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RESEARCH ARTICLE

ANATOMIC POSITION VARIATION OF THE RIGHT INTERNAL JUGULAR VEIN AS DETERMINED BY ULTRASONOGRAPHY: A CLINICAL AND SOCIODEMOGRAPHIC DATA ASSOCIATION

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ABSTRACT

Background: The central venous accesses technique uses a direct visualization puncture. With the advent of the ultrasound (US)-guided puncture, a high variation rate in the anatomical position (AP) of the right internal jugular vein (RIJV) was observed compared to the right common carotid artery (RCCA). **Objective:** This study describes the rate of AP variability in RIJV, compared with previous studies and descriptions. **Methods:** We selected 180 adult patients with diabetes mellitus (DM) and systemic arterial hypertension (SAH), between June and October 2018, for an US evaluation of the AP and diameter of the RIJV and its anatomical corresponding position with the RCCA. **Results-**A higher incidence of anterior lateral position (43%) (p=0.0016) was observed, followed by anterior (31%), lateral (22%) and anterior-internal position (4%). A diameter greater than 11mm in SAH patients (p=0.0011) was also observed (odds ratio 3.80; 95% CI: 1.71 to 8.44). **Conclusions -** The study showed a high variability rate in the RIJV AP as determined by ultrasonography. The larger diameter of the RIJV showed a statistically significant association with SAH.

INTRODUCTION

Central and arterial venous accesses are routine procedures in medical centers; traditionally they are performed using a puncture technique by direct visualization; this procedure may sometimes cause mechanical complications. With the advent of the US-guided technique, anatomical position (AP) variability has become an important factor. Medical procedures, such as hemodialysis, hemodynamic monitoring, vasoactive drugs, plasmapheresis, biopsies and pacemaker implantation, are performed through this venous access.[1] The publications show that the formation of the jugular veins are continuity of the cerebral venous sinuses, determining the formation of the right internal jugular vein (RIJV) in a lateral external position in relation to the right common carotid artery (RCCA).[2,3,4] The success of the traditional venipuncture procedure requires: extensive knowledge of anatomy; a good clinical examination; correct position of the patient, as well as the application of the anatomical parameters of the Sedillot's Triangle, which sides are formed by a bottom line corresponding to the clavicular surface and the other two sides are formed by the medial and lateral portions of the sternocleidomastoid muscle.[5,6] Preliminary studies report that the AP of the RIJV may vary in 57% of the cases described.[7] In relation to the RCCA, the RIJV may be in an anterolateral, anterior incomplete or anterior position in 54% of the cases.[8] An anterolateral position has been reported in 84% of the cases, and a lateral position in 14.2%of the cases.[9] Turba UC reported the same anterolateral AP in 71% of the cases.[10]

The effectiveness of the procedure under review -US-guided puncture -with the description of the vascular anatomy and the variations of the AP has been demonstrated (figure 1), indicating decreased cannulation time and mechanical complications.[11] In recent years, interest in understanding ultrasonography and its benefits described in clinical trials, such as gains in the procedure quality and patient safety as recommended by medical societies, has grown.[12,13,14] This investigation aims to present evidence of the variability of the AP of the RIJV, verified by US, comparing with results from previous publications and association with clinical and sociodemographic variables.

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MATERIALSAND METHODS

Study Design and Participants: An observational, descriptive, prospective study and convenience sample. A total of 180 adult patients were selected in an outpatient clinic in the city of São José dos Campos - São Paulo. This study was previously approved by the Comitê de Ética em Pesquisa da Pontifícia Universidade Católica de Campinas, opinion number: 2.968.807, in 10/18/2018. The patients were identified by name, age, gender, ethnicity, classified according to the 2010 IBGE data[15], comorbidities like: Diabetes Mellitus (DM), Systemic Arterial Hypertension (SAH),and AP, diameter of the RIJV by US. To enter the study, all patients fulfilled the following inclusion criteria: as over 18 years of age, of both genders, could present comorbidities of DM and SAH with the ability to walk. Exclusion criterion were any surgical procedures in the region neck, head and neck neoplasms, dialysis replacement therapy with a Shilley catheter, radiotherapy in the neck region, thyroid biopsy puncture, previous puncture of double lumen catheter and restrictive pulmonary pathologies. All patients signed written informed consent, and the study was conducted according to the Declaration of Helsinki.

US Examination: The US examination was performed by a clinical experienced in intensive care medicine, which performs guided US, to invasive procedures in your clinical practice. The US equipment was a GE Healthcare VSCAN US Dual probe model 2017, ANVISA Registration No: 80071260342), using an 8 MHz linear transducer. The patient was placed in the supine position, setting as reference the cricoid cartilage, drawing an imaginary horizontal line, to assess the anatomical positioning of the RIJV, with reference to the RCCA, in the anatomical region of the Sedillot's Triangle and echographically, to find out if the topography of the jugular vein was correct, through the probe in transversal positioning, the color Doppler was used and the jugular vein was lightly compressed, since the carotid artery is not compressible. The US examination result was showed to the patient and recorded in the machine, as well as in an external recording system.

Statistical Analyses: A descriptive analyzes of categorical variables were performed through the relative and absolute frequencies. The age variable was described both continuously and mean and standard deviation, categorically. The association between the result of the sociodemographic variables (age, gender and race), clinics (comorbidities), AP and diameter of the VJID by the US were evaluated by Fisher's exact test, as well as performed logistic regression models for each variable and multiple logistic regression model, adjusted for age, respectively. The level of significance (α) adopted was 0.05, considering as significant *p* values ≤0.05. The analysis was performed using the SAS® Studio software version 3.8.

RESULTS

The patients presented a mean age of 51.3±17.6 years, the majority being men (50.5%) and caucasian (55.6%);SAH prevalence was 47.2% and DM was 11.1%, as shown in Table 1. The AP of the RIJV classified by US showed a higher incidence in the anterolateral position, with n equal to 78 (43.33%), followed by the anterior position, with n equal to 56 (31.11%), lateral position, with n equal to 39 (21.67%) and medial anterior position, with n equal to 7(3.89%) (figure 2).

Table 1. Sociodemographic and comorbidities characteristics of the patients assessed

Characteristics	n	%
Age Range (years)		
< 30	26	14.4
30-39	29	16.1
40-49	34	18.9
50-59	27	15.0
60-69	28	15.6
≥ 70	36	20.0
Gender		
Male	91	50.5
Female	89	49.5
Ethnicity		
Caucasian	100	55.6
Mulatto	41	22.8
Black	34	18.9
Other	5	2.8
SAH		
Yes	85	47.2
No	95	52.8
DM		
Yes	20	11.1
No	160	88.9

Legends: Diabetes Mellitus (DM); Systemic Arterial Hypertension (SAH)

Table 2. Comparisons between sociodemographic, clinical and US variables

Characteristics	Antero lateral	Anterior	Lateral	Medial anterior	
	n (%)	n (%)	n (%)	n (%)	*p*value*
Age Range (years)					
< 30	15 (19.2)	4 (7.1)	7 (18.0)	0 (0.0)	0.0173
30-39	18 (23.1)	5 (8.9)	6 (15.4)	0 (0.0)	
40-49	16 (20.5)	11(19.6)	7 (18.0)	0 (0.0)	
50-59	9 (11.5)	7 (12.5)	10 (25.6)	1 (14.3)	
60-69	10 (12.8)	12 (21.4)	3 (7.7)	3 (42.9)	
≥ 70	10 (12.8)	17(30.4)	6 (15.4)	3 (42.9)	
Gender					
Male	41 (52. 6)	26 (46.4)	22 (56.4)	2 (28.6)	0.5047
Female	37 (47.4)	30 (53.6)	17 (43.6)	5 (71.4)	
Ethnicity					
Caucasian	40 (51.3)	31 (55.4)	24 (61.5)	5 (71.4)	0.4377
Mulatto	17 (21.8)	15 (26.8)	8 (20.5)	1 (14.3)	
Black	19 (24.4)	10 (17.9)	4 (10.3)	1 (14.3)	
Other	2 (2.6)	0 (0.0)	3 (7.7)	0 (0.0)	
SAH					
Yes	29 (37.2)	37(66.1)	13 (33.3)	6 (85.7)	0.0003
No	49 (62.8)	19(33.9)	26 (66.7)	1 (14.3)	
DM					
Yes	6 (7.7)	6 (10.7)	6 (15.4)	2 (28.6)	0.2190
No	72 (92.3)	50 89.3)	33 (84.6)	5 (71.4)	

Legends: Diabetes Mellitus (DM); Systemic Arterial Hypertension (SAH)
* Fisher's Exact Test.

Table 3. Comparisons between sociodemographic, clinical characteristics and diameter of the RIJV

Characteristics	Right internal jugular vein diameter <= 11 mm n (%)	>11 mm n (%)	p-value*
Age Range (years)			
< 30	20 (22.5)	6 (6.6)	<0.001
30-39	20 (22.5)	9 (9.9)	
40-49	20 (22.5)	14 (15.4)	
50-59	12 (13.5)	15 (16.5)	
60-69	9 (10.1)	19 (20.9)	
≥ 70	8 (9.0)	28 (30.8)	
Gender			
Male	42 (47.2)	49 (53.9)	0.4561
Female	47 (52.8)	42 (46.2)	
Ethnicity			
Caucasian	48 (53.9)	52 (57.1)	0.3199
Mulatto	17 (19.1)	24 (26.4)	
Black	21 (23.6)	13 (14.3)	
Other	3 (3.4)	2 (2.2)	
SAH			
Yes	22 (24.7)	63 (69.3)	<0.0001
No	67 (75.3)	28 (30.8)	
DM			
Yes	6 (6.7)	14 (15.4)	0.0954
No	83 (93.3)	77 (84.6)	
RIJV - AP			
Anterolateral	42 (47.2)	36 (39.6)	0.0016
Anterior	18 (20.2)	38 (41.8)	
Lateral	27 (30.3)	12 (13.2)	
Medial anterior	2 (2.3)	5 (5.5)	

Legends: Diabetes Mellitus (DM); Systemic Arterial Hypertension (SAH); Anatomical Position (AP) and right internal jugular vein (RIJV). * Fisher's Exact Test.

Table 4. Logistic regression analysis considering the Systemic Arterial Hypertension as an outcome

Characteristics						
	OR_1*	95% CI	p-value	OR_2**	95% CI	p-value
Gender						
Male	2.17	1.00-4.71	0.0507	2.42	1.06-5.51	0.0355
Female	1.00	-		1.00	-	
Ethnicity						
Caucasian	0.56	0.20-1.57	0.2912			
Mulatto	0.85	0.27-2.75				
Black	1.00	-				
Other	5.52	0.35-88.25				
RIJV - AP						
Anterolateral	1.67	0.59-4.63	0.1945			
Anterior	3.19	1.08-9.41				
Lateral	1.00	-				
Medial anterior	2.57	0.24-27.89				
RIJV Diameter						
>11mm	3.80	1.71-8.44	0.0011	4.09	1.80-5.51	0.0008
<=11mm	1.00	-		1.00	-	

Legend: Right internal jugular vein (RIJV) and Anatomical Position (AP). OR=Odds ratio 95% CI = 95% Confidence Interval
* Logistic regression models for each variable, adjusted for age ** Multiple logistic regression model, adjusted for age

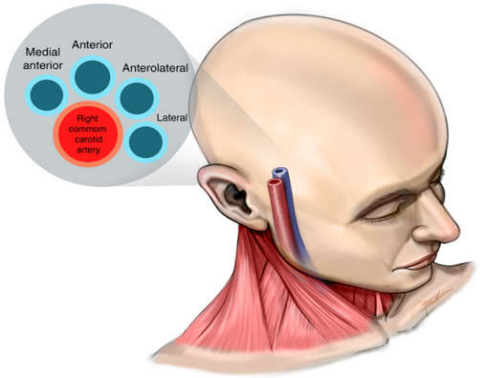
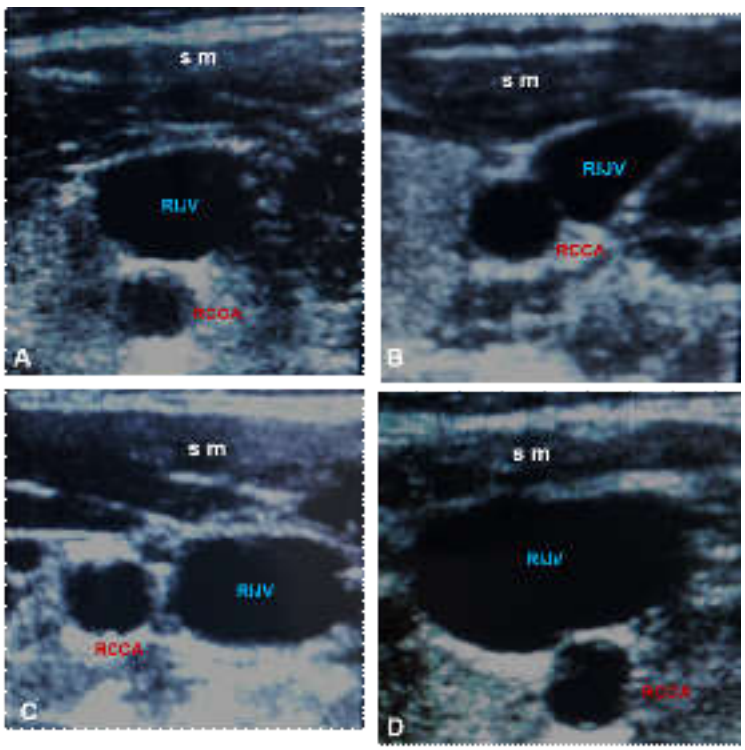


Figure 1 – The anatomical position variation of the RIJV in relation to the position of the ACCD (Author's picture publications).



Legends: Sternocleidomastoid muscle (s m); rigth common carotid artery (RCCA) and right internal jugular vein (RIJV).

Figure 2 – The anatomic position variation of the right internal jugular vein determined by ultrasonography: A. Anterior position; B. Anterolateral position; C. Lateral position and D. Medial anterior position

Comparisons of patients' sociodemographic and clinical characteristics showed a higher percentage of younger patients exhibiting anterolateral and lateral anatomical positions, when compared to patients with anterior and medial anterior positions (p=0.0173). A higher percentage of hypertension cases was also observed in patients with medial anterior and anterior positions (p=0.003). These data are reported in Table 2. All variables were compared with the diameter of the RIJV and it was observed that there was an association with age, SAH and AP. These data are reported in table 3. The logistic regression model was applied with SAH as the outcome, adjusted for age, with each of the variables. This association is shown in Table 2, SAH when adjusted for age, had also an association with the vein AP. However, it was found that age is "more important" than SAH in this association. Nevertheless, the variable "gender" and the diameter showed a highly significant association with SAH, odds ratio 3.80; 95% CI: 1.71 to 8.44. In order to confirm the commitment between this variable, the multiple model was applied, considering age, gender and diameter; their results are organized and shown in Table 4. It was confirmed that the association remained.

DISCUSSION

The description of the lateral AP of the RIJV in relation to RCCA on the same side has been described by many authors.[2,3,4] In recent years, several publications have described the variation in the AP of the RIJV, reaching the percentage of 75% of the cases. Within this percentage, the highest incidence is the anterolateral position occurring in 54% of the cases.[8] Other authors describe the position of the RIJV with a higher incidence in the anterolateral AP in 71% of the cases, [10] higher than the rate described in our graphic. There are also reports of anterior and anterolateral AP of the RIJV in 75% of the cases.[7] However, Shoja et al [9] found an anterolateral AP in 84% of the cases, the highest incidence observed in the literature. A greater incidence of the anterolateral position in an older group has been described by Troianos et al [8], Umaña et al. [7] The use and application of deep venous access is a routine practice in emergency centers and intensive care units according to Araujo [1]Turba et al [10]; Saugel et al [13]. The Seldinger puncture technique is widely used; however, it may cause mechanical and infectious complications with the central catheter Saugel et al [13]. US-guided puncture has shown benefits, when compared with the traditional technique causing less complications, having a direct relationship with a decrease in the number of puncture attempts and in the total procedure time, according to a prospective study by Karlova et al. [12]

We found that these publications describe the great variability of the RIJV position to the detriment of the lateral position. This condition, as will be seen hereafter, has a relevant impact on the complications of non-US guided punctures.[16] The results obtained in this descriptive study account for an AP variation of up to 78% of the cases. The positions with the highest incidence included: 41% of the cases with anterolateral AP; 31% with anterior AP, 4% with medial anterior AP, and 22% with the lateral AP (Table 3). These results are compatible with those found in the literature. According to Ma et al [17] and Asariet al [18] the mean RIJV diameter is 11mm for measurements of both the anteroposterior and lateral-lateral diameter. In this study, patients were divided into two groups, one with a RIJV diameter smaller than or equal to 11 mm and the other group with a RIJV diameter larger than 11 mm.

A significant association was found between the diameter of the RIJV, and gender, age, SAH and AP (Table 3). When the logistic regression model is applied (Table 4) with the SAH outcome adjusted for age, using each of the variables, it was found that the association seen in Table 3 (SAH and AP) when adjusted for age is no longer statistically significant. However, the gender and diameter, both adjusted for age, showed an association with SAH. Thus the multiple model was applied, considering the age, gender and the larger jugular diameter; this association remained with statistically significant relevance. Valecchi et al [19] described a RIJV diameter larger than 11mm in patients aged over 66 years, without any association with SAH, because it was a sample of healthy individuals. However, this study showed association of a RIJV diameter larger than 11 mm with age above 70 and in patients with SAH. As a complement to these results, further studies are suggested to better understand the association of the RIJV with a diameter greater than 11 mm and SAH, as well as its relationship with other cardiovascular and neurological pathologies such as dementia and syncope.

Conclusion

We conclude that a better understanding and description of the variation in the AP of the RIJV in the elderly by US technique, with the availability of the proper equipment in the reference institutions, as well as the training of medical professionals, will allow a reduction of the complications resulting from this procedure blindly. This study had limitations because it is an outpatient population, while most of the literature reviewed has samples of patients with different pathologies, hospitalized or just admitted to hospital.

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