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Research Paper

Evaluation of Carotid Artery Intima-media Thickness and its Correlation With Metabolic and Nutritional Factors

Mehdi Rezazadeh[1], Masoud Pezeshki Rad[2], Saeid Eslami Hasanabadi[3], Morteza Hosseini Jebeli[1], Vahid Khaja Reza Shahri[1], Farzaneh Khoroushi[4], Behzad Aminzadeh[5*]

1. Department of Radiology, Cancer Surgery Research Center, School of Medicine, Imam Reza Hospital, Mashhad University of Medical Sciences, Mashhad, Iran.
2. Department of Radiology, Surgical Oncology Research Center, School of Medicine, Imam Reza Hospital, Mashhad University of Medical Sciences, Mashhad, Iran.
3. Department of Medical Informatics, Pharmaceutical Sciences Research Center, School of Medicine, Institute of Pharmaceutical Technology, Mashhad University of Medical Sciences, Mashhad, Iran.
4. Department of Radiology, School of Medicine, Ghaem Hospital, Mashhad University of Medical Sciences, Mashhad, Iran.
5. Department of Radiology, Vascular and Endovascular Surgery Research Center, School of Medicine, Ghaem Hospital, Mashhad University of Medical Sciences, Mashhad, Iran.

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ABSTRACT

Background and Aim: Carotid intima-media thickness (CIMT) is vital to investigate vascular atherosclerosis. Studies have provided conflicting information regarding the factors affecting this thickness. This study aims to determine CIMT in adults and investigate its relationship with background variables, and metabolic and nutritional factors.

Materials and Methods: This cross-sectional study was conducted on the adult population of Mashhad City, Iran, and in the cohort center of Mashhad University of Medical Sciences during 2018-2019. At the beginning of the study, a complete history was taken and general examinations were performed. For all subjects, a B-mode ultrasound was performed by a radiologist in the neck region to evaluate the carotid arteries. Also, anthropometric characteristics, including height, weight, and body mass index, and metabolic factors, including blood sugar, blood pressure, cholesterol level, triglyceride level, and nutritional factors, including daily calorie consumption were calculated.

Results: A total of 431 people with an mean age of 43.41±6.59 years were included in the study, 190 cases (44.1%) were men and 241 cases (55.9%) were women. The median thickness of the left carotid artery (0.63, 0.50) was 0.55 mm, and the median thickness of the right carotid artery (0.49, 0.61) was 0.54 mm (P=0.003). Also, the mean intima-media thickness (IMT) of the right and left carotid arteries was significantly higher in males than in females (P<0.05). Correlation of different quantitative data with IMT of both carotid arteries showed that all quantitative data except pulse rate (P<0.05) and energy (P<0.05) had a significant positive correlation with IMT of both right and left carotid arteries which were weak to moderate. Age and weight had a direct and significant relationship with the right and left CIMT (P<0.05). In addition, the male gender was associated with greater thickness of the left carotid artery (P<0.05).

Conclusion: The results of our study indicated that what is almost certainly related to CIMT is age and weight, which increases with the increase of both CIMT. More studies are needed to confirm these things.

*** Corresponding Author:**
Behzad Aminzadeh, Assistant Professor.
Address: *Department of Radiology, Vascular and Endovascular Surgery Research Center, School of Medicine, Ghaem Hospital, Mashhad University of Medical Sciences, Mashhad, Iran.*
Phone: *+98 (915) 5082936*
E-mail: *aminzadehb@mums.ac.ir*

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1. Introduction

Coronary artery diseases (CAD) are one of the most common causes of death worldwide and the first cause of death in Iran [1-3]. The main process that ultimately leads to the occurrence of these diseases is atherosclerosis, which starts in childhood [4]. This process progresses over time as a silent phase and can lead to CAD with age. Therefore, if it is possible to assess the condition of atherosclerosis in this phase, it is possible to prevent serious injuries with appropriate interventions. Ultrasound with B mode is a non-invasive method to examine the vessel wall which can be used to evaluate the intima-media thickness (IMT) of vessels and the presence of blockage and plaque in it [5]. Carotid intima-media thickness (CIMT) is a proven criterion to identify early atherosclerosis and is considered an early predictor of vascular events [6-8]. Several studies showed the relationship between increased carotid IMT and heart infarction or stroke in middle-aged and elderly people [9, 10]. The normal amount of carotid artery IMT varies based on factors, such as the method of measurement, lifestyle, dietary habits, race, age, and sex. Also, studies showed that the increase in IMT of carotid arteries occurs under various conditions, including high blood pressure, dyslipidemia, obesity, diabetes, smoking, and cardiovascular diseases [3]. Therefore, the evaluation of this criterion at the community level can be very useful in terms of achieving its normal level in Iranian society and in terms of estimating the cardiovascular status of people as well as identifying people at risk. This study was conducted to determine the CIMT in adult patients referred to the cohort project of Mashhad University of Medical Sciences in 2019, and the relationship between CIMT and background variables, metabolic and nutritional factors were also measured.

2. Materials and Methods

This cross-sectional study was conducted in the cohort center of Mashhad University of Medical Sciences during 2018-2019. This study was conducted as a census and all available patients were included in the study; therefore, the sample size was not calculated for the present study. The samples were selected as convenience sampling. The inclusion criteria included age over 18 years, informed consent to participate in the study, and the healthy appearance of the vessels in the ultrasound, and the exclusion criteria included the history of surgical procedures on the vessels and those who did not complete the study for any reason. Then, after completing the informed consent form, complete history was obtained and general examinations were performed. For all subjects, a B-mode ultrasound was performed in the neck area to evaluate the carotid arteries. Also, anthropometric characteristics, including height, weight, and body mass index, and metabolic factors, including blood sugar, blood pressure, cholesterol level, triglyceride level, and nutritional factors, including daily calorie consumption were calculated. CIMT was measured in the supine position. Considering that ultrasound is operator dependent, all evaluations were performed by a radiologist. After collecting data, SPSS software, version 22 was used for analysis. For statistical analysis, first, the normality of the data was checked based on the Kolmogorov-Smirnov test, and based on the normality or non-normality, the desired statistical test was used. $P<0.05$ were considered significant. To compare the qualitative data, the chi-square test and Fisher's exact test were used if necessary. Also, if the data were normal, Pearson's correlation test was used; otherwise, Spearman's test was used to investigate the simultaneous effect of independent variables, and a stepwise regression test was used.

3. Results

A total of 431 people were included in the study, 190 cases (44.1%) were men and 241 cases (55.9%) were women. The mean age of the studied subjects was 43.41±6.59 years in the range of 35 to 68 years. The Mean right and left CIMT was compared by the Mann-Whitney test, and the mean of the left carotid was significantly higher than the right carotid (0.55 mm vs. 0.54 mm; $P=0.003$). Table 1 presents the relevant details.

Table 2 presents the Mean±SD, minimum, maximum, and percentiles of demographic, anthropometric, vital signs, and tests.

Examining the correlation of different quantitative data with the right and left CIMT showed that all quantitative data except pulse rate ($P<0.05$) and energy ($P<0.05$) had a significant positive correlation with right and left CIMT (Table 3).

The results of stepwise linear regression analysis for the right carotid artery showed that age and weight have a significant direct relationship with the right CIMT ($P<0.001$) (Table 4).

It was also found that age and weight have a significant direct relationship with the left CIMT. In addition, the male gender was associated with greater thickness of this artery ($P=0.008$) (Table 5).

Table 1. The Mean±SD, minimum, maximum, and percentiles of right and left carotid intima-media thickness

Characteristics	Mean±SD	Minimum	Maximum	Percentile			P
				25	50	75	
Right CIMT (mm)	0.54±0.09	0.31	0.90	0.49	0.54	0.61	0.003*
Left CIMT (mm)	0.56±0.09	0.37	0.91	0.50	0.55	0.63	

*Significant in the Mann-Whitney test

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4. Discussion

Our study investigated the right and left CIMT and related factors. The IMT of both arteries was significantly higher in men than in women. The results of the correlation test also showed that age, height, weight, body mass index, diastolic pressure, systolic pressure, fasting sugar, triglyceride, and cholesterol had a significant positive correlation with right and left CIMT. This means that as each of the quantitative findings increased, the thickness of these two arteries also increased. However, this correlation was weak to moderate. Finally, a step-by-step linear regression analysis was performed, which showed that right and left arteries are directly related to age and weight, and the thickness of these arteries increases with age and weight. In addition, the male gender was associated with greater left CIMT. Zhou et al. [11] conducted a similar study in 2020 in China. The study population included 1372 people with type 2 diabetes. In total, 61.4% of these people were men and 38.6% were women. The average age of the subjects in this study was 53.66 years. The regression analysis performed in this study showed that being a woman is related to an increase in CIMT. Also, with the increase in body mass index, the CIMT of the studied subjects increased. In our study, age, height, weight, body mass index, diastolic pressure, systolic pressure, fasting sugar, triglyceride, and cholesterol had a significant positive correlation with right and left CIMT. However, this correlation was weak to moderate. Finally, a step-by-step linear regression analysis was performed, which showed that the thickness of both the right and left arteries is directly related to age and weight, and the thickness of these arteries increases with age and weight. In addition, the male gender was associated with greater left CIMT. The difference in the results of our study with the above study is mainly due to the type of population studied. In our study, the investigations included the general population and were not limited to the diabetic population alone. Maugeri et al. [12] conducted a study in 2019 in the Czech Republic to investigate the relationship between CIMT and intake of antioxidants as well as demographic, anthropometric, clinical, and laboratory factors. In this study, 894 people were included, whose average age was 46.5 years, 54.3% of these people were women and the rest were men. Unlike our study, the investigations of this study did not show a significant difference between the two sexes in terms of CIMT. However, the results of regression analysis indicated that CIMT is related to age, systolic blood pressure, and triglyceride. In our study, age was related to CIMT on both sides. However, systolic blood pressure and triglyceride showed a positive correlation with CIMT in Pearson analysis; however, stepwise linear regression analysis did not show a strong relationship. Part of these differences is due to the type of analysis used in our study, which was stepwise regression, which gave us more accurate results. On the other hand, the average age in our study was less than the above study and equal to 42.0 years. Altin et al. [13] investigated the CIMT and also investigated its changes during sleeve gastrectomy surgery. In this study, they found that after performing this surgery, CIMT decreased significantly in obese people with indications. Factors that had a significant direct correlation with CIMT in the correlation test included body mass index and systolic pressure. However, linear regression analysis by Enter method and step-by-step method did not find a relationship between CIMT with any demographic, anthropometric, nutritional, or clinical data. In our study, age, height, weight, body mass index, diastolic pressure, systolic pressure, fasting sugar, triglyceride, and cholesterol had a significant positive correlation with right and left CIMT. However, this correlation was weak to moderate. Finally, a step-by-step linear regression analysis was performed, which showed that in both right and left arteries, weight is directly related to age and weight, and the thickness of these arteries increases with age and weight. In addition, the male gender was associated with greater left CIMT. However, our study was not limited to the population of patients undergoing sleeve gastrectomy and considered the general population. Wu et al. [14] also conducted another similar study in 2017, which was conducted on 1607 people between the ages of 40 and 74 years. The investigations of this study showed that the common CIMT was significantly higher in men than in women. Also, the results of this study showed that age, body weight, body mass in-

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Table 2. The Mean±SD, minimum, maximum, and percentiles of demographic, anthropometric data, vital signs, and tests

Variables	Percentile			Maximum	Minimum	Mean±SD
	75	50	25			
Age (y)	47.00	42.00	39.00	68	35	43.41±6.59
Height (cm)	173.00	164.00	158.00	179.5	140	169.24±81.59
Weight (kg)	83.60	71.70	64.05	120	39	73.95±14.17
Body mass index (kg/m^2)	29.14	26.74	24.00	42	20	26.93±4.28
Diastolic pressure (mmHg)	75.00	68.00	60.00	120	75	68.39±9.89
Systolic pressure (mmHg)	114.00	104.50	96.00	180	110	105.28±15.08
Pulse rate (per minute)	80.00	75.00	69.00	100	54	75.03±8.68
Fasting sugar (mg/dL)	103.00	94.00	86.00	270	78	98.03±21.73
Triglycerides (mg/dL)	144.75	108.00	75.00	1183	75	126.42±93.40
Cholesterol (mg/dL)	198.00	171.00	145.25	395	80	172.80±38.57
Energy (kJ)	2846.74	2403.81	1986.15	6159	874	2522.87±814.90

Table 3. Correlation of different quantitative data with right and left carotid intima-media thickness

Characteristics	Left CIMT		Right CIMT	
	P	R	P	R
Age (y)	<0.001*	0.274	<0.001*	0.248
Height (cm)	<0.001*	0.172	0.002*	0.153
Weight (kg)	<0.001*	0.209	<0.001*	0.239*
Body mass index (kg/m^2)	0.018*	0.118	<0.001*	0.181
Diastolic pressure (mmHg)	<0.001*	0.209	<0.001*	0.199
Systolic pressure (mmHg)	<0.001*	0.227	<0.001*	0.230
Pulse rate (per minute)	0.393	0.043-	0.805	0.012-
Fasting sugar (mg/dL)	<0.001*	0.181	0.002*	0.154
Triglycerides (mg/dL)	<0.001*	0.238	<0.001*	0.245
Cholesterol (mg/dL)	0.007*	0.134	0.001*	0.170
Energy (kJ)	0.856	0.009	0.654	0.022

*Significant in Pearson correlation test.

CIMT: Carotid intima-media thickness.

Table 4. Results related to stepwise linear regression analysis for right carotid intima-media thickness

Variables	P	SE	%95 CI	Beta
Age (y)	<0.001*	0.001	(0.003-0.005)	0.004
Weight (kg)	<0.001*	0.00	(0.001-0.002)	0.002

CI: Confidence interval

Table 5. Results related to stepwise linear regression analysis for left carotid intima-media thickness

Variables	P	SE	95% CI	Beta
Gender (male/female)	0.008*	0.011	(-0.007, -0.049)	-0.028
Age (y)	<0.001*	0.001	(0.003, 0.005)	0.004
Weight (kg)	0.011*	0.00	(0.00, 0.002)	0.001

CI: Confidence interval

dex, systolic, diastolic pressure, low-density lipoprotein (LDL), fasting blood sugar, and hemoglobin A1c had a significant positive correlation with common CIMT in both genders. Also, high-density lipoprotein (HDL) had a significant negative correlation with CIMT. Finally, the linear regression showed that age, body mass index, the ratio of low-density lipoprotein (LDL) to high-density lipoprotein (HDL), fasting blood sugar, presence of high blood pressure, and systolic pressure are directly related to CIMT. In our study, age, height, weight, body mass index, diastolic pressure, systolic pressure, fasting sugar, triglyceride, and cholesterol had a significant positive correlation with right and left CIMT. However, this correlation was weak to moderate. Finally, a step-by-step linear regression analysis was performed, which showed that the thickness of both the right and left arteries is directly related to age and weight, and the thickness of these arteries increases with age and weight. In addition, the male gender was associated with greater left CIMT. But unlike the above study, which was conducted on the middle-aged and elderly population, our study considered the entire adult population. Kotsis et al. [15] also conducted a similar study in 2006, in which they examined the common CIMT and its related factors. A total of 3173 people were included in this study. Their investigations using stepwise regression analysis showed that age, male gender, and fasting blood sugar are among the factors that are independently related to CIMT so that with increasing age and blood sugar, carotid thickness increased significantly. Also, the carotid thickness was significantly higher in men than in women. Stepwise regression analysis was also used in our study. The results of our study showed that the right and left CIMT increased with age and weight. However, only the diameter of the left carotid was related to gender, the amount of IMT was significantly higher in men than in women. The studies on the factors affecting the greater thickness of the CIMT are heterogeneous and have not concluded this matter. Some studies have investigated a specific population, including, people with overweight or diabetics [11, 15]. Therefore, the studies conducted on the general population are limited. However, what is clear in the studies and our study also confirms that probably weight and age have an effect on the CIMT, and with the increase of these two things, TIM also increases.

5. Conclusion

Studies showed that the thickness of this artery is greater in men than in women. However, age and weight were independently associated with CIMT on both sides. It seems that the crucial factors influencing the TIM are age and weight. However, further studies are needed to confirm this case.

Ethical Considerations

Compliance with ethical guidelines

This article is based on the research design 980508 approved in 2019 and the permission of the Ethics Committee of Mashhad University of Medical Sciences (No.: IR.MUMS.MEDICAL.REC.1398.399) approved in 2019 titled “investigating carotid intima-media thickness and its relationship with metabolic and nutritional factors”.

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Authors' contributions

All authors contributed equally to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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