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ASSOCIATION OF ABDOMINAL OBESITY WITH CAROTID ARTERY DISEASE

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Abstract

Introduction**:** Abdominal obesity (AO) is a condition of excessive abdominal fat deposited to such an extent that it is likely to have a negative impact on health. Carotid artery disease (CAD) usually involves atherosclerotic changes in the arterial wall. CAD is a significant risk factor for cerebrovascular insult (CVI) and transient ischemic attack (TIA).

Objective**:** To show whether there is an association of AO with CAD in our study group. To determine the prevalence of CAD in the subjects with or without AO. To determine the prevalence of asymptomatic and symptomatic CAD in all these subjects.

Materials and methods**:** This cross-sectional study included 73 subjects divided into a study (42 subjects with AO) and a control group (31 subjects without AO), aged 41 to 74 years. AO was determined by measuring waist circumference according to NCEP ATP III criteria reference points; Extracranial carotid evaluation was performed ultrasonographically with a linear probe with a frequency of 7.5 MHz. CAD assessment was performed using Ultrasound Consensus Criteria for Carotid Stenosis.

Results**:** The study group showed a higher incidence of CAD than the control group, but statistically not significant ($p>0.05$). In the study group 25 subjects (59.52%) had CAD, 7 subjects (28%) were symptomatic, while 18 subjects (72%) were asymptomatic. In the control group 16 subjects had CAD (51.61%), 3 subjects were symptomatic (18.75%), while 13 subjects (81.25%) were asymptomatic.

Conclusion**:** Although this study did not show a significant association between AO and CAD, early carotid ultrasound examination is necessary to diagnose CAD in AO subjects, which would achieve effective prevention of CVI and TIA. More powerful studies with much larger number of subjects are needed.

Keywords**:** abdominal obesity, carotid artery disease, cerebrovascular stroke, transient ischemic attack

Introduction

Abdominal obesity (AO) is a condition of excessive abdominal fat that has been deposited to such an extent that it is likely to have a negative impact on health. AO is also known as central obesity, truncal obesity, visceral or intra-abdominal adipose tissue. AO means visceral or intra-abdominal adipose tissue located inside the peritoneal cavity, packed between the internal organs and the torso. Visceral adipose tissue is composed of several fatty deposits including perirenal adipose tissue, mesenteric adipose tissue, and epididymal white adipose tissue (EWAT). In abdominal obesity, the body has an “apple” shape. If the excess fat is dominant on the hips, then the body has the shape of a "pear".

There are a number of studies showing a clear association of AO with vascular and metabolic disease, [1] cardiovascular diseases, [2] Alzheimer's disease, [3] type 2 diabetes and insulin resistance. [4,5] The risk of death increases with increasing waist circumference. [6] AO as a significant metabolic risk factor is part of the criteria for metabolic syndrome. [7,8,9,10]

Carotid artery disease (CAD) involves changes in the arterial wall that cause thickening of the IMT (Intima Media Thickness), narrowing, or complete obstruction of the lumen of the carotid artery. Atherosclerosis is the most common cause of CAD. CAD predisposing sites are carotid bifurcation, the ACI (Arteria Carotis Interna) osteum, including the posterior outer wall of the carotid sinus, and the distal common carotid artery (ACC). CAD can be asymptomatic and symptomatic. Asymptomatic CAD is without clinical manifestation of brain damage. While symptomatic CAD may manifest clinically as TIA (Transitory Ischemic Attack) or CVI (Cerebrovascular insult). CVI is a medical condition in which poor blood flow to the brain results in cell death by initiating an ischemic cascade. TIA is a short episode of vascular dysfunction with vascular cause, with clinical symptoms usually

lasting less than an hour and no evidence of a brain tissue infarction on imaging. [11] Neurological dysfunction in CVI and TIA depends on which part of the brain is affected by ischemic suffering.

Objective

To show whether there is an association of AO with CAD. To determine the prevalence of CAD in the subjects with and without AO. To determine the prevalence of asymptomatic and symptomatic CAD in all these subjects.

Materials and methods

This cross-sectional study included a total of 73 subjects, 41 men (56.16%) and 32 women (43.84%), aged 41 to 74 years who were clinically and ultrasonographically processed in the CGH "8-mi Septemvri" - Skopje in the period from December 2019 to March 2020.

Inclusion criteria: Subjects with AO according to NCEP ATP III (National Cholesterol Education Program, Adult Treatment Panel III) criteria reference points for waist circumference measurement, age ≥ 41 and ≤ 74 years, and without AO (control group). Exclusion criteria: pregnant and breastfeeding women, age <41 and > 74 years, patients with diabetes mellitus, with systemic diseases, malignancies or chronic kidney disease. All participants were informed of the purpose of the study and informed consent was obtained prior to the examination. The research sample was divided into a study and a control group. The study group consisted of 42 subjects with AO: 24 men (57.14%) and 18 women (42.86%), and the control group of 31 subjects without AO: 17 men (54.84%) and 14 women (45.16%). AO was determined by measuring waist circumference according to standard routine protocols and according to NCEP ATP III criteria reference points for waist circumference measurement: waist circumference ≥ 102cm in men and ≥ 88 cm in women. The CAD assessment was performed by ultrasonographic examination of the extracranial carotid arteries with the Esaote MyLab ™ 70 XVG ultrasound device, with a linear probe with a transmission frequency of 7.5 MHz , using B-mode, color and Doppler mode. CAD assessment was performed using ultrasonic consensus criteria for carotid stenosis: I. Absence of stenosis (normal finding) - no plaques, normal IMT (Intima Medica Thickness), PSV (Peak Systolic velocity) <125 cm/s, ACI/ACC ratio of PSV <2, EDV (End-diastolic velocity) <40 cm/s; 2. II Stenosis <50%: present plaque <50%, IMT thickened, PSV <125 cm/s, ACI/ACC ratio of PSV <2, EDV <40 cm/s; III Stenosis <50-69%: IMT thickened, visible plaque> 50%, PSV 125-230 cm/s, ACI/ACC ratio of PSV 2-4, EDV 40-100 cm/s. IV Stenosis 70% to sub-occlusion (up to 99%): visible narrowing> 50%, PSV> 230 cm/s, ACI/ACC ratio of PSV> 4, EDV> 100 cm/s; V Sub-occlusion/close to occlusion: Visible narrowed; almost obliterated artery, PSV may be low or non-detectable, ACI/ACC ratio of PSV variable, EDV variable; VI Occlusion: no flow, lumen visible, PSV no flow, non-detectable ACI/ACC ratio of PSV not applicable, EDV not applicable. Objective neurological assessment of the existence of CVI and TIA was performed by standard protocol for neurological examination and CTM results from medical history were reviewed.

Statistical analysis of the data was performed with the statistical program SPSS for Windows 23.0. To compare numerical values between two groups of subjects, Student t test for independent samples was used, and to compare categorical values, the contingency tables for categorical data were used and for the significance of association of $p<0,05$, the Fisher exact test was used.

Results

Regarding the gender distribution among the total number of subjects, the male gender dominated with 41 subjects (56.16%), while 32 subjects (43.84%) were female.

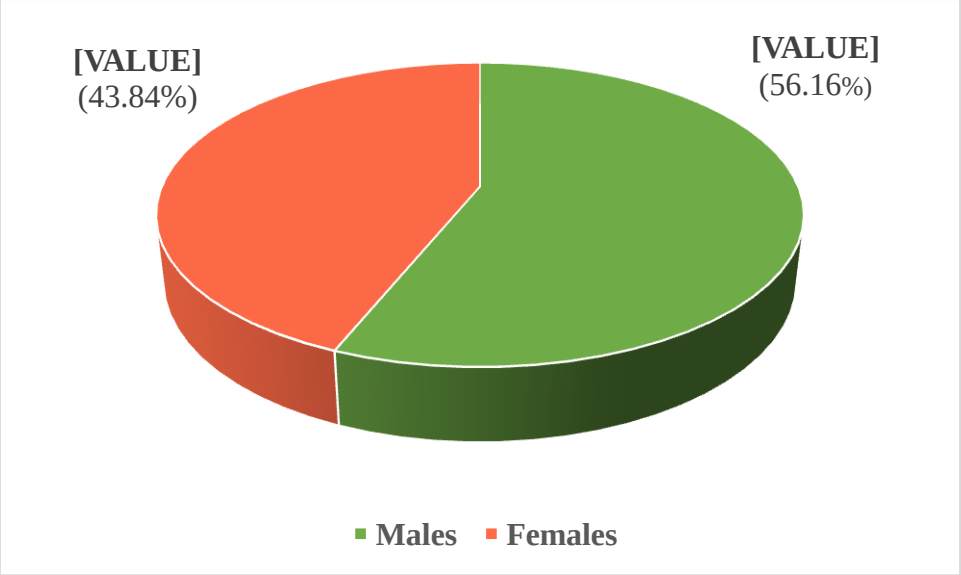

Fig 1. Distribution by gender in the total number of subjects

In the study group, there were a total of 25 subjects (59.52%) with CAD: 16 men (64%) and 9 women (36%), and the control group had a total of 16 subjects (51.61%) with CAD: 10 men (62, 5%) and 6 women (37.5%).

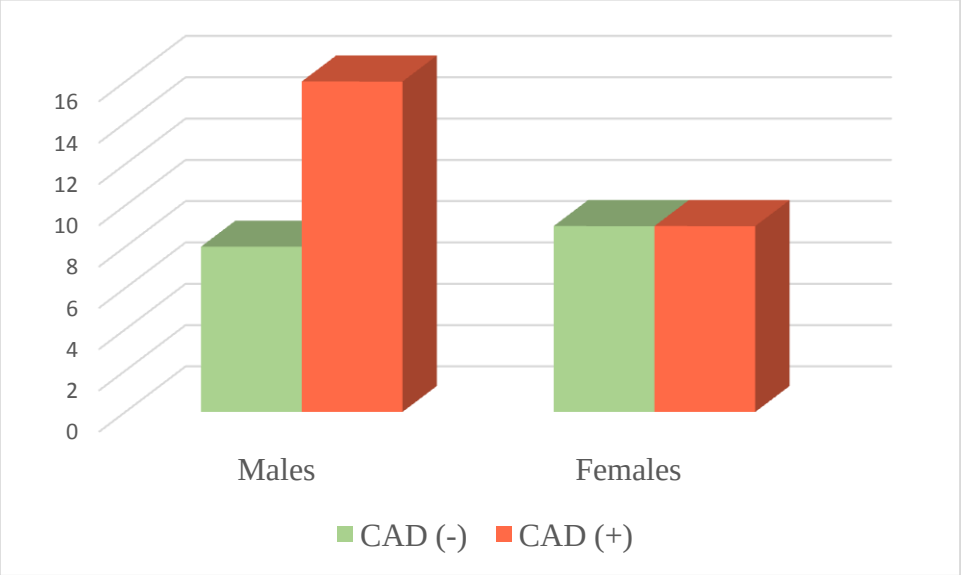

Fig 2. Presence of CAD in the study group.

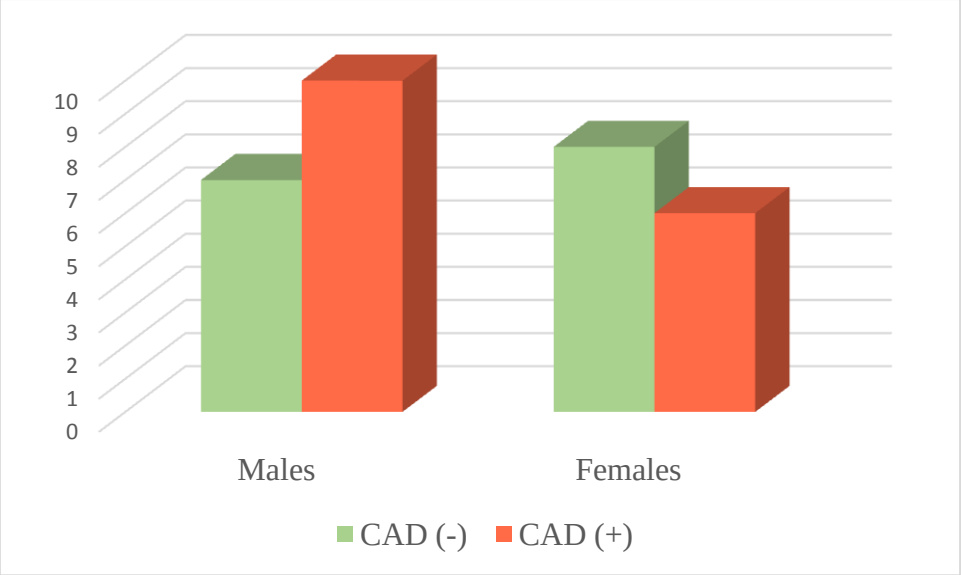

Fig 3. Presence of CAD in the control group.

The mean age of subjects with CAD in the study group was 59.14 years, while in the control group was 57.42 years, and the difference was statistically not significant (p>0,05)
In the study group of 25 subjects (59.52%) with CAD, 7 subjects (28%) were symptomatic, while 18 subjects (72%) were asymptomatic.

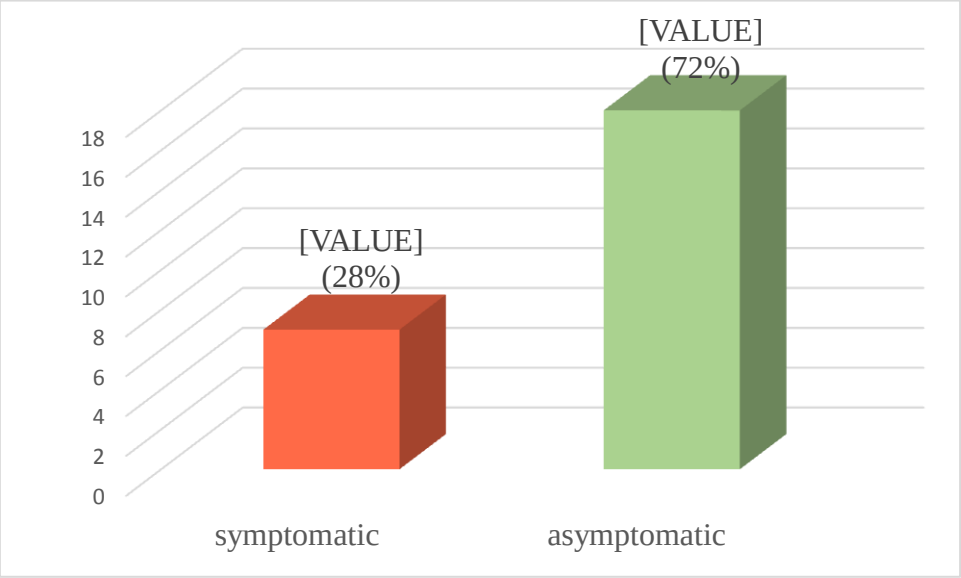

Fig 4. Symptomatic versus asymptomatic subjects with CAD in the study group

In the control group of a total of 16 subjects (51.61%), 3 subjects were symptomatic (18.75%), while 13 subjects (81.25%) were asymptomatic.

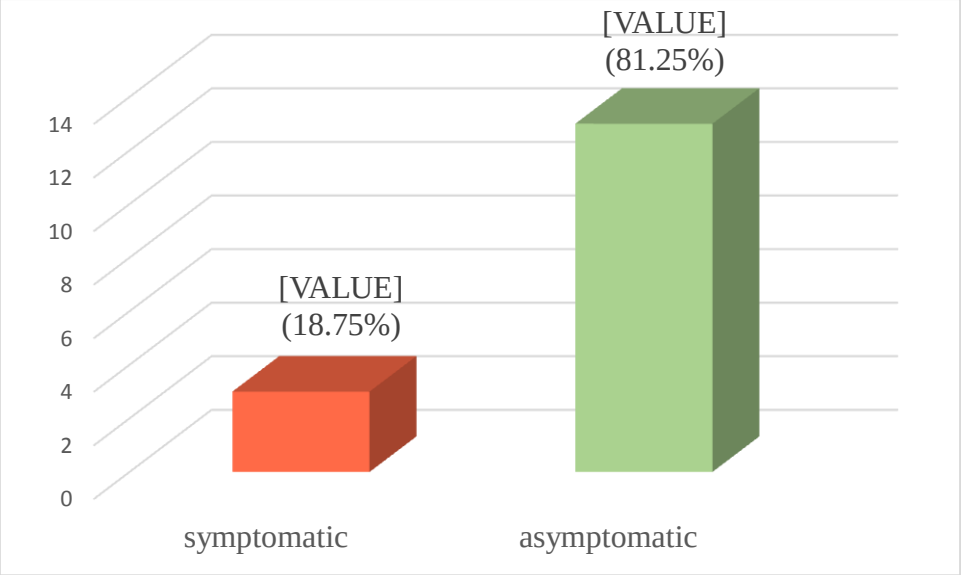

Fig 5. Symptomatic versus asymptomatic subjects with CAD in the control group

Regarding the degree of carotid artery stenosis (CAS) in the study group 17 subjects (40.48%) had normal findings, stenosis <50% had 11 subjects (26.19%), stenosis 50-69% had 9 subjects (21.43%), stenosis 70-99% had 5 subjects (11.9%), while no subjects had occlusion.

Table 1. Prevalence of Carotid Artery Stenosis in the Study group according to degree of stenosis

Degree of Carotid Artery Stenosis (CAS) in the Study Group	(n) Number of Subjects	%
Normal Finding	17	40.48
< 50 %	11	26.19
50-69%	9	21.43
70-99%	5	11.9
Occlusion	0	0

In the control group, 15 subjects (48.39%) had a normal finding, stenosis <50% had 9 subjects (29.03%), stenosis 50-69% had 6 subjects (19.35%), stenosis 70-99 % had 1 subject (3.23%), while no subjects had occlusion.

Table 2. Prevalence of Carotid Artery Stenosis in the Control group according to degree of stenosis

Degree of Carotid Artery Stenosis (CAS) in the Control Group	(n) Number of Subjects	%
Normal Finding	15	48.39
< 50 %	9	29.03
50-69%	6	19.35
70-99%	1	3.23
Occlusion	0	0

The study group showed higher prevalence of CAD than the control group, but statistically not significant. Different stages of stenosis and normal findings were compared between the two groups, but the difference showed to be not statistically significant. The gender and age did not differ between the study and control group which showed that the groups were homogenous. (table 3)

Table 3. Gender, clinical and morphologic differences between the study and control group

	Study group	**Control group**	**Fisher exact test**
gender	24 m	17 m	=1.0 non significant
	18 f	14 f	
With CAD gender	16 m	10 m	=1.0 non significant
	9 f	6 f	
Symptomatic with CAD yes/no	7 yes	3 yes	=0,71 non significant
	18 no	13 no	
CAS 50-99% Normal or <50%	14	7	=0,4339 non significant
	28	24	
CAS normal CAS 70-99%	17	15	= 0,3696 non significant
	5	1	

Discussion

AO is a significant metabolic risk factor associated with serious health consequences. The unequivocal link between AO and atherogenic dyslipidemia (high levels of LDL cholesterol and triglycerides and low levels of HDL cholesterol) and insulin resistance has also been confirmed. [12,13] AO contributes to major causes of death and disability including cerebrovascular and cardiovascular disease, high blood pressure, diabetes, osteoarthritis, fatty liver and depression.

There are a number of studies to determine the atherogenicity of visceral adipose tissue and the association of AO with CAD. But the results of most epidemiological studies are different, most likely due to the use of different measurement methods and indirect determination of AO[14].

The most commonly used methods are determining the waist circumference and determining the waist-hip ratio. Several cross-sectional studies have examined the association of total body fat but not of AO with CAD, and many have not reported significant associations with the intima-media thickness (IMT) of the common carotid artery[15].

Of the two large cross-sectional studies on the association between AO and IMT, one did not confirm this association, [16] and the other showed a significant association of AO with IMT [17]. The strongest support for the atherogenic concept of AO comes from the prospective study of Finnish men, which showed a significant association between AO and 4-year progression of IMT and atherosclerotic plaques [18].

The fact of the reversal of generalized atherosclerosis and carotid atherosclerosis and its great influence on the occurrence of cerebrovascular events is also confirmed and known. Symptomatic CAD involves the etiological association of CAD with TIA and CVI. This is especially important because more than 80% of all strokes are ischemic strokes, and only 20% are intracerebral haemorrhages. Of all ischemic strokes, three-quarters involve the anterior circulation, while the posterior cerebral circulation accounts for a quarter [19]. About 20-25% of stroke patients have atherosclerosis of the large blood vessels in the neck that feed the brain, 85% of which have CAD as the cause. There is a particularly increased risk of stroke in atherosclerotic stenotic lesions in the extracranial internal carotid artery or carotid bifurcation [20] T A Lakka et al. in their study, demonstrated the association of AO and accelerated progression of carotid atherosclerosis in men, which is in fact the first evidence that AO is associated with accelerated progression of atherosclerosis and supports the view that it is an important risk factor for cardiovascular events[18].

Numerous scientific papers have shown that AO is a significant risk factor for CVI and TIA. [21, 22] The results of this study showed that the overall prevalence of CAD in subjects with AO was

59.52% (25 out of 41 subjects), of whom symptomatic CAD had 28%, asymptomatic CAD had 72%, but the overall prevalence of CAD in non-AO subjects in this study was also high, 51.61% (16 of 31 subjects), and 18.75% had symptomatic CAD and 81.25% had asymptomatic CAD. The difference of CAD between the subjects with and without AO appeared to be statistically not significant. But, in the literature the findings are also not consistent. Additionally, our study has a limitation factor, the small number of subjects. If a larger number of subjects in this study is included, a statistically significant difference may be expected.

Conclusion

Although this study did not show a significant association between AO and CAD, in the group with AO a large number of subjects had asymptomatic CAD and are potential and "quiet" candidates for a poor outcome. This imposes the need to raise awareness of abdominal obesity as a significant risk factor and early carotid ultrasound examination in order to diagnose CAD in a timely manner, which would achieve effective prevention of CVI and TIA. More powerful studies with much larger number of subjects are needed.

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