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Colour Doppler Evaluation of Carotid Arteries & Vertebral Arteries in Patients with Stroke

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Abstract: **Stroke is one of the leading causes of death. One-third of cases are deadly, and survivors normally have actually lengthened or irreparable specials need. Color Doppler ultrasound (CDU) of carotid arteries forms a fundamental part of the examination of extracranial deficiency. Precise diagnosis of hemodynamically substantial stenosis is crucial to determine patients who would take advantage of surgical intervention. We conducted a systematic review of the literature to determine the diagnostic accuracy of color dopplor ultrasound, in diagnosing vertebral and carotid arteries stenosis or occlusion in stroke patients. A comprehensive review of the literature combining online and conventional library searches as well as searches to find unpublished studies was performed including different database such PUBMED up to October 2016. Doppler ultrasonography is fairly conscious modifications in the intracranial arterial speeds. A raised intracranial circulation speed is not particular for intracranial arterial dissection, this condition is consisted of in the differential diagnosis, which likewise consists of atherosclerosis and vasospasm.**

Keywords: **Color Doppler ultrasound (CDU), hemodynamically substantial stenosis.**

1. INTRODUCTION

Stroke is one of the leading causes of death. One-third of cases are deadly, and survivors normally have actually lengthened or irreparable specials need [(1)]. An approximated 80% of strokes are thromboembolic in origin, frequently with carotid plaque as embolic source [(2)]. For more than a year's numerous sonographic methods have actually been utilized for the evaluation of carotid arteries in cerebrovascular illness. Of these, continuous-wave Doppler and single-gate pulsed-wave Doppler sonography integrated in duplex systems are reported to be extremely precise relative to angiography for the detection and category of the degree of obstruction producing a constricting of lumen more than 50% [(3)].

Color Doppler ultrasound (CDU) of carotid arteries forms a fundamental part of the examination of extracranial deficiency. Precise diagnosis of hemodynamically substantial stenosis is crucial to determine patients who would take advantage of surgical intervention. The worth of a safe, noninvasive, and affordable screening test is for that reason of an excellent benefit [(4)].

Duplex sonography integrating high-resolution imaging and Doppler spectrum analysis has actually shown to be a popular, noninvasive, precise, and affordable ways of evaluating and identifying carotid illness. Carotid sonography has actually mainly changed angiography for thought extracranial carotid atherosclerosis [(4)].

With high-resolution ultrasound, plaque can be defined into relative danger groups including intraplaque hemorrhage which is believed to be a precursor for plaque ulcer [(5,6)]. The brain is provided by 4 vessels: The two internal carotid arteries (ICAs) and the two vertebral arteries (**Figure 1**) [(7)]. Color flow Doppler ultrasonographic imaging may best demonstrate the true and false lumina [(8)]. Findings of vertebral arterial dissection on Doppler sonograms include the

absence of arterial flow or low blood velocities in the dissected artery, often with a compensatory increased blood flow in the contralateral vertebral artery [9,10]. The sonographer may have difficulty in imaging the intraforaminal segments of the vertebral artery. Of note, the Doppler ultrasonographic findings are nonspecific, and the diagnosis of dissection is suggested only in the appropriate clinical setting [10,11].

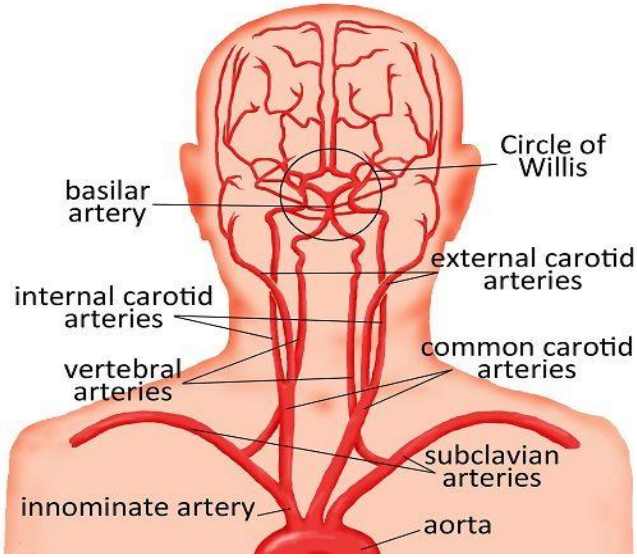

Figure1: Vascular anatomy showing common carotid artery, internal carotid artery, and vertebral artery(7)

We conducted a systematic review of the literature to determine the diagnostic accuracy of color dopplor ultrasound, in diagnosing vertebral and carotid arteries stenosis or occlusion in stroke patients.

2. METHODOLOGY

Systematic review study was conducted following the evidence based of systematic review roles:

Data sources:

A comprehensive review of the literature combining online and conventional library searches as well as searches to find unpublished studies was performed including different database such PUBMED up to October 2016. All studies evaluating the accuracy of Color Doppler sonography in evaluation the carotid and vertebral arteries patients with stroke were included; search was limited to studies of humans and articles in English. To find the studies, we performed a PUBMED search using the following keywords and all possible related terms: carotid artery and angiography combined with stroke evaluation, Color Doppler, carotid arteries occlusion, vertebral arteries evaluatuion. We limited the search to publications published in the English language. Reference lists of original and review publications on this subject were checked, and experts on the subject were consulted to find additional studies. Inclusion criteria were: (A) article in English; (B) used IAA as reference standard (C) assessed vertebral artery for stenosis or occlusion. Case reports were excluded. Full text articles of abstracts fulfilling the criteria were reviewed. In addition, the references of articles which fulfilled the inclusion and exclusion criteria were hand searched. Reference lists of all included studies, were also reviewed for other potential studies that met inclusion criteria.

3. RESULTS AND DISCUSSION

The relationship between the degree of internal carotid artery (ICA) stenosis and the risk of stroke was originally determined in the carotid endarterectomy trials using intraarterial angiography (IAA) to visualise and quantify the degree of stenosis (12). However, while the two large carotid endarterectomy trials, the European Carotid Surgery Trial (ECST) and the North American Symptomatic Carotid Endarterectomy Trial (NASCET), both measured the residual lumen at the point of maximum stenosis, they measured the original normal arterial diameter (denominator) differently (**Figure 2**): ECST measured where the original arterial outline would have been at the point of maximum stenosis (i.e. the observer had to imagine the original vessel outline, as angiography only shows the residual lumen)(12); NASCET measured the ICA diameter in the disease-free ICA distal to the stenosis, or the artery was classified as 95% stenosed if the distal ICA

had collapsed (13). Thus a 70% ECST stenosis is the same as a 50% NASCET stenosis (14). A third method of stenosis quantification was described which used the common carotid artery (CCA) diameter where the walls were disease-free and parallel below the carotid bifurcation as the denominator (15). or carotid artery stenosis, the risk of stroke and the benefit of surgical intervention have been shown to depend on the degree of stenosis. Therefore, accurate assessment of the degree of stenosis is important, and 70% has been identified as the cut-off above which patients particularly benefit from endarterectomy. Whether a similar cut-off exists for vertebral artery stenosis, above which the risk of recurrent stroke is particularly high and there is potential benefit from intervention, remains to be determined (15).

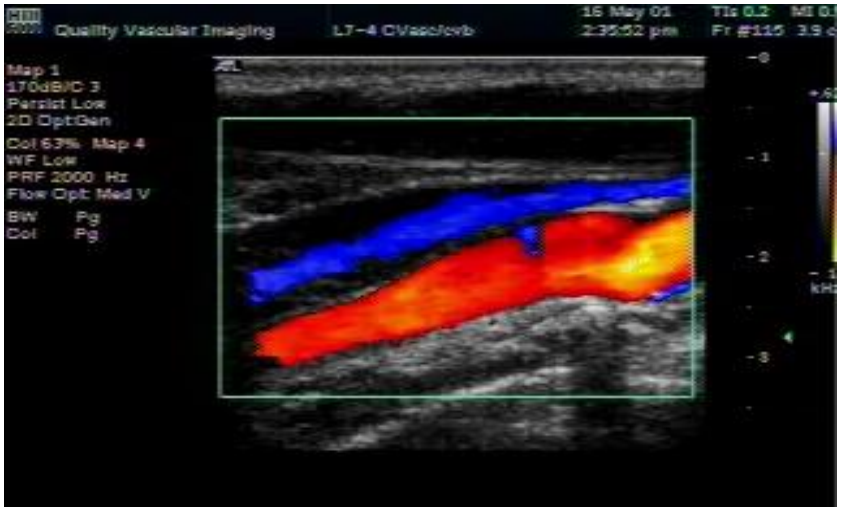

Figure 2: The internal carotid artery, which is the main blood supply to the brain, is shown with gray scale and color Doppler

Two relatively small studies in the early 1990s (n = 63 [16] and 56 [17] patients, respectively) examined an angiogramlike stenosis measurement on CDU compared with angiography. In one [16], an ECST-like stenosis measured on longitudinal and transverse views on CDU was compared to a NASCET stenosis measured on angiography. Both diameter and area lumen reduction were obtained from CDU. The authors suggested that ultrasound slightly underestimated the degree of stenosis compared with IAA, and that the area reduction measurement was a closer correlation with angiography. In the other [17], the stenosis assessedby area reduction from a transverse view on CDU correlated with a NASCET stenosis from IAA at r = 0.94, p < 0.0001. Both of these studies, performed before the equation relating NASCET to ECST and CCA had been derived, confounded their analyses by not using comparable stenosis measurements on the two imaging techniques.

in one included prospective blind study [18] of 316 vertebral arteries was undertaken between 1996 and 1998. One hundred and fifty-eight patients with cerebrovascular disorders without cerebral hemorrhage were studied consecutively by frequency or amplitude color Doppler flow imaging and intra-arterial angiography. concluded that should be proposed first in vertebral artries attacks or stroke to detect and quantify vertebral artery stenoses for surgery and angioplasty.

Three (19,20,21) of the five studies (18,19,20,21,22) used dopplor without colour to assess the vertebral artery origin. The dopplor definition of stenosis differed in the three studies: Ackerstaff *et al* (19) used antegrade direction of flow, with peak frequency >4 KHz, increased spectral broadening and striking turbulence during systole to define 1–99% stenosis. The same definition in Ackerstaff *et al* (20) was used to define 50–99% stenosis and Visona *et al* (21) defined 50–99% stenosis as high velocity signal >2 kHz with a broad spectrum, high pitched and harsh sound. Ackerstaff *et al* (19) was not used for stenosis analysis but results were included for occlusion analysis. One study was prospective, (21) one blindly assessed imaging techniques (20) and all three recruited non-consecutive patients. Pooled sensitivity, specificity and DOR were 70.2 % (95% CI 56.6 to 81.6), 93.4% (95% CI 89.2 to 96.3) and 37 (95% CI 16 to 83), respectively, for diagnosing 50–99% stenosis on duplex without colour versus diagnosing <50% stenosis or 100% (occlusion).

Two colour Dopplor studies (18,22) were included in the analysis. The study of De Bray *et al* was a prospective, consecutive imaging study which blindly assessed the imaging results of 316 arteries,[18] while the study of Harrer *et al* was a retrospective, non-consecutive study blindly assessing the imaging of six arteries (22). Pooled sensitivity, specificity and DOR were 70.2% (95% CI 54.2 to 83.3), 97.7 (95% CI 95.2 to 99.1) and 75 (95% CI 24 to 234), respectively, for diagnosing 50–99% stenosis versus diagnosing <50% stenosis or 100% (occlusion).

Schulz *et al*. (23) studied the family history of stroke and found that 23% of stroke patients had a positive family history. In this study(23), family history of stroke was present in 7 (14%) patients of which 3 (42%) had significant stenosis (23).

Normal CCA color Doppler waveform is shown in (**Figure 3**). In the literature of ultrasound, different studies say that one of the 3 major Doppler parameters that is, PSV, EDV, or PSV ratio is the most accurate predictor of clinically significant ICA stenosis. Because a ratio compensates for the patient to patient physiological variability and also compensate for instrument variability, PSV ratio has been considered best for assessing stenosis. North American Symptomatic Carotid Endarterectomy Trial and European Carotid Endarterectomy Trial clearly demonstrated that the long-term benefits of endarterectomy were significantly greater than medical treatment in patients with 60% or 70% ICA stenosis, whether symptomatic, or asymptomatic. Second, the endarterectomy trials established 60–70% diameter reduction as clinically significant levels of ICA stenosis (24).

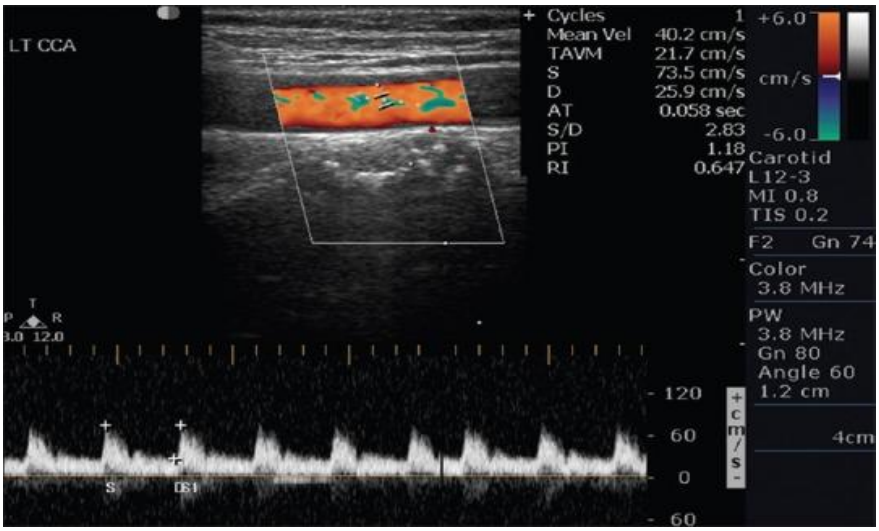

Figure3: Normal Left common carotid artery color Doppler waveform in a 45-year-old male with a history of transient ischemic attack and normal brain computed tomography scan study [(24)]

The duplex imaging of complete carotid occlusion was based on the absence of arterial pulsation, lumen filled with echogenic material, subnormal vessel size, and the absence of Doppler flow signals or weak Doppler signals (25). In this study, we came across 2 patients with complete occlusion, 1 on the left and other on the right side. Severely stenosed contralateral ICA can artificially elevate ultrasound PSV since the effect was greatest when bilateral severe stenosis was present. Caution must be exercised when assessing the degree of ICA stenosis on the basis of ultrasound PSV alone (26).

4. CONCLUSION

Color Doppler assessment is a financial, safe, reproducible, and less lengthy approach of showing the reason for cerebrovascular deficiency in extracranial carotid artery system and will direct in setting up treatment modalities. Doppler ultrasonography is fairly conscious modifications in the intracranial arterial speeds. A raised intracranial circulation speed is not particular for intracranial arterial dissection, this condition is consisted of in the differential diagnosis, which likewise consists of atherosclerosis and vasospasm.

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