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ORIGINAL ARTICLE

Validity of Carotid Doppler Ultrasound for Detection of Carotid Artery Plaque Keeping Computed Tomography Sensitivity as Reference Standard

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ABSTRACT

Objective: To determine the prevalence and specificity of arterial Doppler imaging pathology identification of artery blood vascular disease

Study Design: Cross-sectional

Place and Duration: In the department of Radiology, Peshawar Institute of Cardiology MTI, Peshawar for the duration from January 2022 to May 2022.

Methods: Total 95 patients of both genders were presented. All the patients were suffering from ischemic cerebrovascular illness. Informed written consent of all the patients were taken for detailed demographics. Doppler ultrasound was performed in every patient by a consultant radiologist. Doppler ultrasound findings were compared with Carotid artery stenosis reports. SPSS 20.0 was used to analyze all data.

Results: The mean age of the patients was 52.11±8.40 years and had mean BMI 24.1±13.25 kg/m^2. The mean duration of disease was 1.7±6.34 years. 52 (54.7%) were males and 43 (45.3%) were females. There were 56 (58.9%) cases were smokers. Comorbidities were diabetes mellitus, ischemic heart disease, hypertension, ischemic stroke and dyslipidemia. Doppler ultrasound has a 91% overall sensitivity, 77% specificity, 47.3% positive predictive value, 92.5% negative predictive value, and 80% diagnostic accuracy.

Conclusion: The accuracy of diagnosing Carotid artery stenosis has greatly increased over time because to technological innovation. The finding of additional measures to describe plaque susceptibility in the carotid artery has grown in importance, from monitoring the carotid artery's shrinking diameter to assessing the enhanced velocity field close to the obstruction/lesion site. The sensitivity, precision, and reliability of Artery stenosis diagnosis have improved because to computer-aided programmes used in a variety of imaging modalities.

Keywords: Specificity, Carotid artery stenosis, Doppler ultrasound Sensitivity

INTRODUCTION

Stroke, or cerebrovascular accident, occurs due to abrupt interruption of blood flow to the central nervous system, with sudden onset of “focal neurological deficit” (FND), which lasts for more than twenty-four hours. It constitutes a major cause of mortality and disability. According to etiology, 87% of strokes are ischemic, 10% due to intracerebral hemorrhage, while 3% are due to aneurysmal subarachnoid hemorrhage[1] . The most common cause of ischemic stroke is atherosclerosis, causing thrombosis and subsequent narrowing or occlusion of vessels[2] . Hemorrhagic stroke results from the rupture of these diseased arteries[3] .

There are several neuroimaging modalities useful for imaging of stroke patients, such as computerized tomography (CT), magnetic resonance angiography, and ultrasonography, each with its own advantages and disadvantages. Doppler ultrasound is the most widely used modality for the diagnosis of carotid artery stenosis, with excellent accuracy comparable to angiography[4] .

Shafaat and Sotoudeh[5] stated that, in patients suspected of stroke, carotid ultrasonography is a common screening modality. Compared to other neuroimaging modalities, ultrasonography is a non-invasive, safe, and cheap bedside tool with a short examination time. Currently, it is widely used to assess carotid artery blood flow velocity in a cardiac cycle[6] . Kristensen and colleagues 4 noted that stenosis of the internal carotid artery is an important cause for both stroke and transient ischemic attacks. Endarterectomy for patients with narrowing of internal carotid artery lumen of ≥70% demonstrated great benefit .However, its effectiveness is highly dependent on patients’ selection and its timing. The absolute risk reduction is highest if carotid endarterectomy is performed within two weeks after the index event, but it is rendered almost ineffective if performed after three months. Therefore, timely screening of stroke patients is considered crucial[3] .

CDUS has become a standard noninvasive test for evaluating extracranial carotid disease.[7,8] The advent of transcranial Doppler assessment of intracranial arterial flow and MRA combined with the known inherent risk of angiography has motivated us to evaluate patients preoperatively with the focused use of CDUS, transcranial Doppler, and MRA.[9] Thus, in many patients we have avoided conventional angiography before CEA. With this approach, the marker of severity becomes residual lumen diameter rather than percent stenosis. To date, however, Doppler criteria for establishing the severity of stenosis at the origin of the ICA have been mainly based on angiographic measurement of percent stenosis.[10]

The prevalence of moderate/severe CAS increases with age (total participants: 23,706), especially after the age of 50, and affecting men more than women [11,12]. In a clinical setting, if physician detects the presence of carotid bruit, an ultrasound examination or CTA/MRA is then prescribed to confirm the presence and severity of carotid stenosis. This paper provides a review on the technical development in the imaging modalities for CAS.

MATERIAL AND METHODS

This cross-sectional study was conducted at the department of Radiology, Peshawar Institute of Cardiology MTI, Peshawar for the duration from January 2022 to May 2022 and comprised of 95 patients. Informed written consent of all the patients were taken for detailed demographics. The information of stroke patients who did not have carotid Doppler ultrasonography or CT angiography was excluded.

Patients with stroke who underwent carotid Doppler ultrasound and CT angiography met the inclusion criteria. Both carotid Doppler ultrasonography and CT-angiography were used to evaluate the existence and severity of carotid artery stenosis in the same subjects. According to the North American Exhibiting symptoms Carotid Endarterectomy Trial, the degree of stenosis

was determined. Descriptive statistics' incidence, percent, average, and standard deviation were calculated. Khoury and colleagues assessed the diagnostic accuracy of the amount of carotid artery constriction by Doppler ultrasonography using CT-angiography as the gold reference standards test. SPSS 20.0 was used to analyze all data.

RESULTS

Among 95 cases, 52 (54.7%) were males and 43 (45.3%) were females.(figure-1)

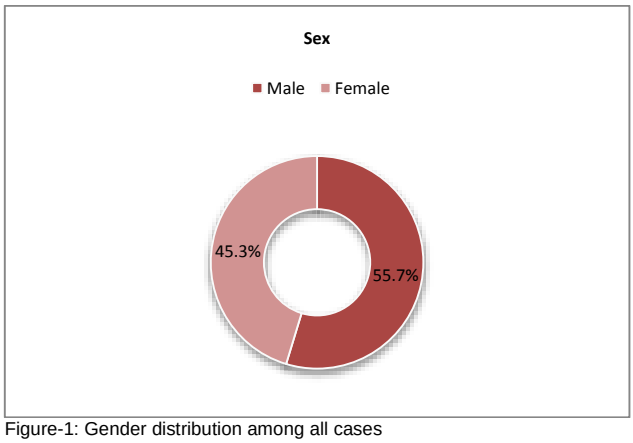

Figure-1: Gender distribution among all cases

The mean age of the patients was 52.11±8.40 years and had mean BMI 24.1±13.25 kg/m^2. The mean duration of disease was 1.7±6.34 years. . Comorbidities were diabetes mellitus, ischemic heart disease, hypertension, ischemic stroke and dyslipidemia.(table-1)

Table-1: Patients with baseline characteristics

Variables	Frequency	Percentage
Mean age (years)	52.11±8.40	
Mean BMI (kg/m^2)	24.1±13.25	
Mean Disease Duration (years)	1.7±6.34	
Co-morbidities		
DM	77	81.1
IHD	70	73.7
HTN	68	71.6
Ischemic stroke	81	85.3
Dyslipidemia	74	77.9

Doppler ultrasound has a 91% overall sensitivity, 77% specificity, 47.3% positive predictive value, 92.5% negative predictive value, and 80% diagnostic accuracy.(figure-2)

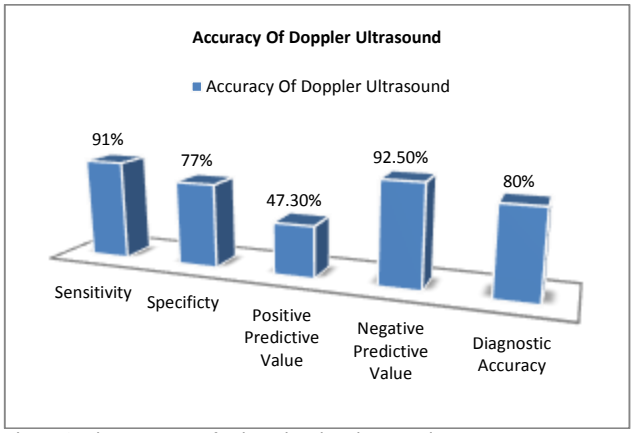

Figure-2: The accuracy of colour doppler ultrasound

DISCUSSION

Difficulties relating to tube-shaped structures caused by atherosclerosis Type 1 diabetes increases arterial hardening, which can be a substantial risk factor. Type 2 polygenic disease patients are more likely to experience type 1 morbidity and death. This is especially true in Asian countries where the number of diabetics is growing. According to the arteriosclerosis project, coronary and cerebral arteries undergo the arteriosclerosis process simultaneously. With a high degree of consistency and accuracy, B mode prenatal diagnostics will measure the membrane medium width (IMT) of the artery (CIMT), giving a valid and trustworthy assessment of the artery wall thickness.[13]

It is of great interest to determine if or not overstated CIMT is linked to an overstated risk of events associated with arteriosclerosis. The use of non-invasive B method designation to measure arteria cell wall media thickness will help diagnose well upset and observe artery hardening at an early stage. [14] In a study of Taiwanese people in good health, CIMT was significantly greater in males than in women (0.558 vs. actual values mm, P = 0.012). In patients without Chd (men vs. women 1.05 vs. 0.93 mm, P0.001)92, Kablak Ziembicka et al. reproduced this finding. In our study, CIMT was absent in Taiwanese healthy subjects, but not in subjects without CVD92 or with conventional aldohexose tolerance. [16]

According to a number of studies, carotid artery disorders may be detected and screened using ultrasonography, which has a high degree of diagnostic validity. Since ultrasonography is a non-invasive, simple-to-use imaging technique, its use for mass screening and properly identifying peripheral arterial stenosis is highly advised. It is also affordable, secure, and dependable. Additionally, it has a sensitivity and specificity for carotid stenoses screening that is fairly high (94.4percent and 91.7%, respectively)[17]. In addition, Henry and colleagues[18] reported high diagnosing validity for jugular Duplex scanning for the prognosis of coronary artery artery airway obstruction >70%, with sensitivity of 96.1%, specificity of 88%, predictive value of 92.5%, poor prognostic value of 93.6%, and overall accuracy of 92.9%. In our study, doppler ultrasound has a 91% overall sensitivity, 77% specificity, 47.3% positive predictive value, 92.5% negative predictive value, and 80% diagnostic accuracy.

High diagnostic validity for stroke patients is provided by carotid Doppler ultrasonography. It is highly advised for screening patients with signs of transient ischemic strokes or for diagnostic process of stroke since it is a non-invasive, secure, and affordable bedside instrument with quick examination times and simple operability. Nevertheless, because it is operator-dependent, ongoing radiographer training and the use of improved technology are crucial steps to increase the diagnostic authenticity for evaluating patients with related symptoms to the cerebral system or without symptomatology but with risk factors for extracranial arterial disease.

CONCLUSION

The accuracy of diagnosing Carotid artery stenosis has greatly increased over time because to technological innovation. The finding of additional measures to describe plaque susceptibility in the carotid artery has grown in importance, from monitoring the carotid artery's shrinking diameter to assessing the enhanced velocity field close to the obstruction/lesion site. The sensitivity, precision, and reliability of Artery stenosis diagnosis have improved because to computer-aided programmes used in a variety of imaging modalities.

REFERENCES

1 Benjamin EJ, Blaha MJ, Chiuve SE, et al. Heart Disease and Stroke Statistics-2017 Update: A Report from the American Heart Association. Circulation 2017;135(10): e146-e603

2 Simon B, Mani SE, Keshava SN, et al. Role of Noninvasive Imaging of Cerebral Arterial System in Ischemic Stroke: Comparison of

Transcranial Color-coded Doppler Sonography with Magnetic Resonance Angiography. J Clin Imaging Sci 2018; 8:19.
3 Campbell BCV, Khatri P. Stroke. Lancet 2020;396(10244):129-42.
4 Kristensen T, Hovind P, Iversen HK, et al. Screening with doppler ultrasound for carotid artery stenosis in patients with stroke or transient ischaemic attack. Clin Physiol Funct Imaging 2018;38(4):617-21.
5 Shafaat O, Sotoudeh H. Stroke Imaging. In: StatPearls Internet. Treasure Island (FL): StatPearls Publishing; 2021.
6 Tagelsir S, Gameraddin MB, Babiker MS, et al. Doppler sonographic assessment of carotid arteries in Sudanese stroke patients. Brain Circ 2017;3(2):114-20.
7 Barnett HJM, Eliasziw M, Meldrum HE, Taylor DW. Do the facts and figures warrant a 10-fold increase in the performance of carotid endarterectomy on asymptomatic patients? Neurology.1996; 46:603-608.
8 Schenk EA, Bond G, Aretz TH, Angelo JN, Choi HY, Rynalski T, Gustafson NF, Berson AS, Ricotta JJ, Goodison MW, Bryan FA, Goldberg BB, Toole JF, O'Leary DH. Multicenter validation study of real-time ultrasonography, arteriography, and pathology: pathologic evaluation of carotid endarterectomy specimens. Stroke. 1988,19:289-296
9 Kistler JP, Ojemann RG, Crowell RM. Atherothrombotic disease of the carotid circulation: pathophysiology, evaluation and management. In: Ojemann RG, Ogilvy CS, Crowell RM, Heros RC, eds. Surgical Management of Neurovascular Disease. 3rd ed. Baltimore, Md: Williams & Wilkins; 1995:1-24.
10 Hunink MGM, 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; 160:619-625
11 De Weerd M, Greving JP, Hedblad B, Lorenz MW, Mathiesen EB, O'Leary DH, et al. Prevalence of asymptomatic carotid artery stenosis in the general population: an individual participant data meta-analysis. Stroke. 2010;41:1294–1297. doi: 10.1161/STROKEAHA.110.581058
12 Schievink WI. Spontaneous dissection of the carotid and vertebral arteries. N Engl J Med. 2001;344:898–906. doi: 10.1056/NEJM200103223441206
13 Arning C, Eckert B. The diagnostic relevance of colour Doppler artefacts in carotid artery examinations. Eur J Radiol. 2004;51(3):246-51
14 Arning C, Eckert B. The diagnostic relevance of colour Doppler artefacts in carotid artery examinations. Eur J Radiol. 2004;51(3):246-51.
15 Anzidei M, Napoli A, Zaccagna F, Di Paolo P, Saba L, CavalloMarincola B, et al. Diagnostic accuracy of colour Doppler ultrasonography, CT angiography and blood-pool-enhanced MR angiography in assessing carotid stenosis: a comparative study with DSA in 170 patients. Radiol Med. 2012; 117(1):54-71.
16 Tang Y, Wang MY, Wu TT, et al. The role of carotid stenosis ultrasound scale in the prediction of ischemic stroke. Neurol Sci 2020;41(5):1193-9
17 Henry JC, Kiser D, Satiani B. A Critical Evaluation of Carotid Duplex Scanning in the Diagnosis of Significant Carotid Artery Occlusive Disease. Adv Vasc Med 2015;6.
18 Henry JC, Kiser D, Satiani B. A Critical Evaluation of Carotid Duplex Scanning in the Diagnosis of Significant Carotid Artery Occlusive Disease. Adv Vasc Med 2015;6.