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MEASURING THE DISTANCE BETWEEN STERNOCLAVICULAR JOINT AND HILAR STRUCTURES WITH TOMOGRAPHY

MEDIDA DA DISTÂNCIA DA ARTICULAÇÃO ESTERNOCLAVICULAR AS ESTRUTURAS HILARES POR TOMOGRAFIA

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ABSTRACT

Objectives: To evaluate the tomographic distance between the sternoclavicular joints and the nearest hilar structures. Methods: Computed tomography images (axial and sagittal slices) in 120 healthy individuals (60 men and 60 women) between 18 and 60 years old were prospectively analyzed. The distances from both sternoclavicular joints to the respective brachiocephalic veins, trachea, esophagus, and lung apexes were measured and related to age, sex, and body mass index. Results: Statistically significant differences were found in the distance from the right and left sternoclavicular joint distances and the corresponding brachiocephalic vein, esophagus, and lung apexes. In women, both sides were closer to the noble structures. In patients with body mass index <25, the distances were significantly less than in heavier patients. Conclusion: The left sternoclavicular joint is closer to the hilar structures than the contralateral side. In women, both sternoclavicular joints are closer to the brachiocephalic veins, esophagus, and lung apexes than in men. Patients with body mass index <25 have shorter distances between these joints and the brachiocephalic veins and esophagus. ***Level of Evidence II; Prognostic studies – Investigating the effect of a patient characteristic on the outcome of disease.***

Keywords: Sternoclavicular joint. Anatomy. Tomography.

RESUMO

Objetivos: avaliar a distância tomográfica entre as articulações esternoclaviculares até as estruturas hilares mais próximas. Métodos: foram analisados prospectivamente cortes tomográficos axiais e sagitais em 120 indivíduos hígidos (60 homens e 60 mulheres), entre 18 e 60 anos, sendo mensuradas as distâncias de ambas as articulações esternoclaviculares até as respectivas veias braquiocefálicas, traqueia, esôfago e ápices pulmonares, relacionando-as com idade, gênero e índice de massa corporal. Resultados: houve diferença estatisticamente significativa entre as distâncias da articulação esternoclavicular direita e esquerda até a veia braquiocefálica correspondente, esôfago e ápices pulmonares. Nas mulheres, ambos os lados estavam mais próximos das estruturas nobres. Pacientes com índice de massa corporal <25 as distâncias foram significativamente menores quando comparados a índices superiores. Conclusão: articulação esternoclavicular esquerda está mais próxima às estruturas hilares do que o lado direito. Nas mulheres, as articulações esternoclaviculares bilaterias encontram-se mais próximas das veias braquiocefálicas, esôfago e ápices pulmonares, comparadas aos homens. Pacientes com índice de massa corporal <25 apresentam distâncias menores da articulação até as veias braquiocefálicas e esôfago. ***Nível de Evidência II. Estudos prognósticos – Investigação do efeito de característica de um paciente sobre o desfecho da doença.***

Descritores: *Articulação Esternoclavicular. Anatomia. Tomografia.*

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INTRODUCTION

The proximity of the sternoclavicular joint (SCJ) with noble anatomical structures of the mediastinal thread should be remembered when surgical procedures are proposed in this region. Adequate knowledge of the anatomy and distance between these elements and the SCJ is essential to avoid iatrogenic lesions. Another important factor refers to cases of trauma in the anterior aspect of the thorax. Traumatic SCJ lesions are uncommon but when they occur they may be associated with fatal complications.[1,2] Although serious, fortunately the incidence is less than 3%, generally involving young, economically active young men caused by high energy trauma.[3,4] Traffic accidents and sports injuries account for more than 80% of injuries.[5-7] The increasing number of traffic accidents (especially motorcycles) and the popularization of contact sports such as football, rugby and martial arts , contributed to the increase in incidence in the last decade.[8] Subsequent dislocations correspond to 5% of the dislocations and are more commonly associated with intrathoracic lesions. Early diagnosis and treatment avoid complications and risks to patients. Conventional clinical and radiographic evaluation are important in the initial evaluation,

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however, due to the lack of experience with the incidences and overlap of the mediastinal and thoracic structures, the correct interpretation is usually difficult. Computed tomography (CT) is the exam of choice for the study of SCJ lesions, because of the speed and ease of obtaining it, as well as the better anatomical definition that favors the more accurate diagnosis.[5,6]

The aim of this study was to measure the distances of the hilar structures: right and left brachiocephalic veins (BCV), trachea, esophagus and pulmonary apex, until the SCJ, demonstrating them as a normal parameter of normality. The hypothesis of variation in measures according to side, age, sex and body mass index (BMI) was also raised.

MATERIAL AND METHODS

The study sample was obtained at a private radiology clinic in the city of Curitiba / Pr. (Institute of Advanced Diagnostic Imaging - DAPI). The selection was performed prospectively among patients submitted to CT, with indications of different specialties when investigating other diseases not related to SCJ. Inclusion criteria were: healthy individuals aged between 18 and 60 or investigation of diseases that did not evolve the mediastinum or thorax. Cases with a history of trauma, spontaneous pain or sensitivity in the SCJ, previous radiotherapy, cervical or thoracic surgery, intrathoracic diseases (cancer, chronic bronchitis, emphysema, etc.), rheumatic diseases, peripheral osteoarthritis were excluded. The total selected by the criteria was 120 patients (60 men and 60 women). All volunteers participated in the study and were submitted to informed consent, after approval by the Ethics and Research Committee of Hospital XV, Curitiba / PR (Protocol number: CEXV/002ART/2015). Demographic and anthropometric data were obtained through the corresponding questionnaire. Axial and sagittal images of multi-slice CT were obtained with Siemens Somatom Definition AS tomographs of 64 and 128 channels, with submillimetric cuts of 0.5mm with reconstruction of the images in orthogonal planes with equal quality of the matrix of the image. During the imaging the patients were in apnea after deep inspiration and their arms raised above the head. The body area involved in the tomographic cuts was from the cervical region superiorly to the level of the inferiorly superior renal poles. The mean individual radiation dose was approximately 19 mGy. The images were reconstructed in the transversal plane to measure the distances between the studied structures. (Figure 1). The demarcated references for measurement were the posterior and superior points of the medial extremities of the right and left clavicles, respectively, at the SCJ level, in relation to the corresponding BCV, anterolateral tracheal margin and anterior wall of the esophagus. (Figures 2 and 3) Next, the tomographic data were reconstructed in the sagittal plane, observing the most posterior point of the medial end of the clavicles in relation to the SCJ level and the corresponding pulmonary apex. (Figure 4) The measurements were performed and reviewed separately by two radiologist specialists in the musculoskeletal area. For the analysis

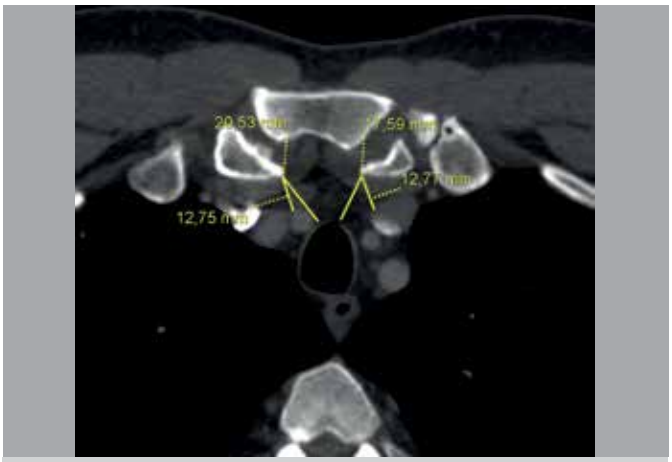

Figure 2. Axial computed tomography image demonstrating measurements of the sternoclavicular joints up to the brachiocephalic veins and trachea.

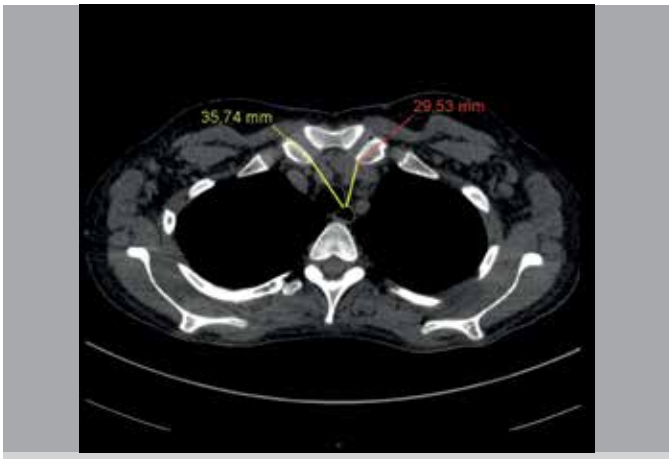

Figure 3. Axial computed tomography image demonstrating measurements of the sternoclavicular joints up to the esophagus.

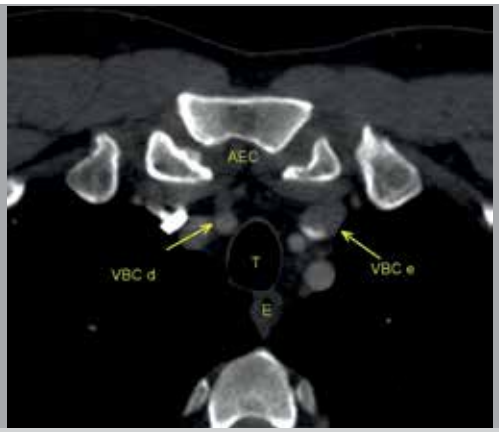

Figure 1. Axial computed tomography image demonstrating the hilar structures (AEC: sternoclavicular joints, VBC d: right brachiocephalic vein, VBC and: left brachiocephalic vein, T: trachea, E: esophagus).

Figure 4. Computed tomography image in sagittal section showing sternoclavicular joint to the pulmonary apex.

of the association between BMI and measures, four groups defined by BMI were considered: ≤ 25; 25.1 to 30; 30.1 to 35 and> 35. The results were submitted to statistical analysis with Statistical software v.8.0, obtaining means, medians, minimum and maximum values and standard deviations. For the comparison between two variables, Student's t-test was used for independent samples. For a group of variables, we used the one-way analysis of variance model and the LSD test for multiple comparisons. Values of p <0.05 indicated statistical significance.

RESULTS

The distances and statistical data are listed in Table 1, showing a significantly higher mean value of the distance between SCJ and right BCV compared to the left side. In relation to the trachea, esophagus and pulmonary apices (Table 2), there was a significantly lower difference between the distance between the left SCJ until esophagus and the right SCJ until the apex. There was no difference in the measurments with respect to age. In the association with gender, mean distance between SCJ and ipsilateral BCV was significantly lower on both sides in women when compared to males. (Table 3) The same has been demonstrated with respect to the esophagus and apex of the lung. (Table 4) There was no difference between genders in the measures between SCJ and trachea. Comparing the different BMIs, individuals with BMI <25 demonstrated significantly lower distances than the others for both SCJ and BCV ratio, especially in relation to left SCJ. Between the trachea and the pulmonary apex there was no difference. The values of distances and statistical comparisons in relation to BMI are shown in Tables 5 and 6, respectively.

Table 1. Measurements of distances (in mm) between sternoclavicular joints to ipsilateral brachiocephalic veins (BCV).

Variable	n	Average	Median	Minimum	Maximum	Standard deviation	p value*
Right BCV	120	10.6	10.4	2.3	24.7	3.5	<0.001**
Left BCV	120	8.1	7.4	2.6	27.1	3.8	<0.001**

* Student's t test for paired samples, p <0.05; ** Statistically significant p value.

Table 2. Measurements of distances (in mm) between the sternoclavicular joints (SCJ) to the trachea, esophagus and ipsilateral apex.

Distances	Right SCJ	Left SCJ	p value*
Trachea	22.2	22.8	0.115
Esophagus	42.8	38.6	<0.001**
Ipsilateral apex	54.9	57.3	<0.001**

* Student's t test for paired samples, p <0.05; ** Statistically significant p value

Table 3. Ratio of distance (in mm) between sternoclavicular joints and ipsilateral brachiocephalic veins (BCV) according to gender.

Variable	Gender	n	Average	Median	Minimum	Maximum	Standard deviation	p value*
Right BCV	Female	60	9.2	9.3	3.8	14.5	2.5	<0.001**
	Male	60	12.2	11.7	2.3	24.7	3.8	<0.001**
Left BCV	Female	60	7.3	6.9	2.6	16	2.8	0.015
	Male	60	9	8	3.5	27.1	4.6	0.015

* Student's t test for paired samples, p <0.05; ** Statistically significant p value.

Table 4. Ratio of distance (in mm) between the sternoclavicular joints (AEC) with the esophagus and ipsilateral apex according to gender.

Variables	Gender	Esophagus		Ipsilateral apex	
		Average	p value*	Average	p value*
Right SCJ	Female	40.6	<0.001**	53.2	0.002**
	Male	45	<0.001**	56.6	0.002**
Left SCJ	Female	37.1	0.003**	54.5	<0.001**
	Male	40.1	0.003**	60.3	<0.001**

* Student's t test for paired samples, p <0.05; ** Statistically significant p value.

Tabela 5. Distância média (em mm) das articulações esternoclaviculares (AEC) em relação às veias braquicefálicas (VBC) e esôfago de acordo com os valores de índice de massa corporal (IMC).

Valores de IMC	AEC e VBC Direita	AEC e VBC Esquerda	AEC e Esôfago Direito	AEC e Esôfago Esquerdo
≤ 25	9.2	6.8	41.1	36.6
25,1 a 30	11.5	9	44.5	39.6
30,1 a 35	11.7	9	43.1	39.6
> 35	12.7	10	43.9	43.2

Table 6. Statistical values comparing the distances between sternoclavicular joints (SCJ) in relation to brachiocephalic veins (BCV) and esophagus according to body mass index (BMI).

BMI values	p value*			
	Right BCV	Left BCV	Right SCJ and Esophagus	Left SCJ and Esophagus
≤ 25 x 25,1 a 30	0.001**	0.006**	0.005**	0.008**
≤ 25 x 30,1 a 35	0.009**	0.040**	0.205	0.040**
≤ 25 x > 35	0.003**	0.015**	0.158	0.001**
25,1 a 30 x 30,1 a 35	0.903	0.959	0.368	0.988
25,1 a 30 x > 35	0.338	0.445	0.747	0.063
30,1 a 35 x > 35	0.442	0.472	0.720	0.098

* Student's t test for paired samples, p <0.05, ** Statistically significant p value.

DISCUSSION

Anatomy in the SCJ region is usually less explored and understood by the orthopedic surgeon, possibly due to the lower number of procedures described and performed in the medial clavicle and SCJ in daily practice, in addition to the proximity to the anatomical retrosternal elements. When necessary, the techniques described require detailed knowledge in this anatomy avoiding the risk of iatrogenic lesions that are often fatal. Some authors recommend including the thoracic surgeon in the surgical team in the SCJ surgeries.[9,10] Another factor related to the possible damages of these structures is related to the posterior dislocation of the SCJ.[15] Fortunately it is infrequent, but by association with high-energy trauma to the chest, it can cause serious injury by its proximity to noble structures. There are few studies in the literature that describe the distance between the SCJ and the hilar elements, which makes it difficult to compare data. CT has been used as the main imaging exam for the diagnosis of SCJ lesions, but there are few studies of anatomical relationships.[5,6] All show BCV as a structure near the SCJ, with a mean distance between 6mm and 7mm, with no difference in relation to the side.[10-12] We found mean values of 8.1mm on the left side and 10.6mm on the right side. In addition to right and left BCV, we include as reference elements the trachea, esophagus and pulmonary apex because they are involved in descriptions of posterior luxation.[1,2,5,6,12,13] Regarding the trachea, the average distance that literature described is 28mm and 31mm, on the right and left side respectively. We had on average 22mm with no difference between the two sides. For the esophagus the mean obtained was 42.8mm on the right and 38.6mm on the left, with significant difference between the sides. We could not compare these values due to lack of data in the literature. The distances found at the apex of the lung were 54.9mm and 57.3mm (right and left side respectively), showing statistical difference in relation to the side. Comparing this data with Ponce et al.[10] Our measurements were much higher (on average they were 7 mm bilaterally) because these authors measured the distance in the axial cut in relation to the pleura and not in the sagittal and apex of the lung. The same authors also had no difference in the measurments regarding sex, age or BMI. There are few articles that compare distances such as age, sex, and BMI. Merriman et al.[14] found differences between

the sexes, with a smaller distance from the medial clavicle to the BCV in females. Regarding these variables, our data demonstrate that the left SCJ is closer to the hilar structures than to the right side; in women both SCJ are closer to the BCV, esophagus and pulmonary apices compared to men; patients with BMI <25 have lower distances up to the BCV and esophagus. Some authors have studied the distance from the SCJ in relation to other structures, such as Lenza et al.[11], recommending a safe distance of 2cm from the superior surface and 1cm from the posterior margin of the joint in relation to the internal jugular vein during surgical access in cadaveric dissection. Variations in relation to our results may have been due to the difference in the methodology used in the other studies. The distances demonstrated by CT suggest greater accuracy because they are obtained in living and healthy individuals, which may vary in cases of cadaveric dissections. On the other hand, during these, data can be modified. Another limitation of this study can be cited by the fact that we did not perform intra- and inter-observer analysis (evaluation of 2 specialists only). The data demonstrated can be followed as anatomical parameters of normality, preventing iatrogenic lesions in the surgical approach of the SCJ. In traumatic cases, especially posterior dislocation of the SCJ, CT is fundamental for the study of possible associated hilar injuries, after clinical evaluation.

CONCLUSION

The anatomical structure closest to the SCJ is the BCV, with a mean distance of 8.1mm on the left side and 10.6mm on the right side. In women, the left ventricle is on average closer to the BCV, esophagus, and pulmonary apexes than in men. Patients with BMI <25 have shorter distances from the SCJ to the BCV and esophagus.

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