients with and without cervicalgia who underwent panoramic radiography of the spine in profile with shoulders in flexion. This study is relevant because of the paucity of such analyses in the literature.

METHODS

This is a cross-sectional, quantitative, descriptive, prospective study of radiographic analyses of the cervical spine in profile with the arms elevated horizontally in 90° flexion in a standing position. The subjects were volunteers between 30 and 70 years old who were seen in the Department of Orthopedics and Traumatology from August to October 2020. The study was approved by the CEP (Research Ethics Committee of Faculdades Integradas Fundação Padre Albino), and the approval opinion was registered under number: 34634820900005430, approved on July 08, 2020.

The patients were informed about the study and were free to join. The group signed the Informed Consent Form. They answered the questionnaire regarding age, presence or absence of cervicalgia, and degree of cervical spine pain. Patients who authorized radiographs were included in the study, with full care taken to maintain medical confidentiality. They were ensured similar treatment conditions to the other patients in the service, obtaining neither exclusive benefits nor prejudices in the medical management of their pathologies. In addition, the patients involved in the study consented to the publication of the obtained data and images in a scientific study, provided their identity was preserved.

Pain intensity was analyzed using a Likert scale based on the Visual Analog and Facial Scales.[9] In the study by Lima et al.,[10] pain was stratified into zero (no pain), 1 to 4 (mild pain), 5 to 9 (moderate pain), and 10 (the worst pain). In this study, we standardized the radiographs with the arms elevated in 90° flexion with the elbows extended, both in the standing position and looking forward.[10] The patients were positioned one and a half meters from the collimator, close to the chassis (Figure 1).[10] All images were obtained by a single radiology technician. The study divided the patients into inclusion and exclusion criteria groups (Figure 2).

The Vestatech Hecra D-0005-Toshiba device was used for this study. The angles were measured by goniometer (Figure 3)[10] and evaluated by the authors, and the radiographic parameters considered for the study were:

1. Cervical lordosis (LC) from the COBB method, based on lines parallel to the lower endplates of C2 and C7, measuring in degrees.[11-15]
2. Tilt angle of T1: angle between a tangent line on the upper-end plate of T1 and the horizontal plane, measured in degrees.[11-15]

Figure 1. Lateral cervical spine radiograph, with arms elevated horizontally in 90° orthostatic flexion.[10]

Age range 30 to 70 years	Patients younger than 30 or older than years of age
Patients evaluated from August to October 2020	Know presence of spinal deformity that would make radiological analysis difficult
Patients treat at the HPA	Patients who underwent previous spine surgery
Patients submitted to radiografic study of the spine performed in the radiology department	Technically inadequate radiographs
Technically adequate radiographs	Patients with glenohumeral pain or limitation
Patients who answered the questionnaire	Patients who refused to participate in the research and did not fill out the questionnaire
Patients who signed the informed Consent Form	Patients who after filing out the ICF and the questionnaire desisted from undergoing the examination

Figure 2. Inclusion and exclusion criteria of the study.

3. Thoracic Inlet Angle (TIA): delimited by the body of the first thoracic vertebra toward the manubrium and a straight line perpendicular to the upper limit of the sternal jugular notch and by the first ribs and the upper edge of the first thoracic vertebra.[11-13]
4. The Necktilt angle is defined as an angle between two lines originating in the upper region of the sternum, one vertical and the other connecting the sternum to the center of the T1 endplate.[12,13,15,16]
5. COG is measured using a line perpendicular to the ground and the head's center of gravity. On lateral radiographs, the COG can be measured using the anterior portion of the external auditory pinna as the starting point to the posterosuperior aspect of the vertebral body of C7 measured in millimeters.[12,14,15]

The authors performed the radiographic analyses in an attempt to avoid bias. They are grouped into groups of patients with cervicalgia and without cervicalgia after the questionnaire evaluation answer. Were compared in two groups: Group 1: without cervicalgia and Group 2: with cervicalgia. The variables are COBB, COG-C7, T1 SLOPE= T1 INCLINATION, THORACIC INLET ANGLE (TIA), and NECKTILT. The data obtained in the wo groups have been distributed in Table 1.

A statistical analysis demonstrating Mean, Median, Mode, Standard Deviation, and paired T-test for the difference between the mean, with 5% significance. It used graphs by Boxplot system, which identifies possible variables: the minimum, first quartile (Q1), median, third quartile (Q3), and maximum. For the comparison between groups 1 and 2, significance was considered when ($p<0.05$).

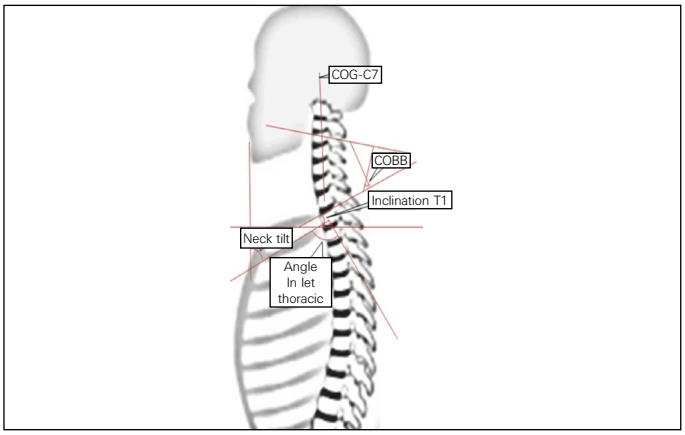

Figure 3. Schematic Angles: COBB, Necktilt, T1 Slope (Inclination T1), Thoracic Inlet Angle, and COG-C7.[10]

RESULTS

Fifty male patients were interviewed. They were distributed into two groups of 25 patients. Group1: No neck pain and Group 2: Neck pain. Then Tables 2, 3, 4, and 5 show the descriptive analysis of the study.

Figures 4, 5, 6, 7, and 8 BoxPlot below refer to angles evaluated neck pain and no neck pain. Com cervicalgia= Neck pain and sem cervicalgia= No neck pain.

The following figure depicts the normality test for quantitative variables of the Sagittal Balance study analyzed No neck pain and Neck pain (Figure 9). Com cervicalgia= Neck pain and sem cervicalgia= No neck pain.

DISCUSSION

The spine is responsible for several functions, which gives it an impressive degree of complexity. Didactically segmented, it can be divided into three major segments, with the cervical segment allowing the integration of the head with the rest of the axial skeleton.[4]

The mobility of the upper limbs and the ability to steady and move the head are directly related to the cervical spine[15] and the structures surrounding it.

Attention has been devoted to the relationships between the occipital region, the vertebral segments of the cervical spine, and the alignment of these structures[17,18] with each other and the spine as a whole. This set of relationships, which can be measured and unfolded in different ways and angulations through specific radiographic examinations, is defined as the sagittal balance of the cervical spine,[6] also described long ago as sagittal balance.[1]

As knowledge has developed regarding the concept of the spine as a set of structures that work uniformly while respecting a balance of forces acting on the vertebral structures to keep the skeleton moving and in balance, more attention has been devoted to the sagittal balance of the spine.[8,11,19]

Initially, the studies focused on a more pronounced knowledge of the lumbosacral region, but the so-called cervical sagittal balance has also demonstrated more modern importance.

Among some of these relationships described are Cervical Lordosis (LC), T1 SLOPE, Thoracic Inlet Angle (TIA), NeckTilt Angle, and COG-C7, and these angulations and measurements are defined as detailed above.[11,13,14]

Several studies have defined a standard for what is considered normal or physiological in these parameters, with publications describing and establishing what relationships are considered "normal". Such relationships are increasingly used in decisions regarding the development of therapies and surgical procedures.[3,17]

Table 1. Statistical description Sagittal balance of patients neck pain and no neck pain. COBB; COG-C7; NECKTILT; THORACIC INLET ANGLE AND T1 SLOPE.

		Mean ± SD.		Minimum Value		Q1		Median		Q3		Maximum Value		
Variable	n	No neck pain	Neck pain	No neck pain	Neck pain	No neck pain	Neck pain	No neck pain	Neck pain	No neck pain	Neck pain	No neck pain	Neck pain	p
COBB (cm)	25	35,44±4,5	34,88±4,9	30	22	32	32	34	34	40	40	42	40	0,7452
COG C0-C7 (cm)	25	11,28±0,9	10,52±0,7	9	9	11	10	11	10	12	11	12	11,5	0,0013*
Neck tilt (cm)	25	39,4±3,3	40,88±3,1	32	32	38	39	40	40	42	43	46	48	0,0852
Thoracic Inlet Angle	25	78,24±6	76,72±4,4	65	70	75	72	80	76	82	81	88	84	0,1789
T1 Slope	25	20,8±2,2	22,24±2,9	16	18	19	20	22	22	22	24	24	28	0,1410

Table 2. Statistical Description: COBB; COG-C7; NECKTILT; THORACIC INLET ANGLE; T1 SLOPE No neck pain.

Variable	Total Count	Mean	St Dey	Minimum	Q1	Median	Q3	Maximum
COBB	25	35,440	491	30,000	32,000	34,000	40,000	42,000
COG-C7 (cm)	25	11,280	0,879	9,000	11,000	11,000	12,000	12,500
Necktilt	25	39,400	3,291	32,000	38,000	40,000	42,000	46,000
Thoracic Inlet Angle	25	78,24	5,99	65,00	75,00	80,00	82,00	88,00
T1 Slope	25	20,800	2,236	16,000	19,000	22,000	22,000	24,000

Table 3. Statistical Description: COBB; COG-C7; NECKTILT; THORACIC INLET ANGLE; T1 SLOPE Neck pain.

Variable	Total Count	Mean	St Dey	Minimum	Q1	Median	Q3	Maximum
COBB	25	34,880	4,868	22,000	32,000	34,000	40,000	40,000
COG-C7 (cm)	25	10,520	0,653	9,000	10,000	10,500	11,000	11,500
Necktilt	25	40,880	3,113	32,000	39,000	40,000	43,000	48,000
Thoracic Inlet Angle	25	76,720	4,430	70,000	72,000	76,000	81,000	84,000
T1 Slope	25	22,240	2,905	18,000	20,000	22,000	24,000	28,000

Table 4. Sagittal balance: COBB; COG-C7; NECKTILT; THORACIC INLET ANGLE; T1 SLOPE Neck pain.

Patients	COBB	COG-C7	Necktilt T	Thoracic Inlet Angle	T1 Slope
1	32	10,5 cm	38	72	18
2	22	9.5 cm	40	74	20
3	32	10,5 cm	38	82	22
4	40	10 cm	40	82	20
5	40	11,5 cm	42	84	22
6	40	10,5 cm	44	72	24
7	38	9 cm	38	72	20
8	34	11 cm	38	78	28
9	32	11 cm	38	80	20
10	40	11,5 cm	32	72	22
11	40	11 cm	40	76	28
12	40	11 cm	44	78	28
13	34	10 cm	48	84	24
14	32	11,5 cm	40	72	24
15	30	10,5 cm	42	72	20
16	40	10,5 cm	44	76	20
17	38	10,5 cm	42	80	22
18	40	11 cm	42	82	20
19	38	11 cm	44	76	22
20	34	10 cm	44	72	22
21	32	10,5 cm	40	76	24
22	28	10 cm	42	70	20
23	36	10 cm	40	82	18
24	30	9.5 cm	40	80	22
25	30	11 cm	42	74	26

Table 5. Sagittal balance: COBB; COG-C7; NECKTILT; THORACIC INLET ANGLE; T1 SLOPE No neck pain.

Patients	COBB	COG-C7	Necktilt T	Thoracic Inlet Angle	T1 Slope
1	30	9 cm	32	88	24
2	32	11 cm	36	68	18
3	34	11,5 cm	38	74	24
4	40	10 cm	44	80	20
5	34	10 cm	46	83	20
6	40	10,5 cm	40	65	24
7	30	11 cm	34	82	22
8	42	10,5 cm	38	76	24
9	32	11 cm	40	78	22
10	42	12 cm	44	84	22
11	34	12,5 cm	40	82	20
12	32	12,5 cm	36	84	22
13	36	11 cm	40	82	22
14	42	12,5 cm	42	78	22
15	34	12 cm	38	82	18
16	38	11 cm	44	82	22
17	30	12 cm	38	72	18
18	40	11 cm	39	82	18
19	40	12 cm	42	82	22
20	42	11 cm	38	68	22
21	38	12 cm	40	78	16
22	30	12 cm	42	76	20
23	32	12 cm	36	68	18
24	32	11 cm	38	82	20
25	30	11 cm	40	80	20

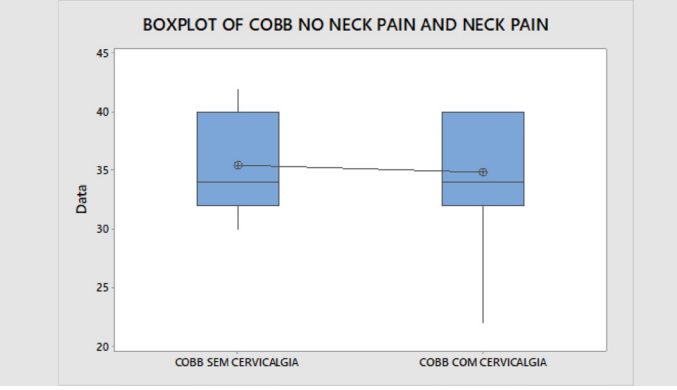

Figure 4. The non-parametric MANN WHITNEY test showed no significant differences between the COBB Neck pain and No neck pain GROUPS (p = 0.7452).

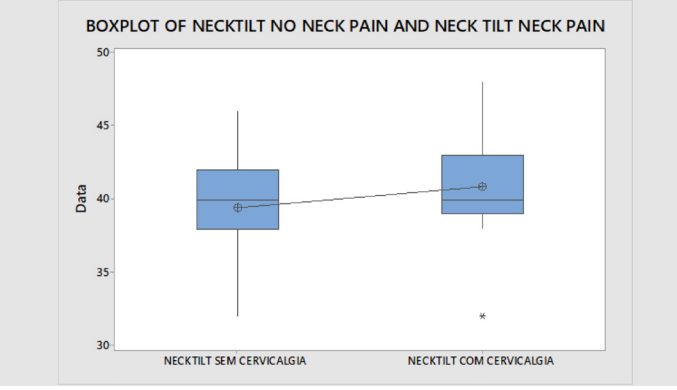

Figure 5. The nonparametric MANN WHITNEY test showed no significant differences between NECKTILT Neck pain and No neck pain GROUPS (p =0.0852).

Back pain is very common in daily clinical practice.[18] The complaint of chronic neck pain is quite common in the office and may reach an incidence of up to 30% of the complaints related to the spine.[4,7] These manifestations are not necessarily related to diseases that cause severe and progressive deformities in the cervical spine.

Since this is a more prolonged pain condition, possible alterations involving the forces to which the cervical spine is subjected can be expected, which could lead to differences between the angular values and measures related to cervical sagittal balance when compared to those evaluated in asymptomatic patients.

In this study, the radiographic examination was performed by the same radiographer to avoid bias. Observing the results obtained in the present study, we verified that the Cobb values found in asymptomatic patients about those who presented complaints of neck pain were not statistically significant, that is, P>0.05, in the various statistical tests analyzed.

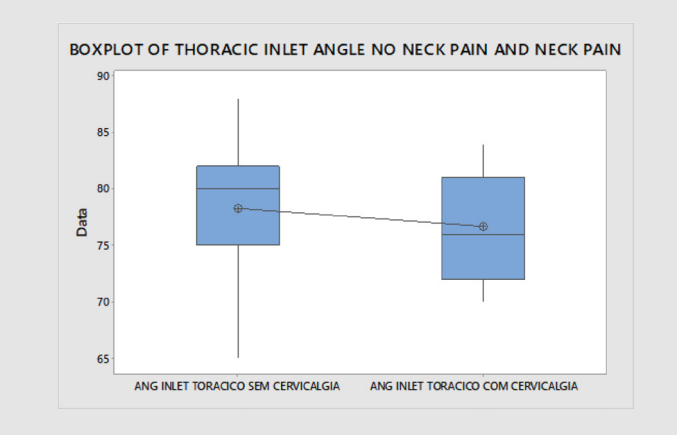

Figure 6. The non-parametric MANN WHITNEY test showed no significant differences between T1 SLOPE Neck pain and No neck pain GROUPS (p =0.1410).

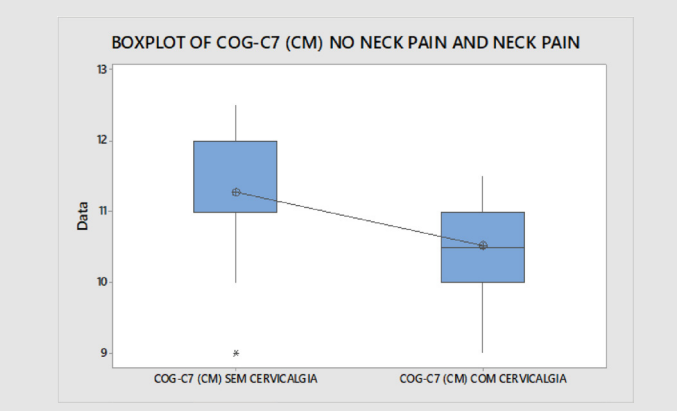

Figure 7. The non-parametric MANN WHITNEY test showed no significant differences between THORACIC INLET ANGLE Neck pain and No neck pain GROUPS.

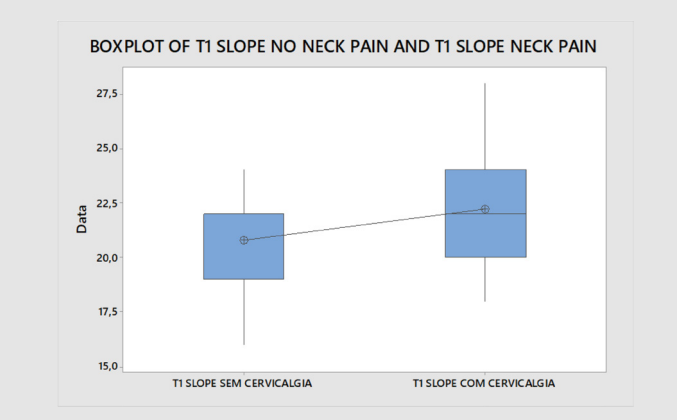

Figure 8. The non-parametric MANN WHITNEY test showed significant differences between COG C0-C7 (cm) No neck pain and Neck pain (p = 0.0013).

According to Been (2017),[15] adequate cervical lordosis is essential for efficient chewing function, breath control, vocal production, and eye movement and serves as part of the shock absorption mechanism during walking and running. The loss of normal cervical curvature may be associated with pain, temporomandibular joint dysfunction, and other disorders.[15,16,19] Thus, changes in Cobb angulation would be expected in patients with cervicalgia, which was not observed in the study in question.

The reciprocal can be questioned despite a well-established relationship of morphological changes in the cervical spine triggering pain. This is because the cervical pain reported in the offices is associated with muscular factors with direct influence from emotional issues, vicious positions, and ergonomic alterations,[16] and not necessarily with morphological alterations of this vertebral segment.[20]

Analogous reasoning can be seen in the analyses of other angle patterns such as T1 SLOPE Angle, Thoracic Inlet Angle (TIA), and NeckTilt Angle. As previously discussed, such measures are often associated with deformities related to diseases affecting the cervical spine and lead to pain. In this case, the exclusion criterion of patients with known spinal deformities may have been responsible for not having a significant angular difference.

However, there was a statistical difference, with important variation in the so-called COG-C7 distance, that is, the distance between the center of gravity of the head and C7. In patients with chronic cervicalgia, the COG-C7 distance was shorter than in asymptomatic patients.

The decrease in this distance can be related to two main factors:
1. Changes are directly seen in the cervical spine, such as degenerative disc changes where disc dehydration processes could lead to such variation;
2. Changes from external elements to the intrinsic structures of the spine, such as exacerbated muscle contracture in this region, which is extremely frequent in patients with chronic neck pain.[20]

The sum of these two situations would often contribute synergistically as an influencing factor in the change of this evaluated parameter. Thus, we verified that the presence of cervical pain, by itself, would not trigger changes in sagittal balance but could be related to changes in COG-C7 measurements.

CONCLUSION

The data analysis showed static significance concerning the variation in the COG-C7 groups, being greater in the group without cervicalgia. This difference does not alter the cervical sagittal balance. Further studies should be carried out to prove this finding. The study showed a limitation in the number of participants due to the pandemic period.

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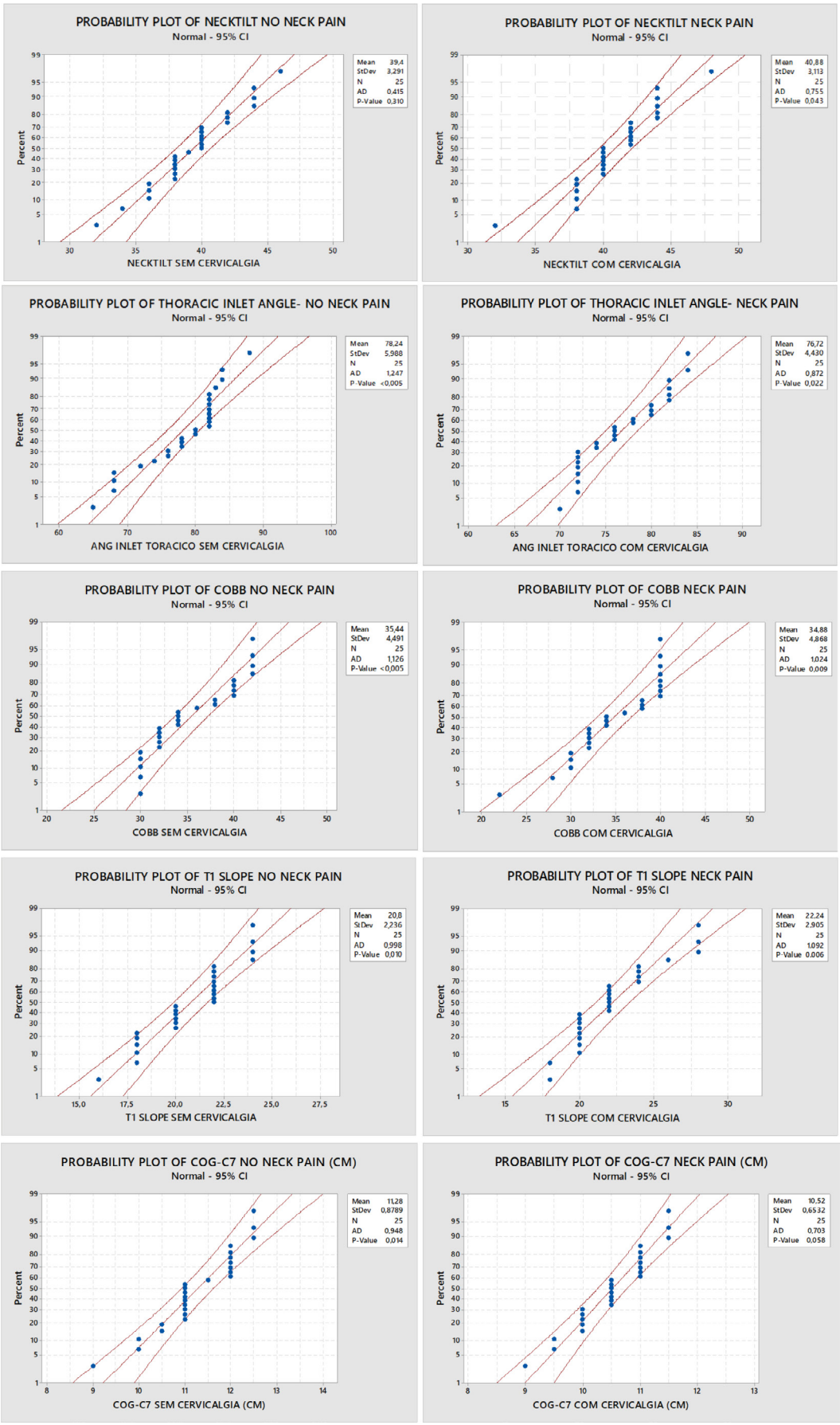

Figure 9. Test of normality for quantitative variables of the Sagittal Balance study analyzed No neck pain and Neck pain.

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