Basic and Clinical Sciences
ISSN 1309-5102
DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949
dergipark.ulakbim.gov.tr/bcs Basic Clin Sci 2015; 4: 45-61

Original Article / Orijinal Araştırma

Carotid blood-flow velocity and intima-media thickness changes in patients with obesity

Obez hastalarda karotis arter akım hızı ve intima-media kalınlık değişiklikleri

Ayselin Güner[1], Hulusi Eğilmez[1], İsmail Şalk[11], Ali Çetin[2], Mehmet H Atalar[1]

Departments of [1]Radiology and [2]Obstetrics and Gynecology, Cumhuriyet University Faculty of Medicine, 58140 Sivas, Turkey

Abstract

Aim. Carotid ultrasound scanning including carotid intima-media thickness (IMT) and Doppler velocity measurements is commonly used modality to assess carotid artery disease related to atherosclerosis as an important result of obesity. The aim of the present study was to assess the effect of obesity on the carotid ultrasonographic parameters including lumen diameters, IMTs, peak systolic velocities (PSVs), and end-diastolic velocities (EDVs) of common carotid arteries (CCAs) and internal carotid arteries (ICAs) in an asymptomatic population. **Methods.** The lumen diameters, IMTs, PSVs, and EDVs of CCAs and ICAs were performed in the study participants grouped according to their body mass index (BMI) in an age-adjusted manner: normal group with BMI 18.50-24.99; overweight group with BMI 25.00-24.99; obesity classes I&II group with BMI 30.00-39.99; obesity class III group with BMI ≥40.00. **Results.** Overall, obesity class I-III increased the lumen diameters of CCAs and ICAs ($p<0.05$); increased the IMTs of CCAs but not of the ICAs. ($p<0.05$); and decreased the PSVs of CCAs but not of the ICAs ($P<0.05$). Overall, in accordance with the severity of obesity, the EDVs were decreased in the CCAs but not in the ICAs ($p<0.05$). **Conclusions.** Obesity may have a potential to increase the lumen diameter of CCAs and ICAs, to increase the IMTs of CCA but not ICA, and to decrease the PSVs and EDVs of CCA but not ICA. There is a need to determine the effect of obesity on the wall and function of carotid arteries in further studies in a broader population subclassified according to the severity and duration of obesity.

Keywords: Carotid artery, intima-media thickness, Doppler blood-flow velocity, obesity

Özet

Amaç. Doppler akım ölçümü ve karotis intima-media kalınlığını (İMK) içeren karotis ultrason taraması, obezitenin önemli sonucu olarak arterioskleroz ile ilişkili karotis arter

[1] Corresponding author:
Dr. İsmail Şalk, Radyoloji Anabilim Dalı, Cumhuriyet Üniversitesi Tıp Fakültesi, TR-58140 Sivas
Emailismailsalk@gmail.com

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

hastalığının değerlendirilmesinde yaygın olarak kullanılmaktadır. Bu çalışmanın amacı, asemptomatik toplulukta internal karotis arterin (İKA) ve kommon karotis arterin (KKA); lümen çapını, IMK, pik-sistolik (PSH) ve end-diastolik hızını (EDH) içeren karotid ultrasonografik bulgularına obezitenin etkilerini değerlendirmektir. **Yöntem.** KKA ile İKA'nin damar lümen capı, IMK, PSH ve EDH'ları yaşlara göre ve body mass indekslerine (BMİ) göre gruplara ayrıldı. Normal grubun BMİ'si: 18.50-24.99; kilolu grubun BMI'si 25.00-24.99; obezite I&II grubun BMI'si 30.00-39.99; obezite III grubun BMI'si ≥40.00 olacak şekilde gruplara ayrıldı. **Bulgular.** Genel olarak, obezite I-III grubunda KKA ve İKA damar lümen çapı artmıştı ($p<0.05$); KKA'in İMK artmasına rağmen İKA'da artış saptanmadı ($p<0.05$) ve KKA'in PSH'ında azalmaya rağmen, İKA'de azalma olarak saptanmadı ($p<0.05$). Genel olarak obezitenin şiddeti göz önüne alındığı zaman, EDH'da, KKA'da azalma saptanırken, İKA'da saptanmadı ($p<0.05$). **Sonuçlar.** Obezite, İKA'nın değil ama KKA'nın İMK'ındaki artış ile PSH ve EDH azalışında ve KKA ile İKA damar lümen çapının artışına sebep olabilir. Karotid arterin duvar ve fonksiyonlarının obeziteden etkilenmesinin saptanması için daha geniş çalışmalara ihtiyaç vardır.

Anahtar sözcükler: Karotis arter, intima-media kalınlığı, Doppler kan akım hızı, obezite

Introduction

Obesity has become one of the most important public health problems worldwide. Obesity, primarily abdominal obesity, is a significant risk factor for the development of atherosclerosis. The clinically defined metabolic syndrome is the most prominent atherosclerotic risk factor based on adipose tissue dysfunction producing low-grade inflammation and endothelial dysfunction [1, 2].Atherosclerosis is a systemic pathologic process of the large and medium-sized arteries such as carotid and cerebral arteries. It causes luminal narrowing as a result of the accumulation of lipid and fibrous material between the intimal and medial layers of the vessel [3-5]. Atherosclerosis as a chronic disease can remain asymptomatic for decades. Approximately 25% of strokes are due to carotid artery disease because of slowly progressive and cumulative narrowing and decreasing blood flow [6, 7]. Stroke is one of the leading cause of death and the most common cause of long-term neurologic disability.

Carotid artery intima-media thickness (IMT) is a well-accepted marker of subclinical atherosclerosis associated with cardiovascular risk factors and predictive of incident stroke [8-10]. Carotid ultrasonography imaging including evaluations of lumen diameter and IMT and color Doppler measurements of peak systolic velocity (PSV) and end diastolic velocity (EDV) has gain important role in the prevention and management of cardiovascular and neurologic disorders. Carotid Doppler ultrasound via B-mode imaging detects focal increases in blood flow velocity indicative of high-grade carotid stenosis [11].

Carotid ultrasonography as a noninvasive, accurate, and cost-effective imaging modality has gained important place to obtain morphologic and functional information for the investigation of carotid abnormalities. It is increasingly becoming the first and often the sole imaging approach for prediction and management of cardiovascular disorders such as determining requirement of endarterectomy, although in special cases, costly and

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

invasive procedures may be required [12]. The PSV is the most frequently used measurement to gauge the severity of the stenosis, but the EDV and other Doppler parameters provide additional information [13, 14].

According to our knowledge, there is not sufficient data to determine the effect of obesity with a body mass index from >25.00 to >40.00 kg/m2 in a population asymptomatic for cardiovascular and neurologic disorders. The aim of the present study was to assess the effect of obesity on the carotid ultrasonographic parameters including the lumen diameters, IMTs, PSVs, and EDVs of common carotid arteries (CCAs) and internal carotid arteries (ICAs) in an asymptomatic population.

Materials and methods

Written informed consent was obtained from each subject, and the study protocol was approved by the Human Ethics Committee of our university. Study participants are a Turkish population of 160 asymptomatic adults aged from 30 to 61 (mean [SD]: 46.8 [5.8]) years. Participants were not included if they had diagnosed as having heart attack, stroke, transient ischemic attack, heart failure, angina, atrial fibrillation, or history of any cardiovascular procedure. Age, gender, BMI, fasting plasma glucose, total LDL and HDL cholesterol and triglyceride levels of the study population were recorded.

Study participants were included to study groups according to their body mass index (BMI) [15] in an age-adjusted manner: normal group with BMI 18.50-24.99; overweight group with BMI 25.00-24.99; obesity classes I&II group with BMI 30.00-39.99; obesity class III group with BMI ≥40.00.

The patients fasted overnight and not given any medication before blood drawn. Blood samples were obtained for determination of glucose and lipids and full blood count. Blood pressures were measured at the right brachial artery after 10-min supine rest. The participants studied underwent ultrasonography of the common, right, and left carotid arteries for Doppler flow and IMT measurements. Heart rate and blood pressure were recorded prior to US examination. One radiologist performed all ultrasound examinations by an ultrasonography device (General Electric Logic 9; Waukesha, WI, USA) equipped with a 10 MHz linear probe. Intraobserver reliability was determined as Kappa coefficient ranged from 0.67-0.87. In all patients, routine carotid US studies were performed, which included gray-scale, pulsed Doppler, and color Doppler flow US examinations of the left and right CCAs and ICAs. Lumen diameters of left and right CCAs and ICAs were recorded.

Assessment of carotid IMT

Participants were examined supine with the head rotated 45° towards the left or right side. Imaging was done in the plane parallel to the neck with the jugular vein lying immediately above the common carotid artery. Images of the right common carotid artery were centered 10 to 15 mm below (caudad to) the right common carotid artery bulb. End-diastolic images (smallest diameter of the artery) were captured. IMT of the common carotid artery (CCA) and presence of plaques were assessed. IMT of the CCA was

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

determined in the far wall according 1 cm proximal to the bifurcation. Carotid artery plaque was excluded [10, 16].

Assessment of carotid Doppler ultrasonography

Patients were examined while they were in a supine position. Doppler spectral waveforms were obtained in the CCA and ICA. The measured angle of insonation was less than 60° for all measurements [17].

Statistical analysis

Data were expressed as mean ± SD. The age, blood test, ultrasonographic and Doppler ultrasonographic findings were analyzed with ANOVA with post hoc Tukey test. Significance was determined at the p<0.05 level.

Results

Table 1 presents age, sex ratio, BMI, and fasting plasma glucose, total cholesterol, LDL cholesterol, HDL cholesterol, and triglyceride levels of the normal, overweight, obesity classes I&II, and obesity class III groups. The age and fasting plasma glucose level of obesity class III group were significantly higher than those of the normal, overweight, obesity classes I&II groups (p<0.05). The ages of overweight and obesity classes I&II groups were significantly higher than that of the normal group (p<0.05). Total, LDL, HDL cholesterol and triglyceride levels were found comparable among the study groups.

Table 1. Selected clinical data of study groups.

	Normal (n=50)	Overweight (n=40)	Obesity classes I&II (n=40)	Obesity class III (n=30)
Age (y)	46.6±4.5	45.8±6.1c	46.6±7.5b	48.9±4.3a
Sex ratio (F/M)	25/25	20/20	20/20	20/10
BMI (kg/m2)	23.1±0.2	27.7±0.3	32.2±0.3	42.0±0.3
Fasting plasma glucose (mg/dL)	93.4±7.6	96.2±12.1	94.4±8.7	103.4±9.1d
Total cholesterol (mg/dL)	197.7±33.7	199.1±44.4	195.5±35.3	198.2±33.6
LDL cholesterol (mg/dL)	115.3±37.9	127.7±33.0	120.0±35.7	120.6±24.4
HDL cholesterol (mg/dL)	47.2±24.2	39.4±8.2	40.4±17.5	44.8±7.1
Triglyceride (mg/dL)	108.6±52.6	127.3±60.1	134.9±60.9	120.1±46.2

[a,d]P < 0.05 vs. normal, overweight, obesity classes I&II groups.
[b,c]P < 0.05 vs. normal group.

Figure 1 shows the lumen diameters of left common and internal carotid arteries of the normal, overweight, obesity classes I&II, and obesity class III groups. The lumen diameter of left common carotid artery of obesity class III group was significantly higher than those of the normal, overweight and obesity CI&II groups (p<0.05).

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

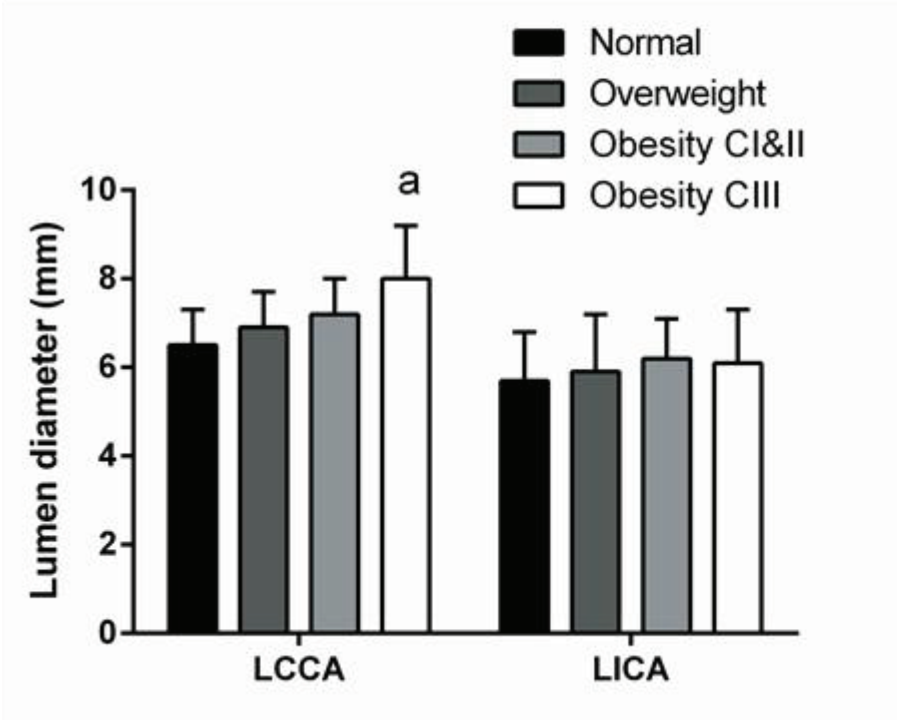

Figure 1. Lumen diameters of left common and internal carotid arteries of study groups. Data were expressed as mean±SD. LCCA, left common carotid artery; LICA, left internal carotid artery; obesity CI&II, obesity classes I&II; obesity CIII, obesity class III.
aP<0.05 vs. normal, overweight, and obesity CI&II groups.

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

Figure 2 displays the lumen diameters of right common and internal carotid arteries of the normal, overweight, obesity classes I&II, and obesity class III groups. The lumen diameters of right common and internal carotid arteries of obesity class III group were significantly higher than those of the normal, overweight, and obesity CI&II groups (p<0.05). The lumen diameters of right common and internal carotid artery of obesity classes I&II group were significantly higher than those of the normal and overweight groups (p<0.05).

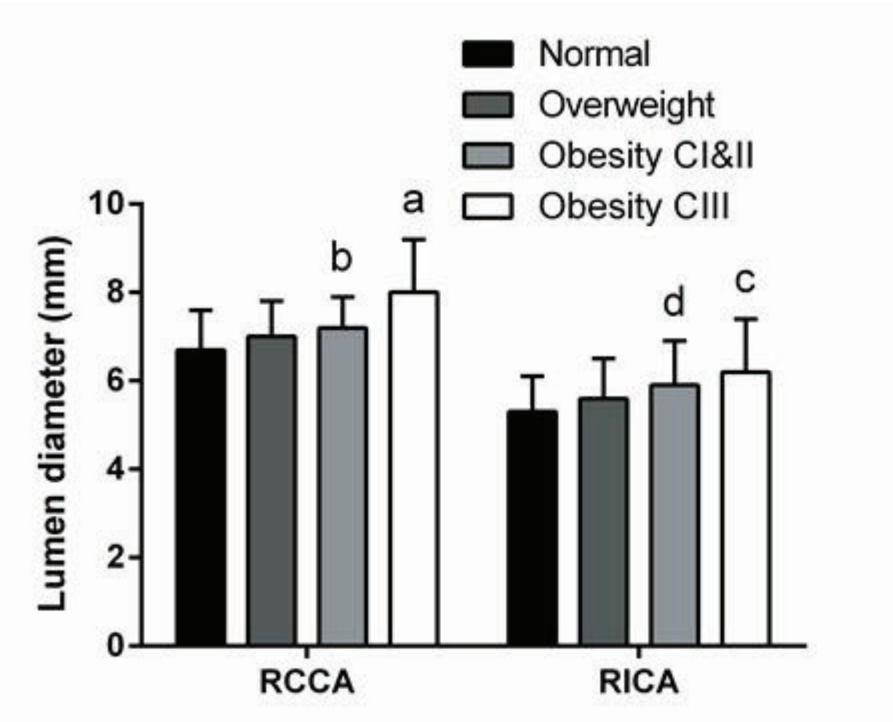

Figure 2. Lumen diameters of right common and internal carotid arteries of study groups. Data were expressed as mean±SD. RCCA, right common carotid artery; RICA, right internal carotid artery; obesity CI&II, obesity classes I&II; obesity CIII, obesity class III.
a,cP<0.05 vs. normal, overweight, and obesity CI&II groups.
b,dP<0.05 vs. normal and overweight groups.

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

Figure 3 displays the IMTs of left common and internal carotid arteries of the normal, overweight, obesity classes I&II, and obesity class III groups. The IMTs of left common and internal carotid arteries of obesity class III group were significantly higher than those of the normal, overweight, and obesity CI&II groups ($p<0.05$). The IMTs of left common and internal carotid arteries of obesity classes I&II group were significantly higher than those of the normal and overweight groups ($p<0.05$). The IMT of left common carotid artery of overweight group was significantly higher than that of the normal group ($p<0.05$).

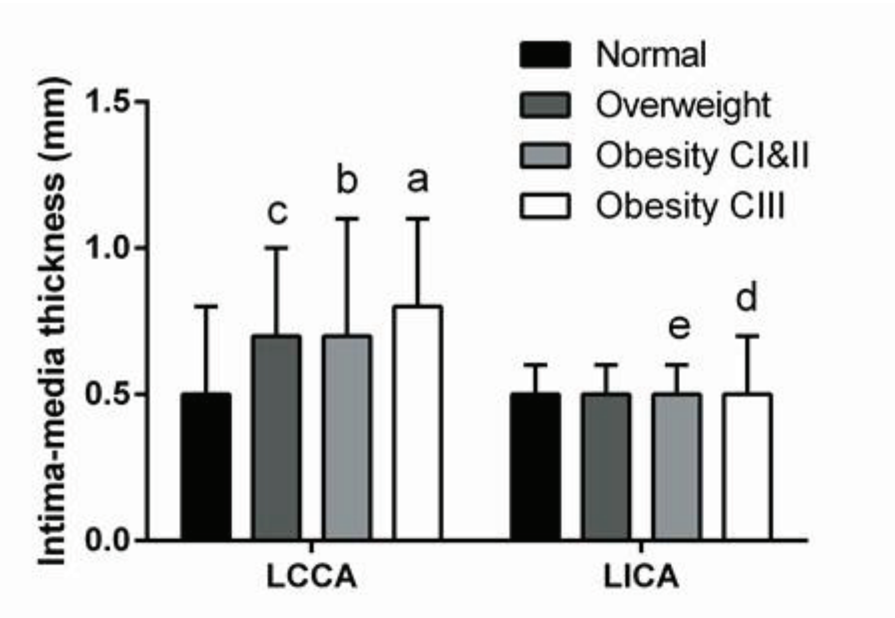

Figure 3. Intima-media thicknesses of left common and internal carotid arteries of study groups. Data were expressed as mean±SD. LCCA, left common carotid artery; LICA, left internal carotid artery; obesity CI&II, obesity classes I&II; obesity CIII, obesity class III.
a,dP<0.05 vs. normal, overweight, and obesity CI&II groups.
b,eP<0.05 vs. normal and overweight groups.
cP<0.05 vs. normal group.

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

Figure 4 presents the IMTs of right common and internal carotid arteries of the normal, overweight, obesity classes I&II, and obesity class III groups. The IMT of right common carotid artery of obesity class III group was significantly higher than those of the normal, overweight, and obesity CI&II groups (p<0.05). The IMT of right common carotid artery of obesity classes I&II group was significantly higher than those of the normal and overweight groups (p<0.05).

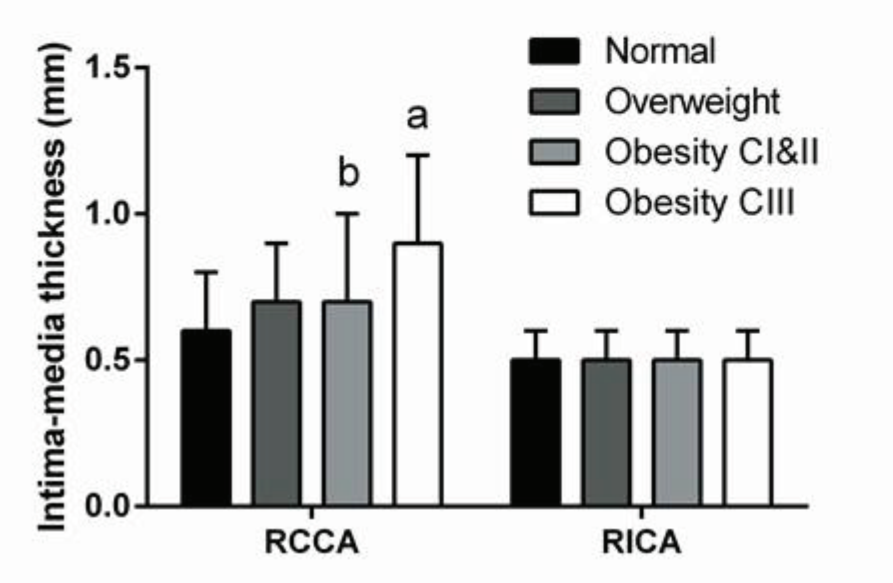

Figure 4. Intima-media thicknesses of right common and internal carotid arteries of study groups. Data were expressed as mean±SD. RCCA, right common carotid artery; RICA, right internal carotid artery; obesity CI&II, obesity classes I&II; obesity CIII, obesity class III.
aP<0.05 vs. normal, overweight, and obesity CI&II groups.
a,bP<0.05 vs. normal and overweight groups.

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

Figure 5 presents the peak systolic velocities of left common and internal carotid arteries of the normal, overweight, obesity classes I&II, and obesity class III groups. The PSV of left common carotid artery of normal group was significantly higher than those of the other groups (p<0.05).

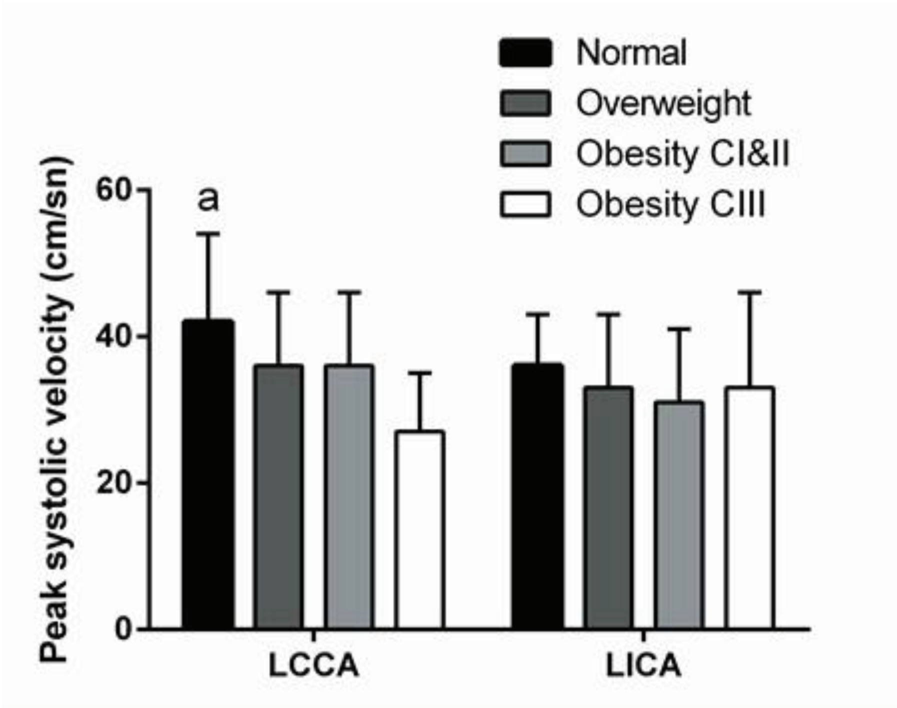

Figure 5. Peak systolic velocities of left common and internal carotid arteries of study groups. Data were expressed as mean±SD. LCCA, left common carotid artery; LICA, left internal carotid artery; obesity CI&II, obesity classes I&II; obesity CIII, obesity class III.
aP<0.05 vs. overweight, obesity CI&II, and obesity CIII groups.

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

Figure 6 shows the peak systolic velocities of right common and internal carotid arteries of the normal, overweight, obesity classes I&II, and obesity class III groups. The PSV of right CCA and ICA of normal group was significantly higher than those of the other groups (p<0.05).

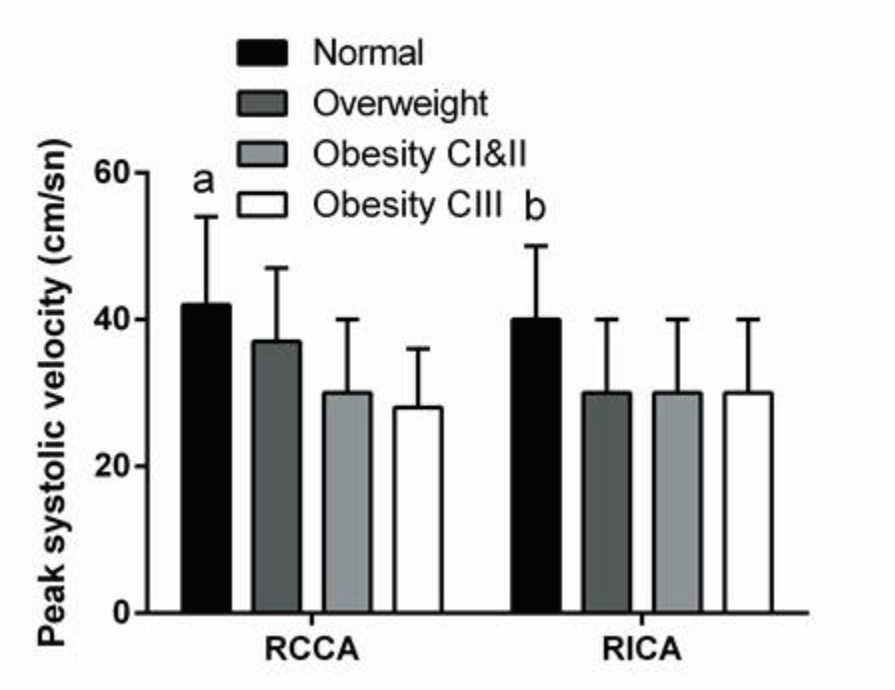

Figure 6. Peak systolic velocities of right common and internal carotid arteries of study groups. Data were expressed as mean±SD. RCCA, right common carotid artery; RICA, right internal carotid artery; obesity CI&II, obesity classes I&II; obesity CIII, obesity class III.
a,bP<0.05 vs. overweight, obesity CI&II, and obesity CIII groups.

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

Figure 7 shows the end diastolic velocities of left common and internal carotid arteries of the normal, overweight, obesity classes I&II, and obesity class III groups. The EDV of left common carotid artery of obesity class III group was significantly lower than those of the other groups (p<0.05).

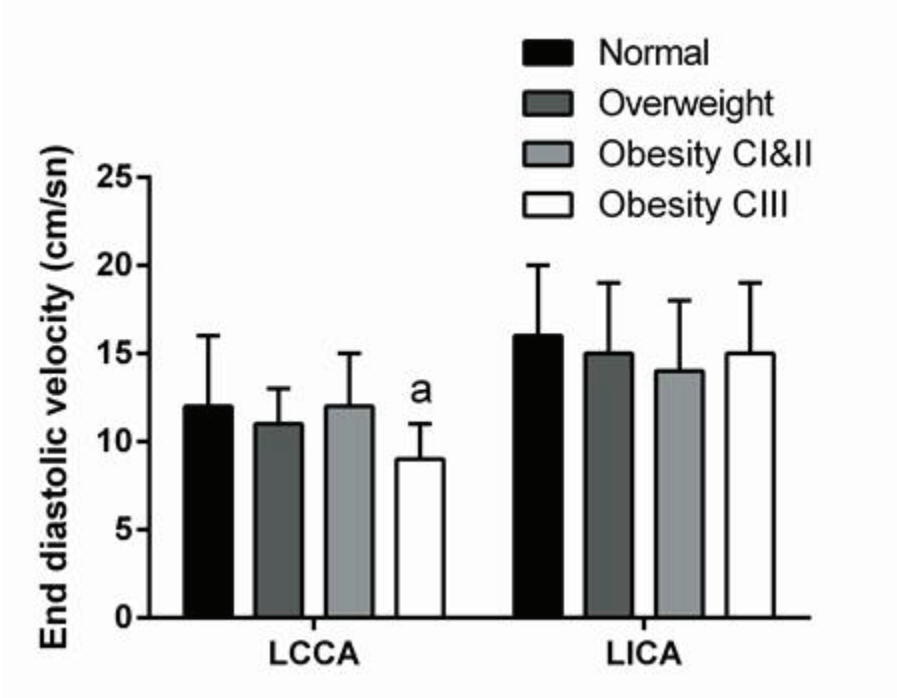

Figure 7. End diastolic velocities of left common and internal carotid arteries of study groups. Data were expressed as mean±SD. LCCA, left common carotid artery; LICA, left internal carotid artery; obesity CI&II, obesity classes I&II; obesity CIII, obesity class III.
aP<0.05 vs. normal, overweight, and obesity CI&II groups

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

Figure 8 shows the end diastolic velocities of right common and internal carotid arteries of the normal, overweight, obesity classes I&II, and obesity class III groups. The EDV of right common carotid artery of obesity class III group was significantly lower than those of the other groups (p<0.05).

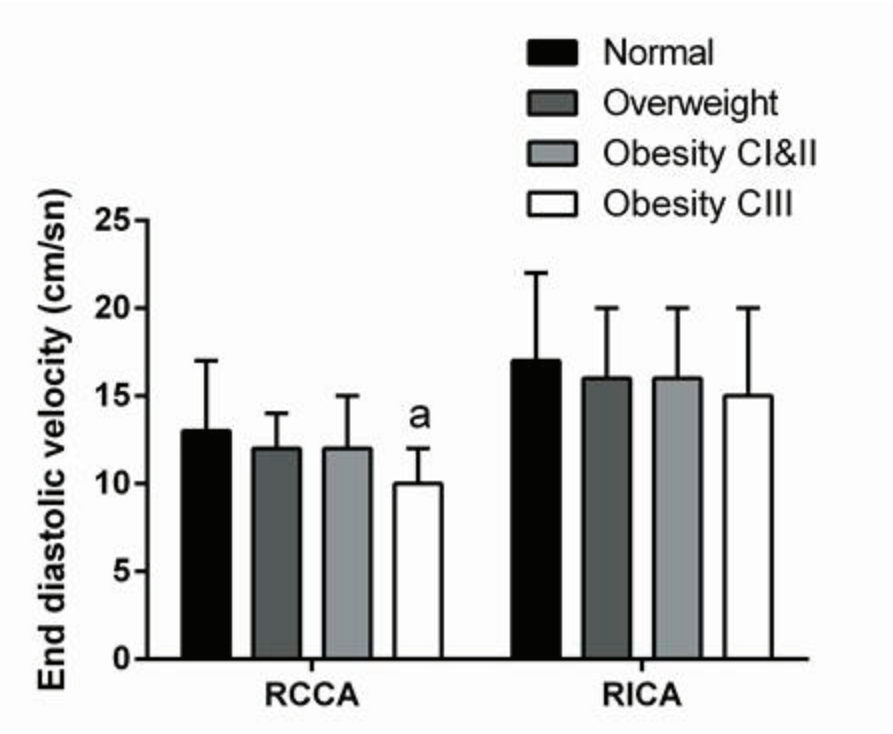

Figure 8. End diastolic velocities of right common and internal carotid arteries of study groups. Data were expressed as mean±SD. RCCA, right common carotid artery; RICA, right internal carotid artery; obesity CI&II, obesity classes I&II; obesity CIII, obesity class III.
aP<0.05 vs. normal, overweight, and obesity CI&II groups

Discussion

In this study, the IMT, PSV, and EDV of left and right CCAs and ICAs were evaluated in adult subjects according to the degree of obesity. Normal, overweight, obesity classes I&II, and obesity class III subjects were found considerable comparable with regard to the fasting plasma glucose and lipid levels. In accordance with the findings of previous study of Wildman et al. [18], overall, we found that the lumen diameter of left and right CCAs and ICAs increased as parallel to the severity of obesity. Overall, according to our findings, obesity increased the IMTs of left and right CCAs but not of the left and right

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

ICAs. Overall, according to our findings, obesity decreased the PSVs and EDVs of left and right CCAs but not of the left and right ICAs.

The carotid artery provides itself an easy way to study by high-resolution ultrasound devices. It is located superficially and found as relatively stationary and parallel to the surface of the neck, at least to the level of the carotid bifurcation [19]. Generally, it is classified into three segments during ultrasound examination, each approximately 1 cm in length: common carotid as the most proximal segment, the 1-cm straight segment of the extracranial carotid artery immediately prior to the bifurcation. Its distal boundary is identified at where it begins to divide into its internal and external ICAs. Of these anatomic segments, the easiest to examine by ultrasound is the CCA, making it a favorable target to perform ultrasonographic measurements. Polak et al. [20] have concluded that carotid IMT measurements made in the CCA, carotid artery bulb and ICA were all associated with cardiovascular risk factors. According to their findings, they were also noted that while some cardiovascular risk factors showed qualitatively stronger associations with IMT measured in the bulb or internal carotid artery, the common carotid artery IMT best reflected overall exposure to traditional cardiovascular risk factors. O'Leary and Bots [19] indicated that the carotid artery has proven to be an extremely complex vessel, with differing associations for each segment to risk factors and outcomes, complicating the search for a standard imaging protocol that best meets every clinical and investigational requirement.

Carotid IMT is a well-known surrogate finding of atherosclerosis and can be used both to detect an accelerated disease process with clinical findings and subclinical conditions [21, 22]. Furthermore, carotid IMT can be used as a surrogate endpoint to monitor the efficacy of therapy against atherosclerosis in clinical practice [23, 24]. Cobble and Bale [25] noted that advantages of carotid IMT were that it was noninvasive, relatively inexpensive, and can be repeatedly performed with no adverse effects on the patient. They have concluded that carotid IMT was associated with cardiovascular disease and was an independent predictor of stroke and myocardial infarction. They have indicated that carotid IMT was currently limited by the lack of standardized protocols that may affect reproducibility from measurement to measurement.

Grau et al. [26] were determined their population reference ranges of carotid IMT for individuals aged 35-84 years in Spain and analyzed the association of carotid IMT with cardiovascular risk factors (age, smoking, diabetes, pulse pressure, lipid profile, and body mass index). They concluded that the main determinants of carotid IMT were age and pulse pressure.

Aldridge et al. [27] were noted that the training of nonsonographer physicians was required to practice carotid IMT and plaque screening by ultrasound for the assessment of subclinical atherosclerosis. They have conducted a study to assess the effect of formal training on carotid IMT evaluation and plaque detection by medical residents. They have found that medical residents performed carotid IMT measurement and plaque visualization to detect subclinical atherosclerosis in a successful manner.

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

Ultrasonography with Doppler modality is the method of choice for the noninvasive evaluation of carotid arteries [28, 29]. The degree of carotid artery stenosis is mainly depends on the measurement of the PSV or EDV, or both, of the carotid arteries [30]. AbuRahma et al. [30] have validated the ultrasonographic imaging consensus criteria published in 2003 and have analyzed 376 carotid arteries. They have found that the consensus criteria used a PSV of 125 to 230 cm/s for detecting angiographic stenosis of 50% to 69%, which had a sensitivity of 93%, specificity of 68%, and overall accuracy of 85% and that a PSV of ≥230 cm/s for ≥70% stenosis had a sensitivity of 99%, specificity of 86%, and overall accuracy of 95%. They have indicated that the consensus criteria for diagnosing 50% to 69% stenosis could be significantly improved by using an ICA PSV of 140 to 230 cm/s, with a sensitivity of 94%, specificity of 92%, and overall accuracy of 92%. They have concluded that the consensus criteria could be accurately used for diagnosing ≥70% stenosis; however, the accuracy could be improved for detecting 50% to 69% stenosis if the ICA PSV was changed to 140 to <230 cm/s.

During comparison of findings of color Doppler ultrasound examinations, differences in equipment, abilities, and experiences of ultrasonographers or radiologists, could cause considerable variability from laboratory to laboratory [28]. Therefore, each laboratory must adapt a method according to its equipment and validate their method when using Carotid Duplex Consensus criteria [29]. As mentioned in the review by Oates et al. [31] including Joint Recommendations for Reporting Carotid Ultrasound Investigations in the United Kingdom, there is need to create general agreement of acquisition, interpretation and reporting of the ultrasound and Doppler ultrasound data related to carotid arteries.

Several potential limitations of our study need to be considered. This study used a small sample size, especially in the obesity class III group. Our study groups were not similar with respect to sex in the obesity class III group and there was a significant male preponderance in the obesity class III group. Due to the small number of patients, sex adjusted analysis could not be conducted. Because of these limitations mentioned, we could not found meaningful differences among the obesity groups with regard to the IMTs, PSVs, and EDVs of ICAs, especially, in accordance with the severity of obesity as expected.

In conclusion, according to our findings, obesity may have a potential to increase the lumen diameter of CCAs and ICAs, to increase the IMTs of CCA but not ICA, and to decrease the PSVs and EDVs of CCA but not ICA. There is a need to determine the effect of obesity on the wall and function of carotid arteries in further studies in a broader population subclassified according to the severity and duration of obesity.

Conflicts of interest

The authors declare that no scientific and/or financial conflicts of interest exists with other people or institutions.

References

1. Dietz WH, Robinson TN. Clinical practice. Overweight children and adolescents. N

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

Engl J Med. 2005 May 19;352(20):2100-9.

2. Sucharda P. [Obesity and atherosclerosis-what's the link?]. Vnitr Lek. 2010 Apr;56(4):289-91.
3. Creager MA, Belkin M, Bluth EI, Casey DE Jr, Chaturvedi S, Dake MD, Fleg JL, Hirsch AT, Jaff MR, Kern JA, Malenka DJ, Martin ET, Mohler ER 3rd, Murphy T, Olin JW, Regensteiner JG, Rosenwasser RH, Sheehan P, Stewart KJ, Treat-Jacobson D, Upchurch GR Jr, White CJ, Ziffer JA. 2012 ACCF/AHA/ACR/SCAI/SIR/STS/SVM/SVN/SVS Key data elements and definitions for peripheral atherosclerotic vascular disease: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Clinical Data Standards (Writing Committee to develop Clinical Data Standards for peripheral atherosclerotic vascular disease). J Am Coll Cardiol. 2012 Jan 17;59(3):294-357.
4. Faxon DP, Fuster V, Libby P, Beckman JA, Hiatt WR, Thompson RW, Topper JN, Annex BH, Rundback JH, Fabunmi RP, Robertson RM, Loscalzo J; American Heart Association. Atherosclerotic Vascular Disease Conference: Writing Group III: pathophysiology. Circulation. 2004 Jun 1;109(21):2617-25.
5. Libby P, Ridker PM, Hansson GK. Progress and challenges in translating the biology of atherosclerosis. Nature. 2011 May 19;473(7347):317-25.
6. Roger VL, Go AS, Lloyd-Jones DM, Benjamin EJ, Berry JD, Borden WB, Bravata DM, Dai S, Ford ES, Fox CS, Fullerton HJ, Gillespie C, Hailpern SM, Heit JA, Howard VJ, Kissela BM, Kittner SJ, Lackland DT, Lichtman JH, Lisabeth LD, Makuc DM, Marcus GM, Marelli A, Matchar DB, Moy CS, Mozaffarian D, Mussolino ME, Nichol G, Paynter NP, Soliman EZ, Sorlie PD, Sotoodehnia N, Turan TN, Virani SS, Wong ND, Woo D, Turner MB; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Executive summary: heart disease and stroke statistics--2012 update: a report from the American Heart Association. Circulation. 2012 Jan 3;125(1):188-97.
7. Endarterectomy for asymptomatic carotid artery stenosis. Executive Committee for the Asymptomatic Carotid Atherosclerosis Study. JAMA. 1995 May 10;273(18):1421-8.
8. Polak JF, Pencina MJ, O'Leary DH, D'Agostino RB. Common carotid artery intima-media thickness progression as a predictor of stroke in multi-ethnic study of atherosclerosis. Stroke. 2011 Nov;42(11):3017-21.
9. Bots ML, Hoes AW, Koudstaal PJ, Hofman A, Grobbee DE. Common carotid intima-media thickness and risk of stroke and myocardial infarction: the Rotterdam Study. Circulation. 1997 Sep 2;96(5):1432-7.
10. Rosvall M, Janzon L, Berglund G, Engström G, Hedblad B. Incidence of stroke is related to carotid IMT even in the absence of plaque. Atherosclerosis. 2005 Apr;179(2):325-31.
11. Zwiebel WJ. Duplex sonography of the cerebral arteries: efficacy, limitations, and indications. AJR Am J Roentgenol. 1992 Jan;158(1):29-36.
12. Gaitini D, Soudack M. Diagnosing carotid stenosis by Doppler sonography: state of the art. J Ultrasound Med. 2005 Aug;24(8):1127-36.

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

13. Hunink MG, Polak JF, Barlan MM, O'Leary DH. Detection and quantification of carotid artery stenosis: efficacy of various Doppler velocity parameters. AJR Am J Roentgenol. 1993 Mar;160(3):619-25.
14. Huston J 3rd, James EM, Brown RD Jr, Lefsrud RD, Ilstrup DM, Robertson EF, Meyer FB, Hallett JW. Redefined duplex ultrasonographic criteria for diagnosis of carotid artery stenosis. Mayo Clin Proc. 2000 Nov;75(11):1133-40.
15. WHO BMI Classification Available at http://apps.who.int/bmi/index.jsp?introPage=intro-3.html. (Accessed July 2013).
16. Polak JF, Backlund JY, Cleary PA, Harrington AP, O'Leary DH, Lachin JM, Nathan DM; DCCT/EDIC Research Group. Progression of carotid artery intima-media thickness during 12 years in the Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications (DCCT/EDIC) study. Diabetes. 2011 Feb;60(2):607-13.
17. Lee VS, Hertzberg BS, Workman MJ, Smith TP, Kliewer MA, DeLong DM, Carroll BA. Variability of Doppler US measurements along the common carotid artery: effects on estimates of internal carotid arterial stenosis in patients with angiographically proved disease. Radiology. 2000 Feb;214(2):387-92.
18. Wildman RP, Mehta V, Thompson T, Brockwell S, Sutton-Tyrrell K. Obesity is associated with larger arterial diameters in Caucasian and African-American young adults. Diabetes Care. 2004 Dec;27(12):2997-9.
19. O'Leary DH, Bots ML. Imaging of atherosclerosis: carotid intima-media thickness. Eur Heart J. 2010 Jul;31(14):1682-9.
20. Polak JF, Person SD, Wei GS, Godreau A, Jacobs DR Jr, Harrington A, Sidney S, O'Leary DH. Segment-specific associations of carotid intima-media thickness with cardiovascular risk factors: the Coronary Artery Risk Development in Young Adults (CARDIA) study. Stroke. 2010 Jan;41(1):9-15.
21. Chambless LE, Heiss G, Folsom AR, Rosamond W, Szklo M, Sharrett AR, Clegg LX. Association of coronary heart disease incidence with carotid arterial wall thickness and major risk factors: the Atherosclerosis Risk in Communities (ARIC) Study, 1987-1993. Am J Epidemiol. 1997 Sep 15;146(6):483-94.
22. O'Leary DH, Polak JF, Kronmal RA, Manolio TA, Burke GL, Wolfson SK Jr. Carotid-artery intima and media thickness as a risk factor for myocardial infarction and stroke in older adults. Cardiovascular Health Study Collaborative Research Group. N Engl J Med. 1999 Jan 7;340(1):14-22.
23. Kastelein JJ, Akdim F, Stroes ES, Zwinderman AH, Bots ML, Stalenhoef AF, Visseren FL, Sijbrands EJ, Trip MD, Stein EA, Gaudet D, Duivenvoorden R, Veltri EP, Marais AD, de Groot E; ENHANCE Investigators. Simvastatin with or without ezetimibe in familial hypercholesterolemia. N Engl J Med. 2008 Apr 3;358(14):1431-43.
24. Crouse JR 3rd, Raichlen JS, Riley WA, Evans GW, Palmer MK, O'Leary DH, Grobbee DE, Bots ML; METEOR Study Group. Effect of rosuvastatin on progression of carotid intima-media thickness in low-risk individuals with subclinical atherosclerosis: the METEOR Trial. JAMA. 2007 Mar 28;297(12):1344-53.

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.

25. Cobble M, Bale B. Carotid intima-media thickness: knowledge and application to everyday practice. Postgrad Med. 2010 Jan;122(1):10-8.

26. Grau M, Marrugat J, Elosua R. Carotid Intima-media Thickness in the Spanish Population: Reference Ranges and Association With Cardiovascular Risk Factors. Response to Related Letters. Rev Esp Cardiol. 2013 Apr;66(4):327.

27. Aldridge ME, Do K, Oo T, Naqvi TZ. Carotid Intima-Media Thickness and Plaque Assessment by Trained Medical Residents: Validation and Preliminary Testing of a Training Protocol. J Am Soc Echocardiogr. 2013 Sep 16. pii: S0894-7317(13)00635-4.

28. AbuRahma AF, Robinson PA, Strickler DL, Alberts S, Young L. Proposed new duplex classification for threshold stenoses used in various symptomatic and asymptomatic carotid endarterectomy trials. Ann Vasc Surg. 1998 Jul;12(4):349-58.

29. Grant EG, Benson CB, Moneta GL, Alexandrov AV, Baker JD, Bluth EI, Carroll BA, Eliasziw M, Gocke J, Hertzberg BS, Katarick S, Needleman L, Pellerito J, Polak JF, Rholl KS, Wooster DL, Zierler E; Society of Radiologists in Ultrasound. Carotid artery stenosis: grayscale and Doppler ultrasound diagnosis-Society of Radiologists in Ultrasound consensus conference. Ultrasound Q. 2003 Dec;19(4):190-8.

30. AbuRahma AF, Srivastava M, Stone PA, Mousa AY, Jain A, Dean LS, Keiffer T, Emmett M. Critical appraisal of the Carotid Duplex Consensus criteria in the diagnosis of carotid artery stenosis. J Vasc Surg. 2011 Jan;53(1):53-9; discussion 59-60.

31. Oates CP, Naylor AR, Hartshorne T, Charles SM, Fail T, Humphries K, Aslam M, Khodabakhsh P. Joint recommendations for reporting carotid ultrasound investigations in the United Kingdom. Eur J Vasc Endovasc Surg. 2009 Mar;37(3):251-61.

This article may be cited as: Güner A, Eğilmez H, Şalk İ, Çetin A, Atalar MH. Carotid blood-flow velocity and intima-media thickness changes in patients with obesity. Basic Clin Sci 2015; 4: 45-61. DOI: dx.doi.org/ 10.12808/bcs.v4i1.5000149949. Available from: dergipark.ulakbim.gov.tr/bcs.