



## Stroke and Carotid Ultrasound .. our Experience

### KEYWORDS

Stroke, CVE, CIMT, CCA, Atherosclerosis, Smoking, DM, HTN, Dyslipidemia

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**ABSTRACT** Background :- World Health Organization has defined stroke as the rapidly developing clinical signs of focal/global disturbances of cerebral function, with symptoms lasting 24 hours or longer or leading to death with no apparent cause other than of vascular origin. Stroke is the commonest life threatening neurological disease and third most common cause of death after cardiovascular disease and cancer. Atherosclerosis is a known risk factor for stroke. Previous studies have indicated an association between increased CIMT and increased risk of cerebrovascular disease (CVE, stroke). Previous studies have shown that DM, HTN, smoking, dyslipidemia are also associated with increased risk of cerebrovascular episode (CVE, stroke). Previous studies have shown that Carotid Intima Media Thickness (CIMT), presence or absence of plaques in carotid arteries reliably give a fair idea of presence or absence of atherosclerosis in carotid artery itself and coronary arteries and cerebral arteries and arteries elsewhere in the body.

**Aim:-** The aim of this study is to describe the mean values of CIMT, presence or absence of plaques in carotid artery in patients of stroke and also evaluate other risk factors in the patients of cerebrovascular disease (CVE, stroke) and discuss their significance.

**Results:-** Mean CIMT was significantly higher (0.9808mm +/- 0.26213mm) in all the patients of stroke than normal individuals (0.6836 +/- 0.12980mm). Atherosclerotic plaques were seen in 52.5% of the total number of patients of stroke [significantly higher than normal individuals (3.4%)]. Other risk factors of stroke like DM (23.2%), HTN (57.6%), smoking (26.3%), dyslipidemia (53.5%) were also noted in stroke patients in this study.

**Conclusion:-** The data of present study of local Indian population of low income group in and around Pune confirms the findings of previous studies in general population. Hence it has been found in the present study that CIMT values (0.9808mm +/- 0.26213mm) in patients of stroke in local Indian population of low income group are higher than normal individuals (0.6836 +/- 0.12980mm) of the same group. Also the incidence of those having carotid plaques (52.5%) is higher in patients of stroke than normal individuals (3.4%).

### Introduction :-

World Health Organization has defined stroke as the rapidly developing clinical signs of focal/global disturbances of cerebral function, with symptoms lasting 24 hours or longer or leading to death with no apparent cause other than of vascular origin<sup>(1)</sup>. The high incidence of CVE and IHD in individuals with atherosclerosis is a well documented fact<sup>(2)</sup><sup>(3)</sup>. Many other risk factors of CVE like DM, HTN, smoking, dyslipidemia (stroke) have been described in earlier studies<sup>(4),(5)</sup>. Atherosclerosis generally occurs all over the arterial tree in the body and more or less equally in coronary, cerebral and carotid arteries. Hence Carotid Intima Media Thickness (CIMT) measurement and presence of plaques in carotid arteries can give a fair idea of atherosclerosis in carotid artery themselves and coronary arteries and cerebral arteries. Hence evaluation of CIMT is a reliable method of assessing atherosclerosis<sup>(6),(7)</sup>. Carotid B Mode ultrasound Imaging is an accurate, non-invasive, cost effective, easy, widely available, easily reproducible method for assessing CIMT<sup>(7)</sup>. CIMT on B Mode ultrasound of carotid arteries corresponds very well to histologic intima and media. It can roughly quantify atherosclerotic burden in the body.

CIMT is defined as the area of tissue starting at the luminal-intimal interface and media-adventitia interface of

CCA; or more precisely defined as the double line pattern visualized by B Mode vascular ultrasound formed by two parallel echogenic lines representing junction of the vessel lumen with the intima; and media-adventitia interface. Thickening of the intima-media complex implies occult plaque formation, but plaque is seen directly with ultrasound when it achieves sufficient size to protrude into the carotid artery lumen. Carotid artery plaque is defined as a focal structure that encroaches into the arterial lumen of at least 0.5mm or 50% of the surrounding IMT value or demonstrates a thickness > 1.5mm as measured from the media-adventitia interface to the intima-lumen interface<sup>(8)</sup>. CIMT varies widely across different age groups. It increases with increasing age<sup>(9),(10)</sup>. The CIMT measurements in this study were done in areas excluding visible plaques.

### Materials and Methods :-

A descriptive, cohort study was conducted. Data was collected over a period of one year from December 2014 to November 2015. Individuals reporting to Radiology department of our institution, Smt Kashibai Navale Medical College and General Hospital, Pune were considered for this study. Their demographic features (age, sex), diagnosis and a documented history of cerebrovascular disease, presence or absence of DM, HTN, dyslipidemia, history

of smoking or using tobacco any form were collected. Patients of stroke were considered for this study.

American Diabetes Association (ADA) criteria were used to label a subject as diabetic. All the subjects labeled as diabetic in this study had at least one of the following criteria; i) A1C  $\geq$  6.5%, ii) Fasting Plasma Glucose level (FPG)  $\geq$  126mg/dL iii) 2 hr Plasma Glucose (PG) level  $\geq$ 200 mg/dL iv)Random PG  $\geq$  200 mg/dL. As per JNC8 guidelines for hypertension<sup>(11)</sup> all patients  $\geq$  age of 60 years having blood pressure  $\geq$  150/90 mm of Hg and all adults less than 60 years having blood pressure  $\geq$  140/90 mm of Hg were considered to be hypertensive for this study.

As per AACE Lipid and Atherosclerosis guidelines patients were labeled to have dyslipidemia if they had at least any one of the following criteria; Total cholesterol  $>$ 200 mg/dL, HDL- C  $\leq$ 60 mg/dL, LDL-C  $>$ 100 mg/dL, Triglycerides  $>$  150mg/dL <sup>(12)</sup>.

Inclusion criteria for this study:- All patients of history of stroke with evidence of haemorrhage or infarct on Computed Tomography (CT) of Brain.

Exclusion criteria for this study:- Patients with cardioembolic stroke and patients with stroke due to secondary causes like trauma, impaired coagulation or tumour were excluded from this group.

Subjects in the age group of 22 to 86 years were included in the study. Carotid artery ultrasonography was performed on all these subjects. Total number of subjects included in this study was 99. Out of them 58 were males, 40 were females and one belonged to other sex. Institute's permission to carry out the study was taken and a consent from the subjects was obtained. For the sake of analysis patients were divided into four age groups. Total of 99 patients of stroke were evaluated. Mean age of the sample was 59.5455 years. They were divided into four age groups; first group less than mean -1 SD, second group mean -1 SD, third group mean + 1 SD and fourth group more than mean +1 SD.

**Ultrasound Protocol:-**

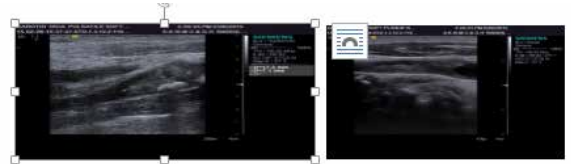
All the carotid ultrasound examinations were done on Siemens Acuson X 300 and Siemens Acuson S 2000 ultrasound machines with high frequency probes of more than 7.5MHz frequency. Both ultrasound operators were the above mentioned first two investigators in this study; both Radiologists having 20 years of experience in conducting B Mode ultrasound and colour Doppler studies of carotid arteries. Interobserver and intraobserver errors were eliminated by strict adherence to examination protocol as follows.

All the conscious patients were explained the procedure and ensured that the patient was comfortable and cooperative during the procedure. As CIMT of CCA ( common carotid artery) has better reproducibility than that of ICA( internal carotid artery) or carotid bifurcation due to ease of access and proximity to the surface and CCA being relatively parallel to skin, measurement of CIMT was done at this site on far wall of CCA in all patients. Presence or absence of atherosclerotic plaques were also noted. CIMT was measured in areas excluding the plaque. Both sonologist and patient were positioned properly to obtain high quality images. CIMT measurement was done in supine position with head of patient resting comfortably and neck slightly hyperextended and rotated in direction opposite to the probe. A wedge pillow at an angle of 45 degrees was

used to standardize the lateral rotation. Images were optimized by adjusting patient's neck position and rolled towels were given under neck for comfort.

The six values of mean CIMT ( three on each side) were obtained and averaged to get mean CIMT. Thus a single mean CIMT value was obtained in each subject. Presence or absence of plaques in carotid arteries was recorded in all the patients.

**Images:-**



B Mode Ultrasound Images showing longitudinal sections of CCA with plaque

**Results:-**

Stroke n=99

**Sex**

	Fre-quency	Percent	Valid Per-cent	Cumulative Percent
Valid	Female	40	40.4	40.4
	Male	58	58.6	99.0
	Other	1	1.0	100.0
	Total	99	100.0	100.0

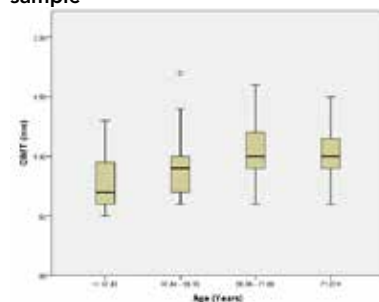
**Table No 1 showing distribution of sex in the sample**

**Report**

**Age in years**

Sex	Mean	N	Std. De- viation	Median	Mini- mum	Maxi- mum
Fe- male	59.3000	40	13.76581	61.5000	22.00	80.00
Male	59.5862	58	11.02952	60.0000	31.00	81.00
Oth- er	67.0000	1	.	67.0000	67.00	67.00
Total	59.5455	99	12.11448	60.0000	22.00	81.00

**Table no 2 showing distribution of age & sex in the sample**



Graph no 1:- showing distribution of age and correlation with CIMT in the sample

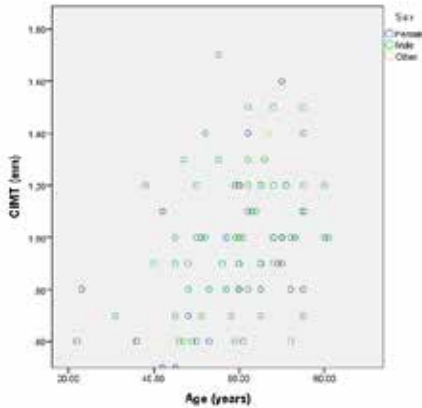
**Report**

**CIMT in mm**

Agebinned	Mean	N	Std. De- viation	Median
1	.7875	16	.25265	.7000
2	.9261	23	.28479	.9000
3	1.0614	44	.22435	1.0000
4	1.0313	16	.23585	1.0000

Total	.9808	99	.26213	1.0000
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**Table no 3:- showing CIMT across different age groups in the sample**



**Graph no 2 :- showing age and sex distribution & correlation with CIMT of the patients in the sample**

Presence/ Hx	Yes		No	
	N	%	N	%
Diabetes	23	23.2	76	76.8
Hypertension	57	57.6	42	42.4
Smoking	26	26.3	73	73.7
Plaques	52	52.5	47	47.5
Dyslipidemia	53	53.53	46	46.47

**4:- showing various risk factors of stroke and presence of plaque in the sample**

**Results:-**

Mean CIMT was significantly higher (0.9808mm +- 0.26213mm) in all the patients than normal individuals (0.6836+-0.12980mm) <sup>(13)</sup>. Atherosclerotic plaques were seen in 52.5% of the total number of patients of stroke [significantly higher than normal individuals(3.4%)<sup>(9)</sup>]. Other risk factors of stroke like DM (23.2%), HTN (57.6%), smoking (26.3%), dyslipidemia (53.5%) were also noted in these patients of stroke in this study.

**Conclusion and discussion:-**

The data of present study of local Indian population mainly comprising of low income group in and around Pune confirms the findings of previous studies in general population. Hence it has been found in the present study that CIMT values in subjects who had stroke in local Indian population of low income group are significantly higher than that of normal population <sup>(13)(14)</sup>. Also the incidence of those having carotid plaques is significantly higher in subjects who had stroke. While analyzing other classic risk factors of stroke it was found that most of the stroke patients had one or more of the following risk factors; namely DM, HTN, smoking, dyslipidemia; apart from high values of CIMT. Carotid B Mode ultrasound Imaging is an accurate, non-invasive, cost effective, easy, widely available, easily reproducible method for assessing CIMT and hence can reliably assess atherosclerotic burden in patients. So it may be worthwhile screening all the patients having one of the risk factors for developing stroke described above by B Mode carotid ultrasound so that a preventive therapy may be initiated in those found to have higher CIMT values & or presence of plaques in carotid arteries (as it is a significant additional risk factor) to prevent risk of stroke <sup>(9)</sup>.

**References :-**

1. Hatano S. Experience from a multicentre stroke register: A preliminary re-

port. Bull WHO 1976;54:541-53.

2. Chambless LE, Heiss G, Folsom AR, Rosamond W, Szklo M, Sharrett AR, et al. 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; 146:483-94

3. O'Leary DH, Polak JF, Kronmal RA, Manolio TA, Burke GL, Wolfson SK. 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; 340:14-22.

4. G S Tell; J F Polak; B J Ward; S J Kittner; P J Savage; J Robbins. Relation of smoking with carotid artery wall thickness and stenosis in older adults. The Cardiovascular Health Study. The Cardiovascular Health Study (CHS) Collaborative Research Group. Circulation. 1994;90:2905-2908.

5. Manuel A. Gomez-Marcos, Jose I. Recio-Rodriguez, Emilliano Rodriguez-Sanchez, Maria C. Patino-Alonso, Rosa Magallon-Botaya, Vicente Martinez-Vizcaino, Leticia Gomez Sanchez, Luis Garcia-Ortiz. Carotid Intima-Media Thickness in Diabetics and Hypertensive Patients., Rev Esp Cardiol. 2011;64-622-5, - Vol. 64 Num.07 DOI: 10.1016/j.rec.2010.10.025.

6. Stein JH, Korcarz CE, Hurst RT, Lonn E, Kendall CB, Mohler ER et al. Use of carotid ultrasound to identify subclinical vascular disease and evaluated cardiovascular disease risk: A consensus statement from the American Society of Echocardiography Carotid Intima-Media Thickness Task Force. Endorsed by the Society for Vascular Medicine. J Am Soc Echocardiogr 2008; 1:93-111.

7. Society of Atherosclerosis imaging and prevention developed in collaboration with the international atherosclerosis Society. Appropriate use of criteria for carotid intima media thickness testing. Atherosclerosis 2011;214:43-6.

8. Touboul PJ, Hennerici MG, Meairs S, Adams H, Amarencu P, Bornstein N, Csiba L, Devarieux M, Ebrahim S, Hernandez Hernandez R, Jaff M, Kownator S, Naqvi T, Schminke U, Tardil JC, Taylor A, Vicant E, Woo KS.; Mannheim carotid intima-media thickness and plaque consensus (2004- 2006 - 2011). An update on behalf of the advisory board of the 3rd, 4th and 5th watching the risk symposia, at the 13th, 15th and 20th European Stroke Conferences, Mannheim, Germany, 2004, Brussels, Belgium, 2006, and Hamburg, Germany 2011.

9. Ravi R Kasliwal, Manish Bansal, Devang Desai, Maya Sharma. Carotid intima-media thickness: Current evidence, practices, and Indian Experience. Indian J Endocr Year 2014; Volume: 18; Issue 1, Page : 13-22.

10. V Madhuri, Suman Chandra and Afzal Jabbar. Age associated increase in Intima Media Thickness in adults. Indian J Physiol Pharmacol 2010; 371-375.

11. Paul A James, MD; Suzanne Oparil, MD; Barry L Carter, PharmD; William C.ushman, MD; Cheryl Dennison-Himmelfarb, RN, ANP,PhD; Joel Handler, MD; Daniel T. Lackland, DrPH; Michael L. LeFevre, MD, MSPH; Thomas D. MacKenzie, MD, MSPH, Oluغبenga Ogedegbe, MD, MPH, MS; Sidney C. Smith Jr, MD; Laura P. Svetkey, MD, MHS; Sandra J. Taler, MD; Raymond R. Townsend, MD; Jackson T. Wright Jr, MD, PhD; Andrew S. Narva, MD; Eduardo Ortiz, MD, MPH. JAMA. 2014;311(5):507-520. doi:10.1001/jama.2013.284427. 2014 Evidence-Based Guideline for the Management of High Blood Pressure in Adults . Report From the Panel Members Appointed to the Eighth Joint National Committee (JNC 8)

12. Paul S Jellinger, MD, MACE; Donald A Smith, MD, FACE; Adi E Mehta, MD, FRCP(C), FACE; Om Ganda, MD, FACE; Yehuda Handelsman, MD, FACP, FACE; Helena W. Roadbard, MD, FACP, MACE; Mark D. Shepherd, MD, FACE; John A. Seibel, MD, MACE; Endocr Pract. 2012; 18(Suppl1); The AACE Task Force for Management of Dyslipidemia and prevention of Atherosclerosis

13. Prashant Naik, Anand Kamat. Relation of age and sex with carotid intima media thickness in adults in local Indian population of lower income group. Indian Journal of Applied Research: Volume : 5; Issue : 11, November -2015, ISSN – 2249-555X

14. Matthias W. Lorenz, MD; Stefan von Kegl, MD; Helmuth Steinmetz, MD; Hugh S. Markus, FRCP; Matthias Sitzer, MD.: Carotid Intima-Media Thickening indicates a higher vascular risk across a wide age range : Stroke.2006;37:87-92