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Is there a correlation between hand preference and vertebral - subclavian artery diameter and vertebral artery flow volume?

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ABSTRACT

Aim: During diagnostic and therapeutic cerebral angiographic studies, the prediction of the dominant vertebral artery side is highly important. The reason for right and left vertebral artery diameter asymmetry is not clear. We believe there may be a correlation between hand preference and vertebral artery flow volume dominance and subclavian artery diameter.

Material and Methods: A total of 112 patients were included in this study. We examined 14 left-handed and 98 right-handed individuals. Ultrasonographic measurements of the vertebral arteries were performed with 7,5 Mhz linear probing between the fifth and sixth cervical vertebrae at each side. Vertebral artery diameter and volume flow and subclavian artery diameters were measured and average values recorded. Normality analysis was conducted by one-sample Kolmogorov-Smirnov testing. The paired-sample t-test was applied to compare the left and right side measures.

Results: There were no significant differences in the diameter or volume flow of the right and left vertebral arteries (VA) between right- and left-handed individuals ($p>0.05$). Beside this, no significant difference was found in the diameter of either the subclavian artery between right- and left-handed individuals ($p<0.47$) (Table2).

Conclusion: We found no correlation between differences in vertebral artery diameter and hand preference. Further, there was no correlation between differences in right and left vertebral artery volume flow or hand preference, either. Novel and comprehensive research is necessary to determine the reason and mechanism of vertebral artery diameter asymmetry.

Key words: *Hand preference, vertebral artery, subclavian artery, Doppler ultrasonography*

Introduction

The total hindbrain blood is supplied by both the left and right vertebral arteries (VA) [1,2]. When hemodynamic status changes, the cerebellum, brain stem, inner air and spinal cord can be damaged. The VA is mainly examined by Doppler ultrasonography and its lumen diameter, mean blood flow velocity, flow direction, and blood flow volume can be measured [3]. However, up to now, digital subtraction angiography (DSA) is still the gold standard modality for VA imaging. The differences of right and left VA diameter have been studied extensively and postmortem, angiographic and sonographic studies have demonstrated that the left side diameter is most often larger than the right side [4-6]. Knowledge of VA dominancy can be vital for making decision regarding certain interventional

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procedures that necessitate sacrificing the subclavian or VA. The reason for right and left VA diameter asymmetry is not clear. Zaina et al. reported that theories of embryological formation and vascular requirements of the brain have been put forward without evidence [7].

Hand preference is one of the most emerged behavioral asymmetry examples in humans. There are speculative ideas for why there is a difference in hand preference, though it may be corrected with asymmetry in cerebral blood flow [8].

We believe that there may be a correlation between hand preference and VA dominance. In the literature, there is only one article that has investigated the dominant VA in left- and right-handed populations [9]. The authors measured the diameter of both VAs but did not calculate the blood volume of them for each of their groups. Therefore, the goal of this study was to demonstrate possible correlations between VA dominance in right-handed and left-handed healthy humans by measuring the diameter and VA blood volumes. Beside this, we also made a comparison of subclavian artery diameters for each group to evaluate the possible correlations with hand preference.

Materials and Methods

We reviewed Doppler ultrasonography imaging studies of 256 patients from September 2015 to December 2015 for evaluation of diameter and volume flow differences in VAs and the diameter of subclavian arteries. We asked the patient to state their hand preference. We excluded patients featuring occlusion and narrowing of the mentioned vessels. The patients that we could not reach and enquire about hand preference to were also excluded from the study. Thus, a total of 112 individuals were included in the study. The patients were placed in the supine position with the head in the neutral position. A GE Logiq 6 sonography device (LOGIQ Ultrasound Products GE Healthcare, United States) was used for the examination. The measurements were performed with a 7,5 Mhz linear probe (LOGIQ Ultrasound Products GE Healthcare, United States) between the fifth and sixth cervical vertebrae at each side. The subclavian artery was measured on the visible side of the origin for both sides. VA diameter and volume flow and subclavian artery diameter was measured by two different radiologists and average values were recorded. The sample imaging of VA diameter with gray scale and color Doppler ultrasonography can be seen in Figures 1 and 2. In the current literature, we have found numerous different diameter criteria to establish the dominant VA. We established our VA

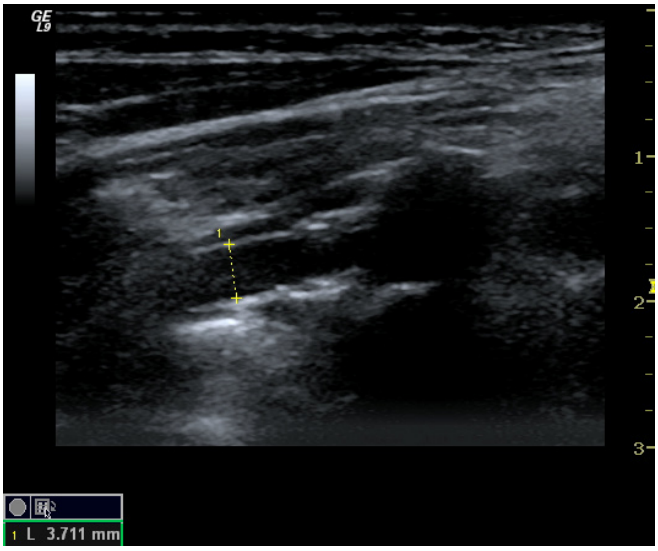

Figure 1. Gray-scale ultrasonographic imaging of left VA between fifth and sixth cervical vertebrae.

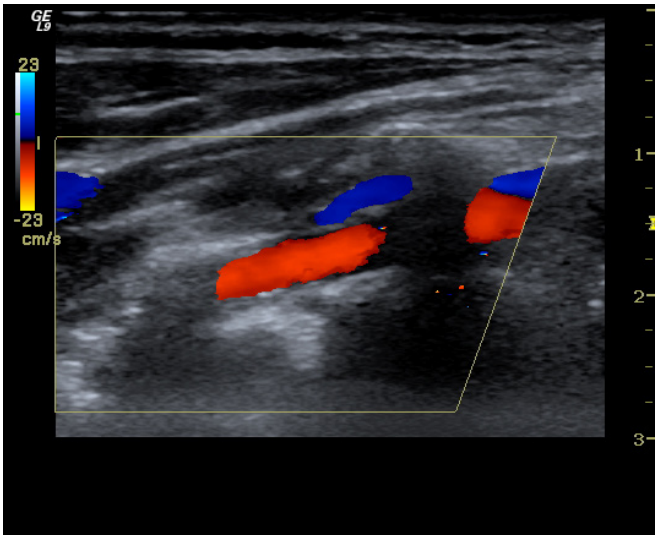

Figure 2. Color Doppler ultrasound imaging of left VA between fifth and sixth cervical vertebrae.

Table 1. Comparison of right and left vertebral and subclavian artery measurement.

	Mean±SD	P*
Right VA diameter (mm)	3,13±0,60	,001
Left VA diameter (mm)	3,45±0,55	
Right VA flow volume (ml/min)	114,98±57,13	,000
Left VA flow volume (ml/min)	150,67±58,97	
Right subclavian diameter	5,41±0,96	,047
Left subclavian diameter	5,26±0,93	

*Paired-sample t-test

dominancy criteria according to a difference in both VA diameters of more than 0.3 mm, just as did Hong et al. [10].

Statistical Analysis

Statistical analysis was performed with Statistical Package for Social Sciences (SPSS) software for Windows, (Version 22.0, Armonk, NY: IBM Corporation). Descriptive statistics were represented as mean +/- standard deviation. Normality analysis was performed by one-sample Kolmogorov-Smirnov testing. A paired-sample t-test was applied to compare left- and right-side measures. A Pearson correlation coefficient was calculated to evaluate the linear correlation between continuous variables and p-values lower than 0.05 were considered statistically significant.

Results

The mean age of the patients was 48,5 years (range: 26-56 years). We examined 14 left handers and 98 right handers.

A difference of 0,3 mm or greater in diameter between the diameters of both VAs showed right VA dominance in 74 (66.1%) and left VA dominance in 35 patients (31.3 %). Seven patient VA diameters differences were <0.3 mm and were considered equal at both sides (n=7 (2,7 %)).

The mean diameter of the right VA was 3,13 mm (± 0,60) while the mean diameter of the left VA was 3,45 mm (±0,54). Right VA mean flow volume was 114,98 ml/min (± 57.12) and left VA flow volume was 150.67 ml/min (±58,97), respectively, while right subclavian artery (SA) mean diameter was 5,412 mm (± 0,96) and left SA diameter was 5,26 mm(±0,92) as shown in Table 1 as paired-sample statistics. None of the comparisons between the left- and right-side measurements were statistically significant (p>0.05).

The distribution of diameters between VAs and SAs on both sides is observed in Table 2 according to the hand preference. There was no significant difference in diameter or volume flow of the right and left VA between right and left handers (p>0.05). Further, no significant difference was determined in the diameter of both SAs between right and left handers (p<0.05).

The results of comparing VA dominance between right- and left-handed participants are listed in Table 3. In terms of VA dominance, no difference was observed between left and right handers.

Discussion

The hindbrain receives necessary blood supply from the two VAs. On the other hand, if a failure takes place within the carotid artery system, the VAs provide

Table 2. Comparison of measurements In right and left hand participants.

	Right Median (Min-Max)	Left Median (Min-Max)	p
Right VA diameter (mm)	3,1(1,8-4,3)	2,9(2,2-4,2)	0,534
Right VA flow volume (ml/min)	107,5(22-285)	116(11-244)	0,926
Left VA diameter (mm)	3,5(2,2-4,7)	3,5(2,8-4,1)	0,874
Left VA flow volume (ml/min)	145(30-294)	190(60-268)	0,113
Right subclavian diameter	5,5(3,6-8,6)	5(4,1-6,3)	0,47
Left subclavian diameter	5,3(3,4-8,3)	5,15(3,7-6,3)	0,573

Table 3. Comparison of VA dominant side between right- and left-handed participants.

			Hand preference			Total
			Equal	Right	Left	
Side of dominance	Right	Count	3	31	64	98
		% within side of VA dominance	3,1%	31,6%	65,3%	100,0%
	Left	Count	0	4	10	14
		% within side of VA dominance	0,0%	28,6%	71,4%	100,0%
Total		Count	3	35	74	112
		% within side of VA dominance	2,7%	31,3%	66,1%	100,0%

VA - vertebral artery

circulation through collateral pathways [11]. For many reasons, imaging of both VA is important. In recent times, DSA continues to be the gold standard modality for VA imaging. Previous work has shown that the left VA is normally the dominant side [4-6].

In the literature, there are many different methods that exist for calculating the dominant VA side. Yet, there is no absolute agreement in terms of which is superior. For example, Smith and Bellon considered the dominant VA being one that was at least 30% wider in diameter [12]. We established our VA dominancy criteria according to the difference in both VAs' side-to-side diameters that was more than 0.3 mm, as did Hong et al. [10]. They found 69.2% left VA dominance. Our result indicated there was 66.1% left dominance and 31.3% right dominance. However, we measured the diameter through Doppler ultrasound while they evaluated diameter with CT angiography. Using the same criteria as Hong et al., Ergun et al. observed a 42.1% right VA dominance and 39% left VA dominance [13]. Much of the literature corresponds with our results that portray left VA dominancy using different criteria [14,15].

It is reported that 2-30% of the human population is left handed or ambidextrous [16]. The reason underlying this difference may be asymmetry in cerebral blood volume [8]. Hence, we hypothesized that there may be a correlation with hand preference and VA dominance. Cagnie et al. investigated the dominant VA in left- and right-handed populations [9], though we found no other studies regarding this topic. They compared VA diameter in right- and left-handed participants and found no correlation between hand preference and VA diameter. They mentioned that the sample size of their work was 50, not adequately representing the general population. Additionally, they highlighted that a true understanding of VA dominance could only be achieved by measuring blood volume [9]. Here, the number of the participants was 112, which was much higher than their study, and we compared both VA diameter and blood volume flow in conjunction with hand preference. As shown at Table I, there were no significant differences between diameter and volume flow of the right and left VA ($p<0.05$). According to our knowledge, our study is unique in that it compares both VA diameter and blood flow with hand preference.

Moreover, we made a unique comparison of SA diameters of each group to evaluate possible correlations with hand preference. The diameter was wider on the preferred-hand side. In the literature, we did not find any works that compared SA diameter with hand preference. In fact, we were able to conclude that there was no correlation between hand preference and SA diameter ($p = 0.47$).

Our study has definite limitations. First of all, it is a retrospective study. Although it is unique in that it studied both VA diameter and blood flow, the number of patients may be insufficient. Further research is re-

quired with larger numbers of participants to investigate the possible underlying mechanism of VA dominance.

In conclusion, we found no correlation between differences in VA diameter and hand preference. Besides that, there was no correlation between differences in right and left VA volume flow and hand preference, either, nor did we observe any correlation between SA diameter and hand dominance. Novel and comprehensive research is needed to establish the reason and mechanism underlying VA diameter asymmetry.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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