ORIGINAL ARTICLE

Sonographic Determination of Common and Internal Carotid Intima Media Thickness in Normal Adult Population in Northeastern Nigeria

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ABSTRACT

Background: Intima-media thickness (IMT) assessment of the common carotid artery (CCA) is a predictor of atherosclerosis. Early detection of this disease is important in management of cardiovascular complications. **Objectives:** The study aimed at establishing the baseline values of IMT for the Northeastern part of Nigerian for reference purposes. This is in order to create standards for defining abnormalities. Ultrasonography is readily available, relatively cheap and does not use ionizing radiation making it an ideal imaging modality to measure the IMT of carotid arteries. **Method:** This was a cross-sectional study carried out at the University of Maiduguri Teaching Hospital from February to October, 2011. Four hundred adult males and females above 18 years underwent carotid artery ultrasonography for measurement of the IMT of the common and internal carotid arteries. The influence of age, sex, weight, height, and the body mass index (BMI) on these parameters was also investigated. **Results:** There were 239 (59.80%) males and 161 (40.20%) females aged between 18 to 81 years (Mean ± SD, 36.74±14.79 years). The mean ± SD IMT for RCCA, LCCA, RICA, and LICA was 0.73±0.14mm, 0.73±0.14mm, 0.72±0.14mm, and 0.71±0.14mm respectively. The IMT of the carotid arteries increased significantly with age. The mean ± SD values were 1.11mm ± 0.09 and 1.08mm ± 0.11 at <20 years for CCA and ICA respectively but 1.90mm ±0.07 and 1.95mm ±0.05 at >70 years in males and 1.13 ±0.23 and 1.13mm ±0.14 for CCA and ICA respectively at less than 20yrs but 2.00 ±0.00 and 1.80mm ± 0.00 at >70 years. IMT also increases with BMI. The IMT in the CCA was 0.73mm ± 0.89, 0.73mm ± 0.13 and 0.79mm ± 0.09 for underweight, normal and overweight, respectively. There was no definite orderly pattern in sex and IMT. **Conclusion:** Normal values of the IMT of CCA and ICA have been established in this environment using ultrasonography. The data may be useful in the prevention of cerebrovascular disease which is related to IMT of carotid arteries.

Keywords: Carotid arteries, IMT, cardiovascular disease, Ultrasonography.

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Introduction

The carotid intima-media thickness (IMT) has become a standard marker in the assessment of early vascular changes, and has been widely used in adults.[1,2] It has also been used in epidemiological and interventional studies as a surrogate index of atherosclerosis.[3] The availability of reference carotid IMT ranges in a given population could be helpful to assess the presence of subclinical disease in clinical practice. In stepwise regression, selected predictors of increasing carotid IMT were older age, impaired fasting glucose, diabetes mellitus, higher systolic blood pressure, higher cholesterol level, smoking, and male gender.[4]

B-mode ultrasonography is a valid approach for identifying and quantifying the presence of subclinical disorders by measuring the carotid intima-media thickness (CIMT) which is an early marker for vascular diseases. It is a noninvasive, sensitive, and reproducible technique for identifying and quantifying atherosclerotic risk. It is also a wellvalidated research tool that has been translated into clinical practice. [5,6,7]

This study was designed to determine IMT of the carotid arteries (common and internal) in normal adults in northeastern Nigeria in order to create standards for defining carotid artery abnormalities in the environment.

Method

This was a cross-sectional study carried out at the University of Maiduguri Teaching Hospital between February to October, 2011 using convenience method of the non-probability sampling technique. Four hundred adults comprising of 239 (59.80%) males and 161 (40.20%) females aged 18 years and above who were referred to radiology department from specialty clinics of the UMTH and other hospitals from the neighboring states and who met the inclusion criteria for the study, underwent carotid artery ultrasonography for measurements of the IMT of the common and internal carotid arteries. Before the ultrasound (US) examination, clinical parameters which include age, sex, measurements of weight (kg) and height (cm) using a weighing scale and stadiometer, respectively were carried out and subsequently body mass index (BMI) were recorded for each participant. The BMI was calculated as a ratio of the measured weight to square of the measured height (kg/m^2). BMI of < 18.50 was termed underweight, 18.50 as normal and 25.00-29.99 as overweight.[8]

Brief history either for inclusion or exclusion was taken prior to the examination.

Excluded from the study were patients with cardiovascular risk factors which include history of stroke or transient ischemic attack, myocardial infarction, or heart failure. Also excluded were patients with diabetes mellitus (fasting blood glucose ≥126 mg/dl) or drug treatment for diabetes mellitus, total cholesterol ≥220 mg/dl or pharmacologic therapy for dyslipidemia. Similarly, patients who were hypertensive (systolic blood pressure [SBP] ≥140 mmHg, diastolic blood pressure [DBP] ≥90 mmHg) or on drug treatment for hypertension, smokers, those with BMI ≥ 30 kg/m^2 and pregnancy were excluded.

Participants were asked to wear comfortable loosely fitted clothing and remove all jewelries around the neck.

The examination was performed using a high-resolution real-time Doppler US scanner (Aloka, SSD-3500) equipped with 7.5 MHz linear-array transducer. The Aloka SSD-3500 is a fully digital beam former, wide dynamic range, 12-bit A/D converter, multi beam processing that utilizes advanced Pro-Sound technologies. The 7.5 MHz linear-array transducer provides greater resolution for superficial structures such as the carotid artery.

The patient's shoulder was placed on a pillow with the neck extended and turned slightly away from the side being scanned. After applying US gel to the neck, the transducer was placed above the clavicle in a transverse projection initially for the grey-scale examination. The common carotid artery (CCA) was located and followed proximally as far as the clavicle permitted. The transducer was moved cephalad following the CCA to the level of the carotid bifurcation (thyroid cartilage). The internal carotid artery (ICA) was followed distally to the angle of the mandible. The longitudinal and transverse views were done.

The IMT measurements were obtained at 1cm proximal to the carotid bulb for the CCA and 1cm above the carotid bulb for the ICA on each side. About 2-3 readings were recorded at each location from the media-adventitia interphase to the lumen-intima interphase (Fig. 1) after then average of the three was taken to avoid intra-observer variability. At the completion of the examination, patients were cleaned up and reassured about the safety of the procedure.

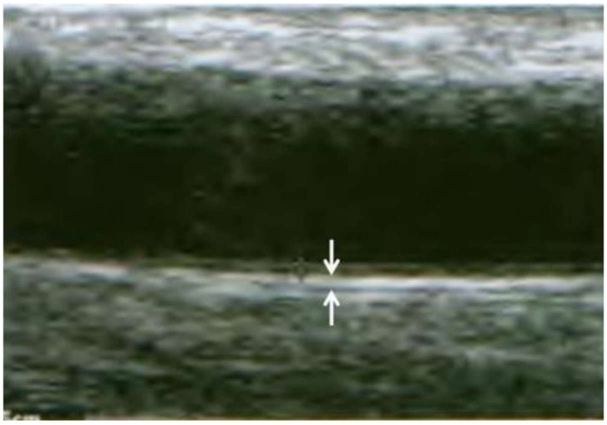

Fig 1: Longitudinal view of the CCA showing points of measurement of the IMT.

Results

Table 1a and 1b show the mean IMT of different age groups for CCA and ICA in both males and females. From the observations, the highest mean ±SD IMT for males was in the age group above 70 years with mean total IMT of 1.90± 0.07mm and 1.95±0.05mm and the least mean ±SD was age group of 20 years and below with the mean total of 1.11±0.09mm and 1.08±0.11mm in CCA and ICA respectively (Table 1a). The LCCA had a higher mean ±SD IMT in all the age groups than the right except in the age group of 20-30 years and 51-60 years which had the same IMT (Table 1a). The right ICA had higher mean ±SD IMT in the age group of 21-30 years, 41-50 years, 51-60 years and 61-70 years, while IMT was higher on the left in the age group of 31-40 years (Table 1a). The highest mean ±SD in both right and left CCA and ICA for females was in the age group of above 70 years with a mean total IMT of 2.00±0.00mm and 1.8±0.00mm CCA and ICA respectively, while the least was in the age group of 20 years and below with a mean total of 1.13±0.23mm and 1.13±0.14mm respectively (Table 1b). The RCCA IMT had a higher mean ± SD than the left in the age group 20 years and below, 31-40 years and 51-60 years, while the LCCA had higher IMT in the remaining age group. The RICA and LCCA IMT are the same in all age groups except the age groups of 31-40 years and 61-70 years which are higher on the right. (Table 1b).

Table 2 shows the overall range and mean of the IMT of the common and internal carotid arteries of the participants studied. The RCCA and LCCA intima media thickness (IMT) had the same mean ± SD of 0.73 ± 0.14mm. The IMT means ± SD for RICA and LICA were 0.72 ± 0.14mm and 0.71 ± 0.14mm, respectively. No statistical differences were observed in both RCCA and LCCA diameters: t=0.816, P= 0.415, and RICA and LICA diameters: t=1.904, P=0.058. The intima media thickness of the carotid arteries increased significantly with age. The mean CCA IMT (RCCA and LCCA) increased from 1.11mm ± 0.09 in males and 1.13mm ±0.23 in females in the age group of ≤20 years to 1.90mm ± 0.07 in males and 2.00±0.00 in females in the age group of ≥70 years (P=0.001), respectively. Similarly, the mean ICA IMT (RICA and LICA) increased from 1.08mm ± 0.11 in males and 1.13 ± 0.14 in females in the age group of ≤20 years to 1.96mm ± 0.05 in males and 1.80mm ±0.00 in the age group of ≥70 years (P=0.001), respectively. (Tables 1a and 1b).

Fig. 2a and 2b show the histogram of the mean age variation of the total IMT for males and females CCA and ICA. On average, males have higher mean IMT than females; however, on age grouping, there was no particular pattern in the IMT in the sex group in both CCA and ICA. The mean total IMT of CCA in males was higher than that of the females in all the age groups except the age group 20 years and below, 41-50 years and 61-70 years which was higher in females. Males also had higher mean total IMT in ICA than females in all age groups except 20 years and below, 41-50 years and 61-70 years.

Table 3 shows the relationship between the mean body parameters and age group of the participants studied. Their weight ranged between 40-96kg (Mean = 63.82kg ± 9.87). The highest mean weight (70.63 kg ± 8.45) was in the age group 41 – 50 years. The lowest mean body weight (55.00 ± 0.00) was in the age group 81-90 years. The height of the study population ranged between 1.50 -1.90m (Mean = 1.67±0.75m). The highest mean height (1.71 ± 0.05m) was in the age group 41-50 years. The lowest height (1.62 ± 0.11m) was observed in the age group 61-70 years. All body parameters were high in the age group 41-50 years.
The BMI ranged 15.10 – 37.50 (Mean = 22.87±3.26). The highest BMI (24.24 ± 2.59) was in the aged group 41-50 years and the lowest BMI was in the aged group 81-90 years (20.40 ± 0.00).

Table 4 shows the relationship of BMI with IMT. From the observation, the mean total IMT diameter was higher in the overweight individuals than the normal and the underweight individuals in the CCA and ICA in both males and females. There was a significant statistical correlation between CCA and ICA diameters and IMT, which means that the diameters and IMT of CCA and ICA increased with higher BMI using Pearson correlation.

Table 1a: Mean IMT of different age groups for males CCA and ICA

IMT(mm)	≤20 yrs M±SD	21-30 yrs M±SD	31-40 yrs M±SD	41-50yrs M±SD	51-60 yrs M±SD	61-70 yrs M±SD	>70 yrs M±SD
RCCA	0.55±0.05	0.67±0.12	0.76±0.08	0.81±0.06	0.87±0.05	0.91±0.03	0.95±0.05
LCCA	0.56±0.05	0.66±0.11	0.77±0.07	0.83±0.71	0.87±0.04	0.92±0.04	0.95±0.05
Mean total	1.11±0.09	1.34±0.22	1.53±0.15	1.64±0.11	1.75±0.09	1.84±0.05	1.90±0.07
RICA	0.54±0.06	0.68±0.18	0.75±0.91	0.81±0.08	0.83±0.04	0.90±0.07	0.97±0.04
LICA	0.54±0.05	0.65±0.13	0.77±0.08	0.80±0.09	0.80±0.04	0.88±0.08	0.97±0.04
Mean total	1.08±0.11	1.34±0.24	1.52±0.16	1.62±0.16	1.67±0.08	1.79±0.14	1.95±0.05

RCCA: Right common carotid artery.

LCCA: Left common carotid artery.

RICA: Right internal carotid artery.

LICA: Left internal carotid artery.

Table 1b: Mean IMT of different age groups for females CCA and ICA

IMT(mm)	≤20 yrs M±SD	21-30 yrs M±SD	31-40 yrs M±SD	41-50yrs M±SD	51-60 yrs M±SD	61-70 yrs M±SD	>70 yrs M±SD
RCCA	0.58±0.15	0.61±0.11	0.70±0.11	0.81±0.03	0.78±0.10	0.96±0.05	1.00±0.00
LCCA	0.55±0.07	0.63±0.10	0.68±0.11	0.83±0.49	0.77±0.09	0.94±0.05	1.00±0.00
Mean total	1.13±0.23	1.25±0.20	1.39±0.22	1.65±0.07	1.55±0.18	1.90±0.09	2.00±0.00
RICA	0.56±0.07	0.61±0.10	0.70±0.13	0.83±0.04	0.75±0.12	0.94±0.05	0.90±0.00
LICA	0.56±0.07	0.61±0.10	0.69±0.11	0.83±0.04	0.75±0.13	0.90±0.06	0.90±0.00
Mean total	1.13±0.14	1.23±0.20	1.40±0.23	1.66±0.09	1.50±0.25	1.84±0.08	1.80±0.00

RCCA: Right common carotid artery.
LCCA: Left common carotid artery.
RICA: Right internal carotid artery.
LICA: Left internal carotid artery.

Table 2: Overall range and means of CCA and ICA IMT

Variable	Sample size(N)	Range	Mean(±SD)
IMT(mm)			
Carotid Arteries			
RCCA	400	0.50-1.00	0.73±0.14
LCCA	400	0.40-1.00	0.73±0.14
RICA	400	0.40-1.00	0.72±0.14
LICA	400	0.40-1.00	0.71±0.14

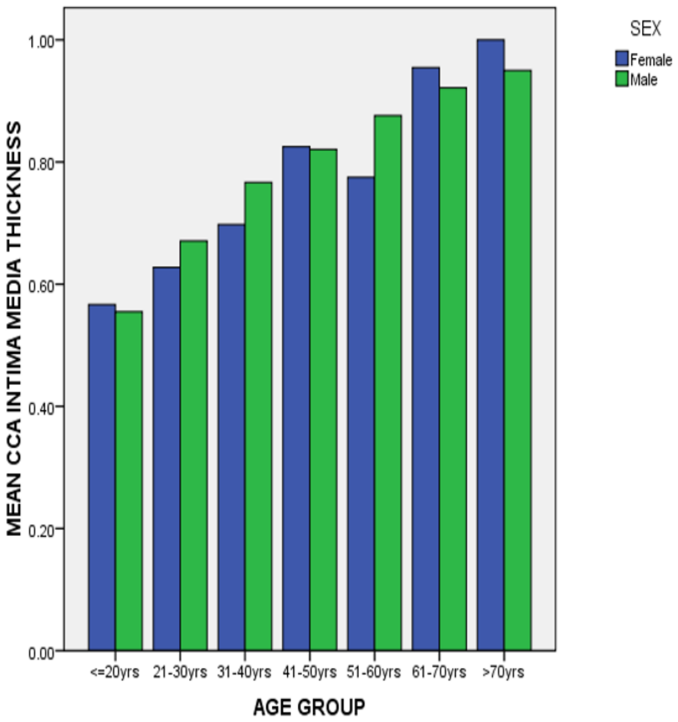

Fig. 2a Histogram of mean total CCA IMT versus Age for males and females

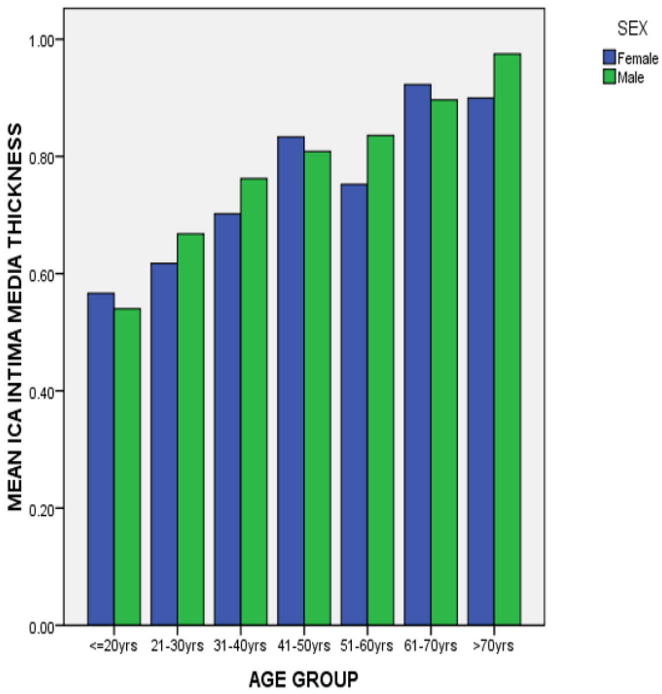

Fig. 2b: Histogram of mean total ICA IMT versus Age for males and females

Table 3: Mean body parameters in each age group

Age group (Years)	Frequency (N)	Height (M)	Weight (kg)	BMI (Kg/m2)
≤ 20	32	1.64 ± 0.80	59.19 ± 7.90	22.30 ± 3.68
21 – 30	148	1.69 ± 0.74	63.20 ± 9.35	22.30 ± 2.90
31 – 40	99	1.68 ± 0.74	65.34 ± 12.30	23.20 ± 4.02
41 – 50	41	1.71 ± 0.05	70.63 ± 8.45	24.24 ± 2.59
51 – 60	45	1.64 ± 0.42	63.27 ± 6.80	23.56 ± 2.07
61 – 70	25	1.62 ± 0.11	59.76 ± 4.07	23.06 ± 3.57
71 – 80	8	1.65 ± 0.31	58.00 ± 5.18	21.27 ± 1.98
81 – 90	2	1.64 ± 0.00	55.00 ± 0.00	20.40 ± 0.00

BMI: body mass index.
SD: standard deviation.
N: sample population.

Table 4: Mean total IMT verses BMI

BMI	Males		Females	
	CCA(M±SD)	ICA(M±SD)	CCA(M±SD)	ICA(M±SD)
Underweight	0.73 ±0.18	0.72 ± 0.20	0.52 ± 0.05	0.58 ±0.03
Normal weight	0.73 ± 0.13	0.77 ±0.13	0.69 ± 0.13	0.67 ± 0.13
Over weight	0.79 ± 0.09	0.78 ±0.10	0.78 ± 0.67	0.77 ± 0.13

Discussion

Measurement of cerebral blood flow is an important parameter in the diagnosis and follow-up of ischaemic cerebrovascular disease.[9] Several studies have been carried out to determine the normal dimensions of common and internal carotid arteries [10-12] and flow velocities.[13,14]

None of the previous studies conducted showed the CCA and ICA wall thickness greater than 1.00mm.[15-18] Paul et al[19] observed that the CCA wall thickness varied from 0.50 – 1.00mm (mean =0.73mm). In a study by Howard et al[20] the mean wall thickness of the CCA was 0.73mm and they observed that the ICA wall thickness values were more variable, with higher proportions of both large and small wall thickness than in the common carotid. The mean CCA and ICA wall thicknesses obtained in this study were 0.73mm and 0.72mm, respectively and varied between 0.40mm to 1.00mm for both CCA and ICA. This study showed similar findings with that of Paul et al[19] Denarie et al.[13] evaluated the dimensions of normal CCA and ICA in adults and found that IMT on both sides increased significantly with increasing age in both sexes (P<0.001). The present study showed that the IMT of the carotid arteries increased significantly with age. The underlying mechanism of this increase is unknown, but data from animal studies suggest that a chronic increase in local distending pressure can act as a stimulus since other risk factors including high lipoprotein levels, high blood pressure, smoking, diabetes, obesity and sedentary lifestyle have been excluded from the study.[21]

The mean CCA IMT increased from 0.69mm ± 0.13 in the age group of 18-51 years to 0.94mm ± 0.01 in the age group 51-81 years (P<0.001). Also, the mean ICA IMT increased from 0.69mm ± 0.13 in the age group of 18-50 years to 0.86mm ± 0.10 in the age group 51-81 years (P<0.001) which corroborated with the findings of Denarie et al[12]

The relationship between gender and IMT was also evaluated by previous researchers. Salonen et al[22] has shown that, the wall IMT is thicker in males than females possibly due to difference in their body habitus. Howard et al[20] revealed in their study that males had uniformly higher wall thickness than females. The present study showed that IMT is higher in males than females which agree with the aforementioned studies done elsewhere.

Conclusion: The established normal values for the IMT of the CCA and ICA are shown to increase significantly with age and in the overweight population. This will serve as reference values in patients' management and will also add to the pool of existing literature for academic references.

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