Morphometry of Common Carotid Artery and Internal Jugular Vein in Relation to Gender and Body Side

Arteria Carotis Communis ve Vena Jugularis İnterna'nın Cinsiyet ve Vücut Tarafına göre Morfometrisi

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ABSTRACT

Introduction: The common carotid arteries originate from brachiocephalic trunk on the right and directly from the aortic arch on the left. These arteries are contained within the carotid sheaths together with the internal jugular veins and vagus nerves. The structures enclosed in carotid sheath are of great importance, since they provide most of the vascular supply of the head and neck. They exhibit a great deal of variation and are related with a number of pathologic conditions and invasive procedures.
Objectives: Thus we focused on morphology of the common carotid artery (CCA) and internal jugular vein (IJV) to determine these possible variations.
Methods: Neck magnetic resonance images of 81 individuals (38 females and 43 males) were evaluated retrospectively. Diameter of the lumen of the common carotid artery (CD) and the diameters of the lumen of the internal jugular vein (ID) were measured at the same level that is one slice inferior to the slice in which the bifurcation of the CCA is observed firstly. CCA intima-media thickness (CIMT), IJV intima-media thickness (IIMT), CCA-midline distance (CMD) and IJV-midline distance (IMD) were also measured at the aforementioned level. The measurements were evaluated in relation to gender and asymmetry.
Results: The values measured for Right CMD, Right IMD, Left CD, Left CMD and Left IMD of males were greater than those of females ($p<0.05$). The results stressed various morphometric parameters and topography of the IJV and CCA.
Conclusion: The results are suggested to be helpful in determination of normal values in terms of diagnostic purposes and treatment planning.

Key Words: Common carotid artery; internal jugular vein; asymmetry; gender

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ÖZET

Giriş: Arteria carotis communis sağ tarafta truncus brachiocephalicus'tan, solda arcus aorta'dan direkt olarak çıkar. Her iki tarafta vena jugularis interna ve nervus vagus ile birlikte vagina carotica'nın içinde bulunan bu damar baş ve boyunun kanlanmasının büyük bölümünden sorumlu olması nedeniyle çok önemlidir. Çok fazla varyasyonu vardır ve bir dizi patolojik durum ve invaziv girişimle ilişkilidir.
Amaç: Bu nedenle olası varyasyonları saptayabilmek amacıyla arteria carotis communis (CCA) ve vena jugularis interna'nın (IJV) morfolojisine odaklandık.
Yöntem: 81 kişinin (38 kadın ve 43 erkek) boyun manyetik rezonans görüntüleri retrospektif olarak değerlendirildi. CCA'nın ikiye ayrılmasının ilk gözlendiği seviyenin bir altından CCA'nın çapı (CD) ve IJV'nin lumen çapı (ID) ölçüldü. CCA intima-media kalınlığı (CIMT), IJV intima-media çapı (IIMT), CCA-orta hat arası mesafe (CMD) ve IJV-orta hat arası mesafe (IMD) de aynı seviyede ölçüldü. Ölçümler cinsiyet ve asimetri açısından değerlendirildi.
Bulgular: Erkeklerden elde edilen sağ CMD, sağ IMD, sol CD, sol SMD ve sol IMD değerleri kadınlardan elde edilen değerlerden yüksekti ($p<0.05$). Sonuçlar IJV ve CCA'nın çeşitli morfometrik parametrelerini ve topografisini ortaya koymaktadır.
Sonuç: Elde edilen bulguların tanı ve tedavi planlaması açısından normal değerlerin ortaya konmasında önemli olduğu ön görülmektedir.

Anahtar Sözcükler: Arteria carotis communis; vena jugularis interna; asimetri; cinsiyet

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INTRODUCTION

The common carotid arteries originate from ascending brachiocephalic trunk on the right and directly from the aortic arch on the left. Thus, left common carotid artery has two distinct parts as thoracic and cervical portions, and the right common carotid artery has only a cervical portion. The cervical sections of both common carotids follow a similar course, and are separated from each other by the trachea, thyroid gland, larynx and pharynx during their upward course. The common carotids are contained within the carotid sheaths together with the internal jugular veins and vagus nerves, lying lateral to the arteries and in between the two, respectively. At the level of the fourth cervical vertebra, they bifurcate into the external and internal carotids (1).

The structures enclosed in carotid sheath are of great importance, since they provide most of the nourishment for and drain almost all of the blood from the head and neck, and exhibit a great deal of variation. Moreover, these structures are related with a number of diseases and operations including severe stenosis of carotid artery with a significant prevalence of %1.7 (2,3,4). Alone stenosis of the carotid artery requires a number of invasive procedures such as carotid endarterectomy and carotid artery stenting (5), techniques both of which require extensive knowledge of the anatomy of the neck and morphology of the structures.

Apart from invasive procedures that obviously require the anatomical and morphological knowledge of the structures, etiology of such diseases correlate with the abnormalities and/or differences in hemodynamics, which also correlates with the anatomical variations shown by the patient (6,7). The effects of the variation is further supported by the ipsilateral predilection of stenosis which introduces a correlation between asymmetry and stenosis (3,8). The fact that etiology of some disease may also be related to the anatomy of the structure also deems an extensive knowledge on the matter at hand necessary. The asymmetry of left and right common carotid artery is of no surprise, since they both vary in terms of their embryological origin. Furthermore, it has been shown that the left common carotid artery varies more than the other (9), presenting another possible origin for asymmetry and etiology of diseases which this article will not further discuss. Because of the reasons listed above, this article will focus on morphology of the common carotid artery (CCA) and internal jugular vein (IJV) and the asymmetry they exhibit or lack thereof.

METHODS

Neck magnetic resonance imaging (MRI) examinations of the patients between January 2015 and January 2016 were reviewed to analyze the CCA and IJV on the hospital picture archiving and communication system (PACS) and 81 individuals (38 females, 43 males) aged between 23 and 89 years were included in the study. Patients with any vascular lesions on brain MRI and those who had technically insufficient MRI scans were excluded from the study. The study was approved by the local ethics committee (number of approval: 2016-07/01, date: 19.10.2016) and performed in accordance with the guidelines of the Helsinki II Declaration. The routine entire neck MRI studies of all patients were performed using a 3T Ingenia (Philips Healthcare, Beth, the Netherlands) clinical scanner at our hospital with axial mDixon turbo spin echo (TSE) T1-weighted (W) (repetition time/echo time (TR/TE) : 636/6 milisecond (ms), coronal mDixon T1-W TSE (TR/TE:560/16 ms), axial mDixon T2-weighted (TR/TE: 2817/100 ms), coronal mDixon T2-weighted (TR/TE: 2697/90 ms), sagittal mDixon T2-weighted (TR/TE: 3000/90 ms), diffusion-weighted (DW) (TR/TE: 12991/ 64ms; b-value: 1000 s/mm2), and gadolinium-enhanced T1W mDIXON TSE imaging. Among these routine entire neck MR sequences, the measurements were usually done on T2-weighted MR images.

Diameter of the lumen of the common carotid artery (CD) and the diameters of the lumen of the internal jugular vein (ID) were measured at the same level that is one slice inferior to the slice in which the bifurcation of the CCA is observed firstly (Figure-1). Since IJV resembles an ellipse in shape two axial diameters that are perpendicular and cross the whole cross-section of the vein either from anterior to posterior (ID1) and from medial to lateral (ID2), were measured to better define the cross-sectional area of the vein. CCA intima-media thickness (CIMT), IJV intima-media thickness (IIMT), CCA-midline distance (CMD) and IJV-midline distance (IMD) were also measured at the aforementioned level (10,11,12).

The midline was designated simply by defining a line that crosses both CCA and crosses the whole neck from one side of the epidermis to the contralateral side and finding the middle point of the said line. Lumen of the carotid sinus (CS) was measured at the slice that is one level superior to the slice in which the bifurcation of the CCA is observed firstly. And the level of the bifurcation of the carotid artery (BCA) is the level of the slice in which the bifurcation of the CCA is observed, reported according to the respective vertebra.

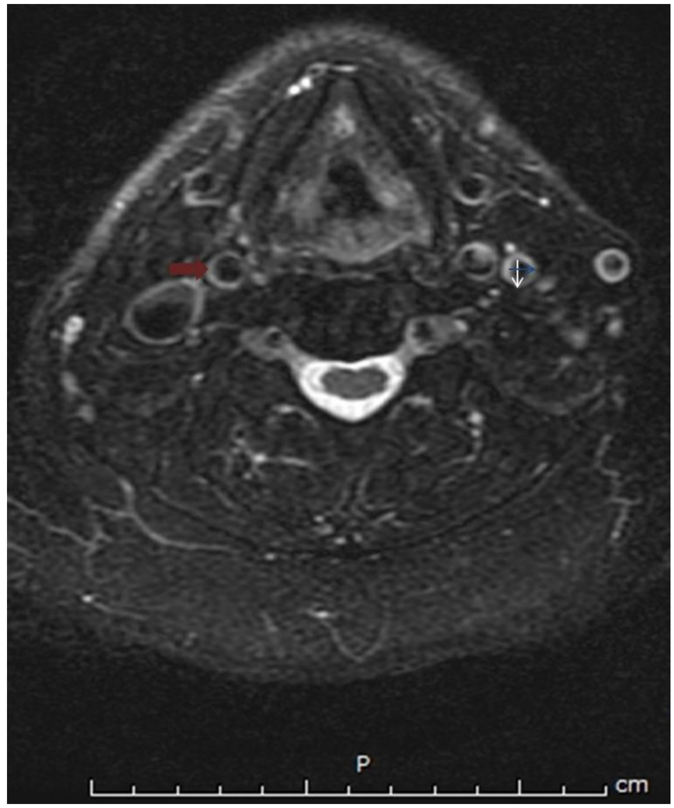

Figure 1. Axial T2W Image of the Neck. One slice (3mm) below the bifurcation. Red Arrow:CCA White Arrow:DD1 Blue Arrow:DD2

To achieve intra-observer precision, three widely used precision estimates were calculated: the technical error of measurement (TEM), the relative technical error of measurement (rTEM), and the coefficient of reliability (R) (13,14,15). The TEM was calculated as the square root of the squared difference between two corresponding measurements divided by twice the sample size (14,15,16). The TEM is interpreted as the typical magnitude of error associated with a certain measurement and can be used to estimate intraobserver precision (16) rTEM is calculated by dividing the TEM for a given variable by the mean for that variable and multiplying the result by 100 (14,15,16). rTEM represents an estimate of error magnitude as a percentage of object size (16). R can be calculated using TEM and ranges from 0 (not reliable) to 1 (complete reliability). R can be calculated using the following equation (13,14,15) : $R= 1 – [(TEM)^2/(SD)^2]$, where SD is the standard deviation of all measurements (14,15). R represents the proportion of between-subject variance free from measurement error (13). All computations regarding intra-observer precision were performed using Excel 2007.

SPSS 19.0 was used for all statistical analysis. Descriptive statistics of continuous variables are given with mean, standard deviation, median, minimum, maximum values and frequency and percent for categorical variables. The Shapiro Wilk test was used as a test of normality. Independent samples t test was used for two independent group comparisons of normal distributed variables and the Mann Whitney U test was used for non-normal distributed variables. The similarly paired samples t test was used for two dependent group comparisons of normal distributed variables and the Wilcoxon test was used for non-normal distributed variables. For all statistical comparisons, a p value below 0.05 was assumed to indicate statistical significance.

RESULTS

TEM, rTEM and R for all variables measured are presented in Table 1. TEM values of all variables measured were 0.024–0.330 mm. The rTEM values were 0.539–3.461%.

The R values of all variables were close to 1, suggesting that most of the variation in the variables in the sample was due to factors other than measurement error. These results suggest that an acceptable degree of intra-observer precision was obtained for the measurements.

Table 1. Precision estimates of measurements (n=15).

Parameters	TEM (mm)	rTEM (%)	R
Right CCA Lumen Diameter (mm)	0,054	1,010	0,99
Right CCA Intima-Media Thickness (mm)	0,034	3,016	0,97
Right IJV Lumen Diameter 1 (mm)	0,220	2,496	0,99
Right IJV Lumen Diameter 2 (mm)	0,049	0,872	0,99
Right IJV Intima-Media Thickness (mm)	0,029	2,870	0,98
Right CCA – Midline Distance(mm)	0,298	1,517	0,99
Right IJV – Midline Distance (mm)	0,330	1,147	0,99
Right Carotid Sinus Diameter (mm)	0,155	2,797	0,99
LeftCCA Lumen Diameter (mm)	0,192	3,461	0,98
LeftCCA Intima-Media Thickness (mm)	0,023	2,059	0,99
LeftIJV Lumen Diameter 1 (mm)	0,044	0,539	0,99
LeftIJV Lumen Diameter 2 (mm)	0,029	0,678	0,99
LeftIJV Intima-Media Thickness (mm)	0,026	3,279	0,99
LeftCCA – Midline Distance(mm)	0,169	0,779	0,99
LeftIJV – Distance Midline (mm)	0,297	1,008	0,99
LeftCarotid Sinus Diameter (mm)	0,044	0,821	0,99

TEM: technical error of measurement
rTEM: relative technical error of measurement
R: coefficient of reliability

Neck MRI of 81 individuals (38 females, 43 males) aged between 23 and 89 years (51,42±15.44) were evaluated (Table 2). There were statistically significant differences between males and females for certain parameters. The values measured for Right CMD, Right IMD, Right CS, Left CD, Left CMD and Left IMD of males were greater than those of females ($p<0.05$) (Table 3).

The Right CIMT of females was greater than the left side and the difference was statistically significant ($p<0.05$). There were no statistically significant differences between the right and left CD, ID 1-2, IIMD, CMD, IMD, CS of females ($p>0.05$) (Table 4). For these latter parameters these results were interpreted in favor of symmetry.

Table 2. Distrubition of parameters in the whole study group (N=81)

Parameters	Mean	Median	Std. Deviation	Minimum	Maximum
Age	51,42	52,00	15,439	23	89
Right CCA Lumen Diameter (mm)	5,5236	5,4100	1,28572	2,69	8,92
Right CCA Intima-Media Thickness (mm)	1,2489	1,2300	,31235	,55	2,38
Right IJV Lumen Diameter 1 (mm)	7,7965	7,7100	2,88881	2,09	15,46
Right IJV Lumen Diameter 2 (mm)	5,0170	4,9000	2,67056	,75	11,41
Right IJV Intima-Media Thickness (mm)	1,0572	1,0800	,28821	,52	1,81
Right CCA – Midline Distance(mm)	22,1283	22,1300	3,83130	12,82	33,86
Right IJV – Midline Distance (mm)	30,3499	30,3600	3,66239	21,04	39,53
Right Carotid Sinus Diameter (mm)	5,6354	5,7400	1,80769	1,50	12,25
LeftCCA Lumen Diameter (mm)	5,5486	5,5300	1,39428	2,86	8,93
LeftCCA Intima-Media Thickness (mm)	1,1583	1,1800	,31070	,51	1,96
LeftIJV Lumen Diameter 1 (mm)	7,3778	7,2600	2,91854	2,45	15,71
LeftIJV Lumen Diameter 2 (mm)	3,9856	3,4300	2,54435	,34	10,32
LeftIJV Intima-Media Thickness (mm)	1,0283	,9400	,37321	,40	1,99
LeftCCA – Midline Distance(mm)	22,4314	22,2600	3,22180	12,48	30,77
LeftIJV – Distance Midline (mm)	30,2358	30,1600	3,78649	19,56	39,67
LeftCarotid Sinus Diameter (mm)	5,6885	5,7700	1,98000	1,68	12,63
CCA Diameter Asymmetry Index	-,0251	,0000	1,05262	-4,11	2,52
CCA Intima-Media Thickness Asymmetry Index	,0906	,1600	,30519	-,61	1,07
IJV Lumen Diameter 1 Asymmetry Index	,4188	,5700	3,86796	-9,43	10,30
IJV Lumen Diameter 2 Asymmetry Index	1,0315	1,1800	2,84314	-6,87	7,99
IJV Intima-Media ThicknessAsymmetry Index	,0289	-,0100	,31740	-,71	,68
CCA – Midline Distance Asymmetry Index	-,3031	,0000	4,30703	-13,46	13,58
IJV – Distance Midline Asymmetry Index	,1141	,4200	4,41225	-13,86	12,22
Carotid Sinus Diameter Asymmetry Index	-,0531	-,0100	1,28687	-4,65	3,09

Table 3.Comparison of parameters according to gender.

	Females (N=38)					Males (N=43)					
Parameters	**Mean**	**Median**	**SD**	**Min**	**Max**	**Mean**	**Median**	**SD**	**Min**	**Max**	**p**
Right CCA Lumen Diameter (mm)	5,2818	5,1450	1,33610	2,69	8,92	5,7372	5,6500	1,21510	3,30	8,45	0,112
Right CCA Intima-Media Thickness (mm)*	1,2395	1,2250	,30280	,61	2,02	1,2572	1,2300	,32391	,55	2,38	0,831
Right IJV Lumen Diameter 1 (mm)	7,5200	7,7100	2,26360	3,22	12,23	8,0409	7,8500	3,35431	2,09	15,46	0,411
Right IJV Lumen Diameter 2 (mm)*	5,2450	5,1050	2,36104	,96	9,92	4,8156	4,0600	2,93004	,75	11,41	0,293
Right IJV Intima-Media Thickness (mm)	1,0387	1,0450	,27601	,52	1,81	1,0735	1,0900	,30087	,52	1,81	0,591
Right CCA – Midline Distance(mm)	20,5489	20,5100	3,07220	12,82	26,38	23,5240	23,2500	3,92351	13,94	33,86	<0.001
Right IJV – Midline Distance (mm)	28,5603	28,7700	2,94544	21,04	34,13	31,9314	32,3800	3,52809	23,15	39,53	<0.001
Right Carotid Sinus Diameter (mm)	5,1111	5,2750	1,60102	1,50	8,09	6,0988	6,2200	1,87016	2,64	12,25	0,012
Left CCA Lumen Diameter (mm)	5,1753	5,0300	1,34386	2,86	8,26	5,8786	5,9300	1,36907	2,97	8,93	0,023
Left CCA Intima-Media Thickness (mm)	1,1153	1,1150	,31249	,51	1,79	1,1963	1,2200	,30773	,69	1,96	0,244
Left IJV Lumen Diameter 1 (mm)*	7,1529	7,0750	2,60185	3,25	13,14	7,5765	7,3000	3,18976	2,45	15,71	0,613
Left IJV Lumen Diameter 2 (mm)*	4,3797	4,2850	2,58496	,48	10,32	3,6372	3,0200	2,48586	,34	10,00	0,174
Left IJV Intima-Media Thickness (mm)	1,0337	,9900	,36746	,40	1,99	1,0235	,9200	,38249	,44	1,89	0,903
Left CCA – Midline Distance(mm)	20,9511	20,9900	2,99437	12,48	28,00	23,7395	22,9800	2,85271	16,40	30,77	<0.001
Left IJV – Distance Midline (mm)	28,4300	28,3600	3,59916	19,56	35,98	31,8316	31,6800	3,21559	24,12	39,67	<0.001
Left Carotid Sinus Diameter (mm)	5,3111	5,2200	2,13423	1,68	10,77	6,0221	5,9100	1,79219	3,25	12,63	0,107
CCA Diameter Asymmetry Index*	,1066	,1000	,86788	-2,05	2,10	-,1414	-,0200	1,19055	-4,11	2,52	0,316
CCA Intima-Media Thickness Asymmetry Index*	,1242	,1700	,30378	-,50	1,07	,0609	,1500	,30690	-,61	,51	0,606
IJV Lumen Diameter 1 Asymmetry Index	,3671	,6850	3,45320	-5,52	7,15	,4644	,5700	4,24120	-9,43	10,30	0,911
IJV Lumen Diameter 2 Asymmetry Index	,8653	,9700	2,81018	-6,87	7,31	1,1784	1,4600	2,89706	-6,16	7,99	0,624
IJV Intima-Media Thickness Asymmetry Index	,0050	,0000	,33285	-,71	,62	,0500	-,0300	,30549	-,70	,68	0,528
CCA – Midline Distance Asymmetry Index*	-,4021	-,1500	3,60804	-7,71	5,75	-,2156	,0000	4,88358	-13,46	13,58	0,813
IJV – Distance Midline Asymmetry Index	,1303	-,0100	3,69119	-7,88	7,68	,0998	,5100	5,00784	-13,86	12,22	0,975
Carotid Sinus Diameter Asymmetry Index	-,2000	-,1550	1,20911	-4,65	2,47	,0767	,0200	1,35265	-3,02	3,09	0,337

* Mann-Whitney U Test

The right, ID 2 of males was greater than the left side and the difference was statistically significant (p<0.05). There were no statistically significant differences between the right and left CD, CIMT, ID 1, IIMA, CMD, IMD, CS of females (p>0.05) (Table 4). For these latter parameters these results were interpreted in favor of symmetry.

When the whole study group was considered, the right CIMT and ID2 were found to be greater than the left side and the differences were statistically significant (p<0.05). There was no statistically significant difference between the CD, ID 1, IIMA, CMD, IMD, CS of the right and left sides (p>0.05) (Table 4).

Table 4. Comparison of parameters according to body side.

		Right					Left					
	Parameters	**Mean**	**Median**	**SD**	**Min**	**Max**	**Mean**	**Median**	**SD**	**Min**	**Max**	**p**
Female	CCA Lumen Diameter	5,2818	5,1450	1,33610	2,69	8,92	5,1753	5,0300	1,34386	2,86	8,26	0,454
(N=38)	CCA Intima-Media Thickness *	1,2395	1,2250	,30280	,61	2,02	1,1153	1,1150	,31249	,51	1,79	0,016
	IJV Lumen Diameter 1 *	7,5200	7,7100	2,26360	3,22	12,23	7,1529	7,0750	2,60185	3,25	13,14	0,612
	IJV Lumen Diameter 2*	5,2450	5,1050	2,36104	,96	9,92	4,3797	4,2850	2,58496	,48	10,32	0,054
	IJV Intima-Media Thickness	1,0387	1,0450	,27601	,52	1,81	1,0337	,9900	,36746	,40	1,99	0,927
	CCA – Midline Distance	20,5489	20,5100	3,07220	12,82	26,38	20,9511	20,9900	2,99437	12,48	28,00	0,496
	IJV – Midline Distance	28,5603	28,7700	2,94544	21,04	34,13	28,4300	28,3600	3,59916	19,56	35,98	0,829
	Carotid Sinus Diameter	5,1111	5,2750	1,60102	1,50	8,09	5,3111	5,2200	2,13423	1,68	10,77	0,315
Male	CCA Lumen Diameter	5,7372	5,6500	1,21510	3,30	8,45	5,8786	5,9300	1,36907	2,97	8,93	0,440
(N=43)	CCA Intima-Media Thickness *	1,2572	1,2300	,32391	,55	2,38	1,1963	1,2200	,30773	,69	1,96	0,149
	IJV Lumen Diameter 1 *	8,0409	7,8500	3,35431	2,09	15,46	7,5765	7,3000	3,18976	2,45	15,71	0,418
	IJV Lumen Diameter 2*	4,8156	4,0600	2,93004	,75	11,41	3,6372	3,0200	2,48586	,34	10,00	0,014
	IJV Intima-Media Thickness	1,0735	1,0900	,30087	,52	1,81	1,0235	,9200	,38249	,44	1,89	0,289
	CCA – Midline Distance	23,5240	23,2500	3,92351	13,94	33,86	23,7395	22,9800	2,85271	16,40	30,77	0,774
	IJV – Midline Distance	31,9314	32,3800	3,52809	23,15	39,53	31,8316	31,6800	3,21559	24,12	39,67	0,897
	Carotid Sinus Diameter	6,0988	6,2200	1,87016	2,64	12,25	6,0221	5,9100	1,79219	3,25	12,63	0,712
Whole Group	CCA Lumen Diameter	5,5236	5,4100	1,28572	2,69	8,92	5,5486	5,5300	1,39428	2,86	8,93	0,831
(N=81)	CCA Intima-Media Thickness *	1,2489	1,2300	,31235	,55	2,38	1,1583	1,1800	,31070	,51	1,96	0,006
	IJV Lumen Diameter 1 *	7,7965	7,7100	2,88881	2,09	15,46	7,3778	7,2600	2,91854	2,45	15,71	0,348
	IJV Lumen Diameter 2*	5,0170	4,9000	2,67056	,75	11,41	3,9856	3,4300	2,54435	,34	10,32	0,002
	IJV Intima-Media Thickness	1,0572	1,0800	,28821	,52	1,81	1,0283	,9400	,37321	,40	1,99	0,415
	CCA – Midline Distance	22,1283	22,1300	3,83130	12,82	33,86	22,4314	22,2600	3,22180	12,48	30,77	0,538
	IJV – Midline Distance	30,3499	30,3600	3,66239	21,04	39,53	30,2358	30,1600	3,78649	19,56	39,67	0,817
	Carotid Sinus Diameter	5,6354	5,7400	1,80769	1,50	12,25	5,6885	5,7700	1,98000	1,68	12,63	0,711

*Wilcoxon Signed Ranks

The distribution of the level of bifurcation of common carotid artery according to vertebral column is given in Table 5. In females the most frequent bifurcation level was the intervertebral disc between C3 and C4 on the right side (28.95) and the left side (23.7%). In males the most frequent bifurcation level was upper border of body of C4 on the right and left sides (32.6%). When the whole study group was considered the most frequent bifurcation level was upper border of body of C4 on the right (28.4%) and left sides (29.6%) (Table 5).

Table 5. The distribution of level of bifurcation of the common carotid artery according to vertebral column.

	Female				**Male**				**Whole group**			
Level	**Right**		**Left**		**Right**		**Left**		**Right**		**Left**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
C2-C3	0	0	1	2,6	0	0	0	0	0	0	1	1,2
C3 inf. 1/3	3	7,9	6	15,8	2	4,7	5	11,6	5	6,2	11	13,6
C3 sup. 1/3	2	5,3	2	5,3	3	7,0	2	4,7	5	6,2	4	4,9
C3-C4	11	28,9	9	23,7	1	2,3	4	9,3	12	14,8	13	16,0
C4	0	0	0	0	2	4,7	1	2,3	2	2,5	1	1,2
C4 inf. 1/3	8	21,1	3	7,9	12	27,9	10	23,3	20	24,7	13	16,0
C4 sup. 1/3	9	23,7	10	26,3	14	32,6	14	32,6	23	28,4	24	29,6
C4-C5	3	7,9	5	13,2	7	16,3	6	14,0	10	12,3	11	13,6
C5	0	0	0	0	1	2,3	0	0	1	1,2	0	0
C5 inf. 1/3	1	2,6	0	0	0	0	0	0	1	1,2	0	0
C5 sup. 1/3	1	2,6	2	5,3	1	2,3	1	2,3	2	2,5	3	3,7
Total	38	100,0	38	100,0	43	100,0	43	100,0	81	100,0	81	100,0

DISCUSSION

Morphology and asymmetry of body parts of interest have been widely discussed in earlier studies and it is apparent that this information is of value not just for the morphological and anatomical curiosity but also for surgical procedures, myriad therapeutic applications and general hemodynamics of the patient (17-21). Furthermore, it is of utmost importance to collect data and expand the knowledge of cardiovascular theory and practices regarding different populations since ailments regarding this system are copious and mortal (5,22). That being the case there have been many studies that regarded the matter at hand.

During one of the studies about the matter at hand Eigenbrodt et al (23) compared people with baseline carotid artery lesions and people without the lesions and among 7956 people 5001 presenting with no carotid lesions, CIMT and external diameter were measured. Their findings regarding IMT were lower and diameter were higher than ours, however, when adjusted for external diameter our results were greater, also results were not specified for genders. Ruan et. al. (7) in their study, compared black, white; male and female people in terms of their IMT and CD. Our results about IMT were greater across the board however, their results regarding CCA lumen diameter were greater than ours black and white alike. Polak et al (24), found IMT to be 0.87±0.19 mm and Interadventitial diameter of the common carotid artery to be 7.57±0.92 mm without specifying gender or side. Compared to our study, their results were lower in both IMT and CD adjusted for interadventitial measurement. Oishi et al (25), found CD to be similar amongst their study group under 50 years of age and greater amongst the study group who are older than 50 years of age however, they did not specify gender. All four above measurements were performed by ultrasonography, which may explain disagreements between their measurements and ours (26). Furthermore, none of the studies shown above performed or mentioned of intraobsever precision estimates, which may also explain the disagreements between their measurements and ours. Moreover, the differences regarding ethnicity, race and conditions of the patients/volunteers also readily further explain the disunion.

Contrary to the CCA, literature regarding IJV diameter is rather unsatisfactory. In one of the very few studies, Bos et al (27) reported the ID and position of IJV regarding CCA using ultrasonography without specifying gender or position of the ID and their results were far greater than ours. They have also found majority of the population to be right IJV dominant, a result concordant with ours. In another study, Urakov et al (28) measured changes in the diameter of the IJV during different elevations of the head and found, at the position pertinent to our study, similar results adjusted with the means, since they have measured maximum and minimum diameters and we measured posterior-anterior and right-to-left diameters the similarities between the studies remain, at best, vague. Similarly Cleneghan et al (29) measured only one IJV diameter at Trendelenburg position, as one might expect, their results were far greater than ours. Literature for IJV wall thickness (IIMT) is even more barren than for IJV diameter. However, the research of Yoshida et al (30) is of relevance. During their research, amongst 56 people, using ultrasonography they have identified IWT as 0,73 mm and 0,60 mm in two groups median years of age being 70 and 71 respectively. Their results were not specified for gender. Most measurements in this field were done using ultrasonography and during different head elevations in different ethnicities, also none of the researchers needed to search for intraobserver validity, all of which are factors that may warrant differing results. Moreover, in their research Podgórski et al (31) concluded that some CCA may result from its position, angle or degree of adherence to the IJV, manifesting the need for more in-depth research regarding the IJV.

Various studies have been reported regarding Artery (BCA) however, only the ones that accept the vertebra as the point of reference are relevant in this discussion. While, defining the bifurcation according to the thyroid cartilage is arguably more clinically relevant it must be considered that the thyroid cartilage itself shows a great deal of mobility (1). In one of the studies of interest Espalieu et al (32), determined the bifurcation at the level of the body of the C4 vertebra at 67% of the test group, a result similar but greater than ours, without specifying whether it is upper, lower or middle third of it or specifying gender. In another cadaveric study, Anu et al (33) found the level of bifurcation to be the level of C3 at the 50% and 55% of the patients for the right and left carotid artery respectively, presenting a disagreement with our results. Klosek et al (34), in their study on Thai cadavers, signified differences between bifurcations at woman-men and left-right. However, their study too, shows a great deal of disconnection from ours. All discussed articles also differ greatly in their results which may be due to ethnicity of the subjects or methodical differences.

There is a plethora of research regarding carotid sinus and its related nervous net in fields of pathophysiology, clinic, topography and even morphology in animals (35-43), however the information regarding human CS is scarce. Hauswald et al (44), in their article, studied the effects of posture on CS diameter and found the mean diameter as 5.7mm in 20 volunteers, which almost perfectly correlates with our results. Another mention worthy point was made by Hansen (37), in his study where he compared two group of mice's CS and found the hypertensive ones to have greater wall/lumen ratio, suggesting hypertensive population to have greater mean vessel wall thickness. However, the lack of research regarding CS morphology and anatomy in humans remains disturbing. Even though a model such as Seong et al (35) demonstrate for the hemodynamic function of the vessel and its surroundings is present it is frank that this subject requires far deeper investigation that has already been put into it.

Concerning symmetry of the subject at hand, while Right CCA IMT (RCI) was greater than the left in females and Right IJV Lumen Diameter (RIL) of males was greater than the left. In the whole group, RCI was greater than LCI and RIL was greater than LIL due to statistically significant differences in females and males respectively. However, only a few articles were interested in carotid artery bilaterally and none, to our knowledge, were interested in its anatomy. Research groups of Li (45), Gareth (46) and Benetos (47) were interested in carotid artery plaques and have deduced that left and right were strongly correlated in most cases. Oppenheimer et al (48) researched symmetry/asymmetry in neck in Velocardiofacial Syndrome and found a great deal of asymmetry between right and left side, a result that suggest that asymmetry may be a congenital or developmental abnormality.

In our study for the most of the parameters evaluated there were statistically no significant differences between right and left side values which were interpreted in favor of symmetry (Table 4). This issue is suggested to be important for evaluation of the neck region during diagnostic procedures. In addition to that, uneven hemodynamic load during daily activities and can be a possible explanation for the parameters which had significant differences between right and left sides (Table 4) (28,49).

CONCLUSION

This study determined various morphometric parameters and topography of the internal jugular vein and the common carotid artery as well as the symmetry-asymmetry condition of these structures. At the end CCA and many related parameters were greater in Turkish population, however, these findings, as stated before can be attributable to MRI imaging technique. These outcomes are helpful in developing a database to determine normal values so that quantitative assessment of these structures will be possible both for diagnostic purposes and for treatment planning related with neck region.

Conflict of interest
No conflict of interest was declared by the authors.

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