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Carotid Duplex Ultrasound Versus Computed Tomography Angiogram For Detecting Cerebral Revascularization Selection Criteria In ICU Patients in The Transient and Permanent Neurological Deficit

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Abstract

Background: All medical illnesses that affect the heart, blood, or blood vessels are known as cardiovascular diseases (CVDs). If the atherosclerotic plaque develops as a reaction to physical or metabolic harm, a stroke may occur, and this can be life-altering. It is now common practise to use duplex ultrasonography (DUS) to detect carotid disease. An overall sensitivity of 97% and a specificity of 100% were established for CTA in detecting the degree of carotid obstruction. The purpose of this study is to compare the findings of carotid duplex examinations of the extracranial carotid circulation with those of CT angiography. First assault of transient and non-transient cerebral insults in patients brought to the ICU. 40 ICU patients with a transitory or persistent neurological disability owing to carotid atherosclerosis were studied in a prospective case-serious research. Analysis of each parameter was done using a statistical tool for social science data that was used to revise, code, tabulate, and introduce the data to a PC. Results There was an overall concordance of 77.5 percent (31/40) between CDUS and CTA, with CDUS underestimating the degree of stenosis in 7/40 (17.5 percent) and CTA overestimating the degree of stenosis in 2/40 (5 percent). Other criteria were not linked to concordance or disconcordance. The stenosis grades of the duplex US and CT angiograms were identical, with 100% sensitivity, 100% specificity, 100% PPV, 100% NPV, and 100% accuracy. As a result, DCUS and CTA were shown to have good agreement, whereas CDUS remains the first-line non-invasive imaging approach for the evaluation of ICA stenosis.

Key words: Stroke, cardiovascular disease, duplex ultrasound, Ct angiography**.**

1. Introduction

As a general practitioner, I often see patients with severe narrowing of the carotid arteries, which may lead to stroke and other cardiovascular problems. Nearly one-fifth of all patients who have an acute ischemic stroke have this condition. Treatment options for CAS are vastly different depending on whether it is diagnosed as a symptomatic or asymptomatic condition. It is possible that 1acute neurologic ischemia or amaurosis may represent symptoms of illness. If a carotid bruit is detected or an accidental discovery on imaging is made while doing an imaging test, then CAS may be diagnosed asymptomatically [1]. It is believed that CAS is linked to the formation of atherosclerotic plaque in the internal carotid artery (ICA), which runs through the neck and skull (extracranially) (intracranial). As a chronic artery disease, atherosclerosis is caused by the buildup of cholesterol, fat and calcium deposits in the inner wall of blood vessels [2]. An embolism of atherosclerotic material that goes into the brain might cause artery blockage and lead to neurological ischemia. There are two types of acute neurological ischemia: transient ischemic attacks (TIA) and stroke. [2]The symptoms that are experienced are determined by the areas of the brain and arteries that have been damaged. CAS mainly affects the anterior circulation or the retinal artery, which is where the ischemia occurs and what causes the symptoms. A turbulent flow pattern and regions of varying shear stress along the carotid artery walls result from the preponderance of carotid occlusive disease occurring around the carotid bifurcation. There are several ways in which fibro intimal thickening of the carotid artery proceeds to become symptomatic, and this progression may be seen in a number of ways. [5, 6] Near the middle of the plaque, rather than at the borders or shoulders, most plaque ruptures occur. Hypo echoic and homogeneic patterns on duplex ultrasonography have been linked to embolic potential and symptomatic condition. [8] Individuals who have recently encountered signs of carotid stenosis have a greater risk of stroke than patients who have never had symptoms of carotid stenosis. First-week post-event stroke risk is greatest; however, this risk diminishes with time. It's also critical to consider the sort of presentation taking place. [9] Another key risk factor to identify future stroke risk is the severity of the ipsilateral carotid stenosis, which is higher in patients who had a hemispheric stroke than in those who had a transient ischemic attack (TIA) or an ocular event (amaurosis fugax or retinal ischemia). [9] Those with significant carotid stenosis are most at risk of having a stroke. Other factors include ageing, an uneven and ulcerated plaque surface morphology, hypertension, and coronary heart disease.. With strong histological correlation, MRI may show structural correlates of plaque instability. IPH is a potential biomarker for plaque instability because of its capacity to show intra-plaque bleeding. [11] More over half of individuals with symptomatic carotid stenosis (approximately 30–50 percent) have IPH; in contrast, only 20–30 percent of patients with asymptomatic carotid narrowing do. [12] Even individuals with modest carotid stenosis (50 percent according to the criteria employed in the North American Symptomatic Carotid Endarterectomy Trial (NASCET)) had an elevated risk of ipsilateral stroke in a recent meta-analysis of individual patient data.[12]]Symptoms of carotid disease include numbness, paresthesias, slurred speech, paralysis, or monocular blindness in [12] percent of patients (amaurosis fugax). A transient ischemia attack occurs if the symptoms disappear within 24 hours and there is no long-term brain damage (TIA). The National Institutes of Health Stroke Scale may be used to classify symptoms that have persisted for more than 24 hours as those of a completed stroke. Crescendo TIAs are defined as recurrent bouts of localised neurological impairment marked by a failure to recover to baseline.[13] Stroke-in-evolution is defined as a condition in which a patient's symptoms increase and worsen over a period of hours to days. Patients with these symptoms should have a bilateral carotid duplex ultrasound performed to see whether carotid stenosis is to blame. The vast majority of individuals show no signs or symptoms of their condition. Health care clinicians use the NIH Stroke Scale (NIHSS) to measure the severity of stroke-related disability in their patients. The NIHSS consists of 11 items, each of which assigns a score ranging from 0 to 414 based on a certain skill.

CVDs often appear as diseases of the carotid arteries or peripheral vascular disease. The condition known as carotid artery stenosis (CAS) has the potential to result in a devastating stroke. Shockingly, according to the American Heart Association (AHA), stroke killed 6.5 million people worldwide in 2013. It is estimated that stroke would cost the United States an additional 129 percent of its national health expenditures by 2030. [16] A patient with a stenosis of 60% or more has a 16% chance of having a stroke over the course of five years[17]. Russia and France had the highest and lowest incidence rates, with 627 and 638 cases per 100,000 people, respectively, while the remainder of the areas had rates between 300 and 500 cases per 100,000 people. [18]. After the age of 50, males are more likely to suffer with moderate/severe CAS than women. An ultrasound examination or CTA/MRA is then recommended to establish the existence and degree of carotid stenosis in a clinical context if the physician identifies the presence of carotid bruit Hemodynamic forces have a significant role in carotid plaque development near the bifurcation. TIAs and strokes may occur if the carotid artery narrows over time or if a rapid plaque rupture causes thrombus blockage or embolization. [20]. Contrast material injections under X-ray exposure in the form of DSA or mask mode subtraction may be used to better view the cardiovascular system. Carotid artery DSA visualisation is 95% sensitive, 97% specific, and 97% accurate compared to conventional carotid angiography [22]. The ECST criteria of 75% stenosis are nearly equivalent to the NASCET standards of 50% stenosis. For patients with severe stenosis (NASCET 70–99 percent, and ECST 80% stenosis), both investigations revealed that CEA was more effective than medicinal treatment in alleviating symptoms. The development of the cerebral hyper perfusion phenomenon (HPP) after carotid procedures may be predicted using DSA. HPP is a rare condition, but it may lead to serious health complications and even death.[24] Watershed cerebral infarction is a possible complication of HPP. DSA has a sensitivity and specificity of 75% and 100%, respectively, for predicting HPP (prolonged CCT) by measuring the time it takes to attain the maximum contrast intensity. It was in 1973 that the first effective CT scanner was released, which claimed to be 100 times more sensitive than the standard X-ray angiography. Slice-based imaging of the three-dimensional body is used in CTA, resulting in a sequence of two-dimensional slice pictures of the whole three-dimensional body. A 3D reconstruction may be created from the 2D slices for a more accurate representation. In comparison to traditional angiography, CTA requires less contrast agent and so uses less of it. A number of semi- and fully automated 3D CTA analysis tools have been created and evaluated as a result of the advancements in image processing and analysis methods [28]. Segmentation reference points and adequate contrast intensity higher and lower bounds must be identified manually in semi-automated techniques (in Hu units). The correlation coefficient (r: 0.53 to 0.82) between semi-automated CTA and DSA 31 improved by 55% after post-processing human adjustments.

Recently, a fully-automated CTA revealed a carotid artery recognition rate of 75 percent on a small dataset of 14 individuals. Automatic detection of a circular area of interest in a 200–450 Hu and 2–6 mm diameter range that correlates to the carotid artery labelling is conducted after normalising the raw slice pictures in this manner. [33] High contrast pictures of the body's interior structures may be obtained using magnetic resonance imaging (MRI), where radio frequency pulses are used to excite the proton spinning in a tissue. As a result of flow information being recorded, Magnetic resonance angiography was developed (MRA). MRA projection imaging is used to reduce the amount of static tissue in the picture while increasing the image contrast related to blood flow in the arteries. Projection pictures are created by the use of techniques such as temporal subtraction, inversion excitation, stimulation of neighbouring areas, and phase shift. [34]. More than half of the vessels in the 50–69 percent and 70–99 percent stenosis ranges were found to have an agreement rate of 57% and 77%, respectively. An index of similarity (Dice overlap) of 0.87 was attained in a recent first-of-its-kind effort to identify the lumen border using a hierarchical tree model and the deployment of k-NN supervised classifier in both normal (15) and atherosclerotic (20) participants [35]. Duplex ultrasonography (DUS) is a highly reliable, noninvasive, and cost-effective way of diagnosing carotid illness. Color-Doppler ultrasonography visualises the movement of moving components or fluid (blood) to detect speed and other flow characteristics in a way that regular B-mode (greyscale) ultrasound cannot. [36]. Ultrasound in B-mode, often known as brightness mode, provides a cross-sectional view in two dimensions. Pulse–echo principle is a term for this. When it comes to Doppler ultrasonography, there are two main types: continuous-wave Doppler (CWD) and pulsed-wave Doppler (PWD) (PWD). For a more realistic evaluation of interior anatomy, a greyscale B-mode picture and blood flow information are shown on the same screen[37]. As blood flow increases, the existence of a stenosis is visible in the grayscale pictures, and this serves as a foundation or criteria for noninvasive stenosis assessment. Doppler ultrasonography, which measures the blood flow in the artery, is an essential tool in the CAS diagnostic process. There have been several studies looking at the relationship between risk factors such as age, gender, race, diabetes, pulse rate, and cigarette smoking and the development of carotid atherosclerosis. [40]. Since the IMT [41] is essential for B-mode diagnosis, a precise delineation of the wall borders is necessary. A multi-detector CTA (MDCTA) has been developed to quantify the plaque volume and its correlation with ulceration [42]. In addition to the degree of stenosis, plaque characterisation and progression are critical factors in clinical treatment choices [42]. [43]. Because of its apparent capacity to create high contrast pictures of soft tissues with high sensitivity and specificity, MRA may be superior at characterising the susceptible plaque. [44]. Researchers should consider looking at the possibility of using the link between MRI-detectable brain damage and the presence of high-grade carotid stenosis (> 50%) as a diagnostic tool for CAS [45]. Utilizing CFD, a patient-specific carotid hemodynamic may be explored using geometry from CTA and blood flow data from MRI (CFD) [46]. The administration of an ultrasonography contrast agent is contraindicated in patients who have heart failure, severe coronary disease or acute myocardial infarction, ventricular arrhythmias, or unstable breathing. With DUS, it is possible to link the strain of the plaque during the heartbeat to the measure of physical plaque instability, which is likely to be more clinically significant than stenosis level assessment. [47]. DUS in 2D relies heavily on the operator's ability to work with little planar information. Since DUS may be relied upon for an accurate CAS diagnosis, a 3D volume-based plaque measurement may prove useful. A high-repeatability volumetric picture of the luminal plaque is provided by a 3D ultrasound in 3D space[49].

An acoustic wave is generated by the thermal expansion of human tissue in the presence of modulated electromagnetic radiation. The tissue absorbs the delivered energy according to its specific absorption characteristics. This resulted in an auditory signal as a consequence of tissue expansion as a result of heating. A transducer is used to detect these acoustic waves, and a picture is produced using a back projection technique either in time or frequency. Photoacoustic tomography (PAT), optoacoustic tomography (OAT), and thermoacoustic tomography (TAT) are all terms for this kind of imaging. Multi-spectral OAT with Nd:YAG laser allows visualisation of human carotid artery and jugular vein [51]. There is also an immediate inflammatory response that causes an increase in temperature at these sites of lesion, in addition to the physiological changes that occur there. As a result, the local skin temperature rises. In 57% of the instances, aberrant thermal maps were detected as a probable indicator of carotid illness during a standard IR thermography assessment. In addition, a proactive thermography test using head clamp cooling may be employed, and the test's sensitivity was increased by 83%. Patients with carotid artery stenosis are the major focus of carotid artery revascularization. The following are possible treatment options: Carotid endarterectomy, Carotid artery stenting, and best medical treatment (CAS). The following considerations are considered when deciding which treatment option is best for a patient: Factors that affect the health and well-being of a patient, as well as the resources available to CAS is linked with a higher incidence of periprocedural complications as compared to CEA in patients younger than 70 years of age. Results of the CREST (Carotid Revascularization Endarterectomy vs Stenting Trial) subanalysis[54].

The most common non-neurological side effect of carotid revascularization is myocardial infarction. Compared to CAS in recent RCTs, CEA has been linked with an increased incidence of periprocedural myocardial infarctions. [55] As a result, each patient's heart health should be assessed before a suitable carotid revascularization technique is selected. [56]. Both CEA and CAS have been linked to a higher risk of problems in patients with chronic renal disease, but nothing is known about the influence of diabetes mellitus on either procedure. [57]. Patients with clinically significant cardiac disease (congestive heart failure, abnormal stress tests, or the need for open-heart surgery) and severe pulmonary disease were defined as being at high risk for carotid revascularization in the SAPPHIRE trial, which showed non inferiority of CAS in high-risk patients. [58]. When weighing the benefits of carotid artery revascularization vs the risks, it's critical to consider the patient's life expectancy. There was a substantial decrease in stroke rates in the two to three-year follow-up period of RCTs with symptomatic carotid artery stenosis. [59]

Risk of Stroke includes, Symptomatic status, Degree of stenosis, Plaque characteristics, Contralateral disease, Hostile neck, Hostile carotid, Aortic arch and When it comes to CAS, the availability of resources is critical. [60]. Increased operator and institutional experience has also been associated with lower rates of stroke/death following CAS, with operator volume of ≥6 cases per year and center experience of >150 CAS procedures associated with the best outcomes. Therefore, if CAS is considered, patients should be referred to an operator and center with endovascular expertise in this procedure [61].Reducing cardiovascular risk factors Medical management of patient with carotid stenosis is always warranted and applied to any patient with atheromatous lesions. Carotid endarterectomy consists of surgical removal of the atherosclerotic material causing stenosis at the carotid bifurcation. although only local anaesthetic offers the opportunity to directly observe and monitor the patient's neurological status throughout the procedure [62]. Carotid artery stenting is more frequently carried out under local anaesthetic. It involves passing a wire beyond the stenotic lesion and either employing an umbrella-like filter or using balloon inflation in the external/ common carotid arteries to encourage reverse flow down the internal carotid whilst the stent is placed across the stenosis and expanded to restore the normal luminal diameter [63]. More recently, a direct common carotid approach (called'TCAR' for Transcarotid Artery Revascularization) has been shown to be safe and is likely to be employed more frequently in the future; The indications for CEA and CAS are similar: for symptomatic patients (non-disabling stroke, TIA within the last 6months, or multiple episodes of amaurosis fugax) if stenosis>50% [64]. For asymptomatic patients: tight stenosis (>60%) and a perceived high long-term risk of stroke. Choice of procedure may be influenced by anatomy prior illness or treatment or patient risk [65]. Risks from undertaking CEA include stroke, cranial nerve palsy, a moderate risk of MI and some risk of infection and bleeding. Risks from CAS include stroke, lower bleeding risk than CEA, and a smaller risk of MIl [66]

.2.Subjects and methods

This is a prospective case series study. It was conducted on 40 ICU patients of both genders who were be admitted to ICU at Benha University hospital with transient and permenant neurological deficit due to carotid atherosclerosis. Exclusion criteria: were age < 40 years old, patients known to have contrast hypersensitivity patients with renal failure, patients with previous neck surgeries, and patients with neck tumors or previous irradiation. All enrolled patients were subjected to history taking, examination, ESR, CBC, ABG, liver, kidney function, Duplex U/S, bilateral examination of CCA, ICA, ECA with vertebrobasilar arterial system. Measurement parameters were PSV and EDV. In addition, CTA was performed with toshiba multislice(16)CT. Slice thickness was 1.5mm at an increment of 1.0 mm. Area imaged was from aortic arch to pituitary gland. Non iodinated contrast media 80-100ml was injected by automated injector.

The mean age of studied cases was 63 years, ranged from 52 to 73 years. They were 26 males (65%) and 14 females (35%). The mean weight of all studied cases was 83.2 kg, ranged from 68 to 98 kg. All studied patients were subjected to carotid duplex for evaluation of extracranial carotid circulation, mean PSV was 182.3, ranged from 110 to 240, mean EVD was 90 ranged from 20 to 150, mean stenosis was 66.6, ranged from 30 to 83. Stenosis grades were stratified into mild (12.5%), moderate (50%) and severe (37.5%). All studied patients were subjected to carotid duplex for evaluation of extracranial carotid circulation, mean PSV was 182.3, ranged from 110 to 240, mean EVD was 90 ranged from 20 to 150, mean stenosis was 66.6, ranged from 30 to 83. Stenosis grades were stratified into mild (12.5%), moderate (50%) and severe (37.5%). Moreover, all studied patients were subjected to CT angiography for evaluation of extracranial carotid circulation. Mean NASCET criteria was 66.8, ranged from 30 to 85. Stenosis grades were stratified into mild (12.5%), moderate (50%) and severe (37.5%).

2.1Statistical Analysis

The collected data was analysed using Statistical package for Social Science The collected data was revised, coded, tabulated and introduced to a PC using Statistical package for Social Science (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Data were presented and suitable analysis was done according to the type of data obtained for each parameter. Student T Test was used to assess the statistical significance of the difference between two study group means. For the comparison of more than two groups' means, one way analysis of variance (ANOVA) was used. Chi-Square test was used to examine the relationship between two qualitative variables. Correlation analysis: To assess the strength of association between two quantitative variables.. Intra class Correlation Coefficient and correlation coefficient were analyzed for agreement between methods. Bland-Altman plot: For each pair of values, limits of agreement were assessed by evaluating the mean difference (bias) and the standard deviation of the differences using the Bland-Altman plot which was used to visually assess agreement between the methods. A *p* value is considered significant if <0.05 at confidence interval 95%.

3.Results

The overall concordance between both CDUS and CTA was 77.5% (31/40), CDUS under-estimated the degree of stenosis in 7/40 (17.5%), and over-estimated the degree of stenosis in 2/40 (5%), respectively. The overall disconcordance was 9/40 (22.5%).The overall disconcordance was 9/40 (22.5%). **Figure 1.** Regarding the agreement between mild, moderate and severe grades of stenosis assessed by duplex and CTA, there was perfect agreement between both methods **(table 1).**

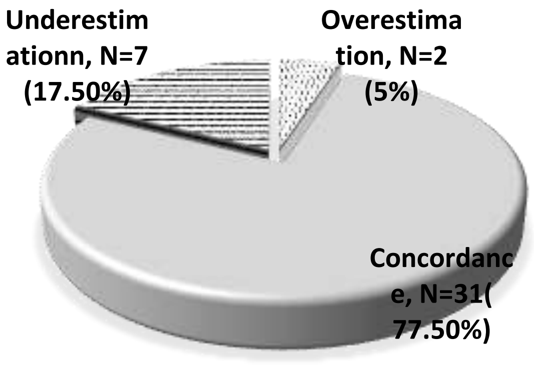

Fig. (1) Concordance among all studied cases.

Table (1) Agreement of stenosis grades of duplex US and CT angiogram.

		CT angiogram stenosis grades		
		mild	**moderate**	**severe**
Duplex stenosis grades	**mild**	5	0	0
	moderate	0	20	0
	severe	0	0	15
	Sensitivity		100%	
	Specificity		100%	
	PPV		100%	
	NPV		100%	
	Accuracy		100%	

No significant association was found between concordance of duplex and CT angiogram with smoking, hypertension, DM, hyperlipidemia, CAD, COPD, ESRD and LCF, diagnosis, DCL, bulbar palsy, hypertension and hyperglycemia, PSV, EDV, stenosis and degree of stenosis. Among concordant cases, 16.1% had mild, 38.7% had moderate and 45.2% had severe stenosis. Among overestimated cases, 2 (100%) had moderate stenosis. Among underestimated cases, 85.7% had moderate and 14.3% had severe stenosis **(table 2).**

Table (2). Association of concordance between CDUS and CTA with studied parameters.

			Overestimation n=2	**Concordance** n=31	**Under estimation** n=7	***p***
Age (years)		**mean±SD**	63.5±5	63.0±4.9	63.1±8.5	0.990
		range	60-67	52-69	53-73	
Gender	**males**	**N (%)**	1(50%)	19(61.3%)	6(85.7%)	0.458
	females	**N (%)**	1(50%)	12(38.7%)	1(14.3%)	
Weight (kg)		**mean±SD**	82.5±9.2	83.4±8.5	82.3±9.5	0.946
		range	76-89	69-98	68-94	
Risk factros	**Smoking**	**N (%)**	0(0%)	5(16.1%)	3(42.9%)	0.215
	HTN	**N (%)**	1(50%)	14(45.2%)	1(14.3%)	0.308
	DM	**N (%)**	1(50%)	8(25.8%)	3(42.9%)	0.551
	Hyperlipidemia	**N (%)**	0(0%)	4(12.9%)	0(0%)	0.525
Comorbidities	**CAD**	**N (%)**	1(50%)	11(35.5%)	3(42.9%)	0.872
	COPD	**N (%)**	0(0%)	7(22.6%)	4(57.1%)	0.121
	ESRD	**N (%)**	0(0%)	6(19.4%)	0(0%)	0.359
	LCF	**N (%)**	1(50%)	7(22.6%)	0(0%)	0.222
Diagnosis	**Stroke**	**N (%)**	2(100%)	22(71%)	4(57.1%)	0.682
	TIA	**N (%)**	0(0%)	9(29%)	3(42.9%)	
cause of admission to ICU	**DCL**	**N (%)**	1(50%)	11(35.5%)	1(14.3%)	0.481
	Bulber palsy	**N (%)**	1(50%)	8(25.8%)	3(42.9%)	0.551
	Hypertension	**N (%)**	0(0%)	6(19.4%)	3(42.9%)	0.298
	Hyperglycemia	**N (%)**	0(0%)	6(19.4%)	0(0%)	0.359

CDUS	**PSV**	**mean±SD** **range**	155±21.2 140-170	185.2±39.7 110-230	177.1±34 140-240	0.527
	EDV	**mean±SD** **range**	60±14.1 50-70	93.6±41 20-140	82.9±33.5 50-150	0.447
	stenosis	**mean±SD** **range**	65.5±5 62-69	66.6±14.9 30-82	66.6±7.9 58-83	0.994
CTA	**NASCET criteria**	**mean±SD** **range**	63.5±5.0 60-67	66.6±14.9 30-82	68.7±7.8 60-85	0.881
Degree of stenosis		**mild**	0(0%)	5(16.1%)	0(0%)	0.436
		moderate	2(100%)	12(38.7%)	6(85.7%)	p=0.028 p1=0.089 p2=0.571 p3=0.024
		severe	0(0%)	14(45.2%)	1(14.3%)	0.166

P, comparison between overestimation, concordance and underestimation; p1, comparison between overestimation and concordance; p2, comparison between overestimation and underestimation; p3, comparison between concordance and underestimation.

Bias of all the individual differences was calculated as a measure of variability (repeatability); from which the limits of agreement (LOA) are determined. The limits of agreement represent the range of values in which agreement between methods will lie for approximately 95% of the sample. The overall mean difference between the DUS and CTA was (-0.275)±0.99 and the limits of agreement were from (-2.21) to 1.66. We compared the degree of agreement with the Bland–Altman method. About 95% of the errors on measurements estimated by the difference between the two groups lay within the limits of agreement. The distribution of the dots on the scatter diagrams shows a higher distribution of the dots on the zero line as no differences between both methods (concordance). Most of the measurements were located between the upper and the lower limits of agreement. This indicates that the results of DUS and CTA measurements were not graphically different from each other and denoting good agreement between them. Two cases of overestimation and 1 case of underestimation lie beyond LOA **(Figure 2,3)**

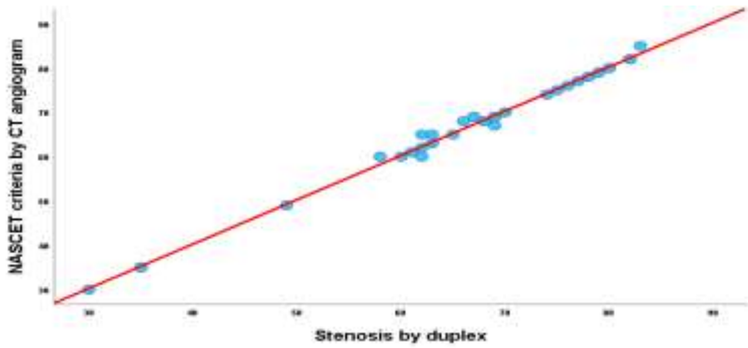

Fig. (2) Correlation between duplex US and CT angiogram results

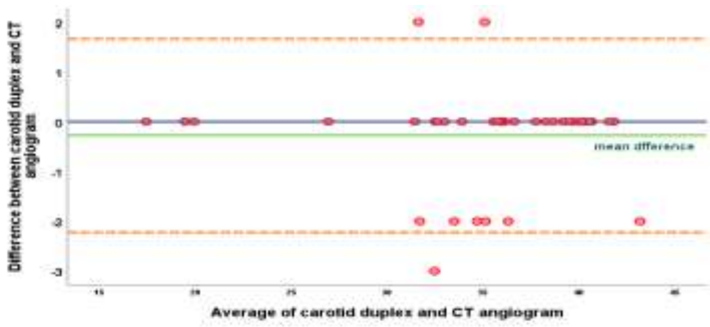

Fig. (3) Bland Altamn plot between duplex US and CT angiogram results. Green line indicate the mean of difference between both methods, Blue line indicate the zero difference between both methods, Dotted lines indicate limits of agreement (the 95% Confidence Interval).

No significant association was found regarding concordance between duplex and CT angiogram with NASCET criteria and degree of stenosis. Among concordant cases, 16.1% had mild, 38.7% had moderate and 45.2% had severe stenosis. Among overestimated cases, 2 (100%) had moderate stenosis. Among underestimated cases, 85.7% had moderate and 14.3% had severe stenosis. Moderate stenosis was significantly associated with different degrees of concordance, this was attributed to significant association of moderate stenosis with underestimation when compared to concordance. Concordance showed significant differences among mild, moderate and severe cases, this was due to significant higher association of concordance with severe than moderate. Over estimation and underestimation did not differ significantly between mild, moderate and severe cases **(Table 3).**

Table (3). Association of degree of stenosis with studied parametrs among all studied cases.

			Stenosis			
			mild n=5	**moderate** n=20	**severe** n=15	*p*
Age (years)		**mean±SD**	62.6±4.2	62.8±6.1	63.5±5.3	0.906
		range	57-68	52-73	53-69	
Gender	**males**	**N (%)**	3(60%)	13(65%)	10(66.7%)	0.964
	females	**N (%)**	2(40%)	7(35%)	5(33.3%)	
Weight (kg)		**mean±SD**	83.2±9.3	80±8	87.4±7.3	p=0.033
		range	73-98	68-94	72-97	p1=0.424 p2=0.311 p3=0.010
Risk	**Smoking**	**N (%)**	0(0%)	4(20%)	4(26.7%)	0.435
	HTN	**N (%)**	1(20%)	9(45%)	6(40%)	0.594
	DM	**N (%)**	4(80%)	5(25%)	3(20%)	p=0.032 p1=0.022 p2=0.015 p3=0.727
	Hyperlipidemia	**N (%)**	0(0%)	2(10%)	2(13.3%)	0.690
Comorbidities	**CAD**	**N (%)**	1(20%)	9(45%)	5(33.3%)	0.537
	COPD	**N (%)**	2(40%)	4(20%)	5(33.3%)	0.545
	ESRD	**N (%)**	1(20%)	4(20%)	1(6.7%)	0.520
	LCF	**N (%)**	1(20%)	3(15%)	4(26.7%)	0.694
Diagnosis	**Stroke**	**N (%)**	4(80%)	13(65%)	11(73.3%)	0.896
	TIA	**N (%)**	1(20%)	7(35%)	4(26.7%)	
cause of admission to ICU	**DCL**	**N (%)**	1(20%)	9(45%)	3(20%)	0.241
	Bulber palsy	**N (%)**	1(20%)	6(30%)	5(33.3%)	0.853
	HTN	**N (%)**	1(20%)	3(15%)	5(33.3%)	0.433
	Hyperglycemia	**N (%)**	2(40%)	2(10%)	2(13.3%)	0.237
CDUS findings	**PSV**	**mean±SD**	120±7.1	167.5±19.2	222.7±9.6	p<0.001
		range	110-130	140-200	210-240	p1<0.001 p2<0.001 p3<0.001
	EDV	**mean±SD**	28±4.5	73.5±18.4	132.7±9.6	p<0.001
		range	20-30	50-100	120-150	p1<0.001 p2<0.001 p3<0.001
	stenosis in duplex	**mean±SD**	36.8±7.2	65.3±3.6	78.1±3.4	p<0.001
		range	30-49	58-69	70-83	p1<0.001 p2<0.001 p3<0.001
CTA findings	**NASCET criteria**	**mean±SD**	36.8±7.2	65.8±3.5	78.3±3.6	p<0.001
		range	30-49	60-69	70-85	p1<0.001 p2<0.001 p3<0.001
Concordance	**Overestimation**	**N (%)**	0(0%)	2(10%)	0(0%)	0.349
	Concordance	**N (%)**	5(100%)	12(60%)	14(93.3%)	p=0.028 p1=0.086 p2=0.554 p3=0.026

Underestimationn	N (%)	0(0%)	6(30%)	1(6.7%)	0.108

P, comparison between mild, moderate and severe stenosis; p1, comparison between mild, moderate stenosis; p2, comparison between mild, and severe stenosis; p3, comparison between moderate and severe stenosis.

4. Discussion

An initial development of localised neurologic signs in a vascular region that results in long-term neurological damage is known as a stroke. Neurologic impairment that lasts for less than 24 hours, most typically minutes, is known as a transient ischemic attack (TIA). [68]. A stroke is classified as either an ischemic (85%) or a hemorrhagic (5%). (15 percent) Carotid artery stenosis is one of the most common causes of stroke. In the over-65 demographic In proximal carotid stenosis, embolism from an unstable plaque or hypo-perfusion owing to severe stenosis with weak collaterals may cause stroke or transient ischemic attack. [70] Duplex ultrasonography (DUS) has supplanted angiography as the "Gold Standard" in the majority of diagnostic situations. [71] Detecting occlusive lesions in the carotid vessels is made easier with the use of a carotid Doppler examination. Cerebral infarction is more likely to occur in patients with severe stenosis (70%). [72] Angiography (CTA) is a more precise method of diagnosing blocked arteries than CT angiogram (CTA). Compared to invasive angiography, DUS and CTA imaging technologies provide excellent sensitivity and specificity in defining anatomy and planning revascularization [74]. CDUS has been well recognized[75] for its diagnostic accuracy in a variety of vascular diseases. CDUS is a non-invasive, bedside or outpatient imaging method that is safe and effective. [76]. In addition, it examines the state of the artery wall and offers significant information on the dynamics of blood flow through the stenosis [77] CEA [78] treatment decisions in certain facilities are primarily based on CDUS test findings. CDUS and CTA concordance was 77.5 percent overall in our research. Approximately 17.5 percent of CDUS patients were under- or over-estimated in the degree of stenosis, respectively. The total concordance was reported to be 79.1 percent, which was in accord with this. Studies on peripheral arteries [80] have shown similar results, and this study's findings support their findings. CDUS may overestimate the stenotic degree in situations of contralateral internal carotid stenosis, which may explain the overestimation. Different calf filling rates, inadequate arterial opacification distal to occlusions, and other factors may create discrepancies between CDUS and CTA. CDUS is also operator dependant and has certain limitations[82], and the blooming effect of calcium may again be misinterpreted for an occluded artery [83]. Another factor that may have contributed to the inconsistencies between the CDUS examination results and the CDUS results is potential arrhythmia. It is true that the ICA and/or CCA PSV may be considerably changed if it is assessed shortly after a premature ventricular contraction or a compensating pause is taken into account. In our investigation, the stenosis grades of duplex US and CT angiograms were in perfect agreement, with 100% sensitivity, 100% specificity, 100% PPV, 100% NPV, and 100% accuracy in stenosis grades. Detection of iliac stenosis and obstruction was confirmed in 85 of the studies that revealed comparable outcomes. There were 16.1 percent mild, 38.7 percent moderate, and 45.2 percent severe stenosis among the concordant cases in the present series. Two (one hundred percent) of the exaggerated instances had mild stenosis. On average, 85.7% of those with moderate and 14.3% with severe stenosis were underreported. Underestimation was shown to be a major risk factor for moderate stenosis. According to the second report, [85], this was the case There was no correlation between CDUS and CTA concordance based on age, gender, weight, smoking status or any of the other risk factors examined in this study. The researchers also found that no other factors such as diagnosis, DCL and bulbar palsy, blood pressure and blood sugar levels, PSV and EDV, NASCET criteria stenosis, or the degree of stenosis could explain the discrepancy. Age and gender, smoking, hypertension, hyperlipidemia, CAD, COPD, ESRD, LCF, diagnosis, DCL, bulbar palsy, hypertension, and hyperglycemia are all associated with this condition. Others, on the other hand, discovered a considerable decline in carotid blood flow velocities with age [86]. We found that more weight was related with more severe stenosis in our study subjects. In accordance with the opinions of others[86,87]. Possibly because of the greater levels of atherosclerosis. While minor stenosis was seen in diabetes individuals in our investigation. DUS [88, 89] may not be able to see the complete length of calcified arteries, particularly in diabetics and those with chronic renal insufficiency. In instances with carotid web [88], a combination of CDUS and CTA might boost the likelihood of a correct diagnosis. PSV ratio measurements have greatly improved the quantitative accuracy for assessing the hemodynamic importance of stenosis in patients with multilayer segmental occlusions or widespread stenotic illness. There was a strong correlation between stenosis grade and PSV and EVD levels in the present study. Like many others, I believe [89] For stenosis more than 70 percent, the PSV ratio helps detect the true importance of the lesion when ultrasonography assessment is inconclusive. There are a few drawbacks to using PSV instead of PSV, such as the effect of heart activity on arterial velocity and false-negative results at the distal stenosis owing to lower preexisting proximal flow due to tandem stenoses or blockages. Additionally, the PSV ratio helps reduce the variability in ultrasound results between observers. Stenosis was assessed using both the PSV and the EVD in this research. The inclusion of the proposed EDV threshold, according to Hersant and his colleagues[90], might have reduced the number of differences. The study's key drawback was that only a limited number of patients could be analysed. There was a selection bias due to the fact that stroke and TIA are clinical diagnoses, which can't be avoided. Further trials should be multicentric and cover a greater number of patients, according to the authors. Analysis of individuals with significant carotid calcification would also be extremely helpful in establishing the diagnostic quality of CDUS vs CTA in the most problematic instances.

5. Conclusion

It could be concluded that, DCUS and CTA showed excellent agreement, while CDUS remains the first-line non-invasive imaging technique for assessment of ICA stenosis; it is subject to several limitations. CTA provides an excellent adjunctive technique in the pre-operative assessment of carotid disease and may significantly affect the decision regarding operative treatment

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