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"Role Of Caroto-Vertebral Duplex Ultrasonography In Patients With Cerebro-Vascular Accident - Hemodynamic Characterisation & Etiological Stratification"

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Abstract:
Introduction: *Cerebrovascular accident is defined as a sudden, non-convulsive focal neurological deficit resulting due to brain ischemia predominantly caused by the thrombo-embolism or with atheromatous carotid plaque as the embolic source[1]. Cerebrovascular accident is the leading cause of morbidity in elderly patients with varying degrees of neurological deficit. Since it is a preventable condition and with timely intervention, the severity of the disease can be minimized. Hence, the aim of the present study was real time visualization of vascular lesions to characterize the morphology of vessels for intimal-media complex & for any plaque or stenosis, to quantify the degree and percentage of stenosis in the caroto-vertebral arteries and to correlate the degree of stenosis with severity of clinical disease.*
Materials and methods: *Prospective cross-sectional study was conducted on 100 patients presenting with CVA with or without persistent neurological deficit referred to Department of Radio-diagnosis and Imaging from indoor and outdoor departments of Jan Sewa hospital of Dr. S. S. Tantia Medical College, Sri Ganganagar.*
Results: *The majority of patients were in the age group of 60-69 years with 56% being male, 47% presenting with transient ischemic attack, commonest clinical feature being coronary artery disease (29%) followed by haeadache (17%), nausea vomiting (4%), hemiplegia (2%) patients and coma (1%). Hypertension was the most commonest risk factor (59%) followed by diabetes mellitus (18%), hyperlipidemia (14%), atrial fibrillations (5%) and smoking (4%). Majority of plaques were seen in the carotid bulb with variable laterality & echopattern. It was seen that as the degree of stenosis increases the various velocities and their respective ratios (ICA PSV/ CCA PSV, ICA EDV/CCA EDV, ICA PSV/CCA EDV) tend to increase in proportion to the stenosis suggestive of a positive correlation between them.*
Conclusion: *Caroto-vertebral duplex ultrasonography provides a "road map" for carotid endartectomy and/or carotid angioplasty and stenting due to direct visualization of plaque morphology & surface configuration, measurement of the length of stenosed segment, precise determination of grade of stenosis and to get an insight into hemodynamic disorders.*
Key-words: *Cerebro-Vascular Accident (CVA), caroto-vertebral duplex ultrasonography, hemodynamic characterization, etiological stratification*

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I. Introduction:

Cerebrovascular accident (CVA) is defined as a sudden, non-convulsive focal neurological deficit resulting due to brain ischemia caused by the thrombo-embolism or atheromatous carotid plaque as the embolic source[1]. Causes of CVA include thrombosis, embolic occlusion at carotid bifurcation, aortic arch & arterial dissection and cardio embolic causes like atrial fibrillation, mural thrombus, myocardial infarction & dilated cardiomyopathy. Risk factors include hypertension, diabetes, smoking, hyperlipidemia and atrial fibrillation[2]. In its mildest form it may consist of a trivial neurological disorder insufficient even to arouse concern or demand medical attention But In its most severe form, patient becomes hemiplegic and even comatose, an event of stroke is so dramatic that it has been given its own designation name apoplexy, CVA shock or cerebro-vascular accidents.[3] The common neurological symptoms of brain ischemia are cerebrovascular accidents, transient ischemic attack, bruit in the region of carotid bifurcation, a palpable pulsatile mass in neck and amaurosis fugax[4].

Cerebrovascular accident is the leading cause of morbidity in elderly patients with varying and often greatly disabling degrees of neurological deficit. Since it is a preventable condition and with timely intervention, the severity of the disease can be minimized.

The main goal of caroto-vertebral duplex imaging is to quantify the degree of stenosis caused by atherosclerotic vascular disease in symptomatic patients who have a history of transient ischemic attack or complete CVA. The collateral circulation should also be assessed to determine the preoperative or pre interventional complication risk.[5] It is highly sensitive, specific, non invasive, cheap, affordable and bedside investigation of choice. Sonography is now the most common imaging study performed for the diagnosis of cerebro-vascular diseases.

Because of their superficial location and easy access, the extra cranial carotid and vertebral arteries are optimal for duplex sonography. Grey scale sonography allows for imaging of atherosclerotic plaques and intima-media thickness (IMT) which is considered a marker of early atherosclerosis and is the only sonography parameter recommended by the American Heart Association to be used routinely when screening for cardiovascular risk. Color Doppler sonography allows simultaneous real time visualization of vascular lesions and associated flow abnormalities, guides cursor position on suspected areas of stenosis, and assists in differentiating critical stenosis and occlusion. Examination and recording of pathologic findings on gray scale and Colour Doppler Sonography are followed by spectral Doppler haemodynamic analysis.

The significance of caroto-vertebral duplex ultrasonography in patients selection for carotid endartectomy, lies in the possibility of direct visualization of plaque morphology, determination of its properties, and the composition of configuration of its surface, which cannot be measured with other diagnostic procedures. Moreover, it is possible to measure the length of stenosis invovled segment, to determine precisely the grade of stenosis and to get an insight into hemodynamic disorders.[6]

II. Aims And Objectives

To characterize the morphology of vessels for intimal-media complex and for any plaque or stenosis.
To quantify the degree and percentage of stenosis in the carotid and vertebral arteries.
To correlate the degree of stenosis with severity of clinical disease.

III. Materials And Methods

Prospective cross-sectional study was conducted on 100 patients presenting with CVA with or without persistent neurological deficit referred to Department of Radio-Diagnosis and Imaging from indoor and outdoor departments of Jan Sewa Hospital of Dr. S. S. Tantia Medical College, Sri Ganganagar. After taking the consent of the patient for investigation, the sonographic evaluation was carried out using a real time scanner (GE Voluson P8) whole body Doppler machine with probe of 3-12 MHZ frequency. Doppler scanning combines a B-mode ultrasound image with a pulsed Doppler flow detectors and spectrum analysis. Carotid examination was performed with the patient in supine position, the neck slightly extended with pillow under the shoulder, head turned away from the side being examined and the examiner sitting by the side of the patient. The examination began with gray scale 2D ultrasonography, with transducer placed transversely followed by longitudinal scanning and then the application of colour duplex scanning.

The common carotid artery could be identified by its pulsations and by prominent linear reflections adjacent to vessel wall. The internal jugular vein lies adjacent to the carotid artery, but Doppler signals in the jugular vein had a "windstorm" character that is distinctly different from arterial pulsation. After the vessels were identified, the scans were obtained along the entire course of the cervical part of carotid artery from the supraclavicular notch cephalad to the angle of the mandible. The order of examination was common carotid artery, carotid bulbs, internal carotid artery, external carotid artery and finally vertebral arteries. As the flow velocity increases from proximal to distal course, measurements like peak systolic velocity (PSV), end diastolic velocity (EDV), resistive index (RI) and pulsatility index (PI) were taken at same points in all patients. Images were obtained to display the relationship of both branches at the carotid bifurcation to the visible part of disease (stenosis or plaque) and its extent was measured. Vertebral artery duplex examination was performed by first locating the common carotid artery in the longitudinal plane. A gradual sweep of transducer laterally demonstrated the vertebral artery and vein running between the transverse processes of C2 to C6 which were identified by their periodic acoustic shadowing. Angling the transducer caudal allowed visualization of the vertebral artery. The presence and direction of flow was established. Visible plaque disease was assessed for Duplex examination.

The results of study were systematically collected, assimilated and analyzed to draw valid conclusions.

IV. Results & Discussion

The present study "Caroto-vertebral duplex ultrasonography in patients with cerebrovascular

accidents" was conducted on 100 patients presenting with CVA with or without persistent neurological deficit referred to Department of Radio-Diagnosis and Imaging from indoor and outdoor departments of Jan Sewa Hospital of Dr. S. S. Tantia Medical College, Sri Ganganagar. Grey scale & Doppler imaging was done on carotid and vertebral arteries for the suspicion of any occlusive lesion in these arteries. The basis of such suspicion was the presence of transient ischemic attack coronary artery disease, headache, vomiting, nausea and hemiplegia. The results were tabulated & categorically arranged and statistical analysis was carried out.

The majority of patients were in the age group of 60-69 years with 56% being male, 47% presenting with transient ischemic attack, commonest clinical feature being coronary artery disease (29%) followed by haeadache (17%), nausea vomiting (4%), hemiplegia (2%) patients and coma (1%). Hypertension was the most commonest risk factor (59%) followed by diabetes mellitus (18%), hyperlipidemia (14%), atrial fibrillations (5%) and smoking (4%). Majority of plaques were seen in the carotid bulb with variable laterality & echopattern. Almost similar results were published in studies done by **Moneta G L et al.**[7]

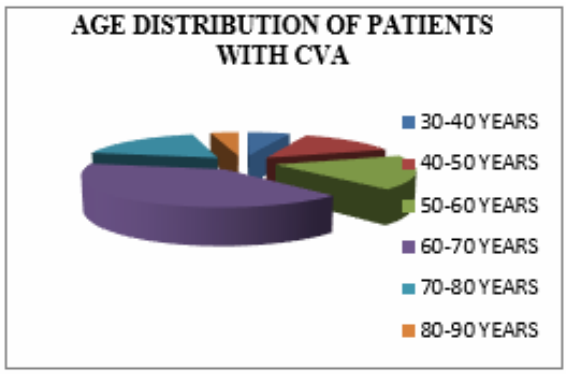
The total number of arteries with normal intima media thickness (<0.8mm) were seen in 44% patients on right side and 37% patients on the left side. The total number of arteries above the normal values (>0.8mm) were seen in 63% on left side and 56% patients on right side. Out of the 150 plaques maximum number of plaques was seen in the carotid bulb, 55.26% were on left side and 45.94% were on right side. The common carotid artery showed 33.78% plaques on right side and 30.26% plaques on left side. The internal carotid artery showed 18.91% plaques on right side and 13.15% plaques on left side. The external carotid artery showed 1.35% plaque on right side and 1.31% plaque on left side. These findings very well corresponds to the studies done by **Gaitini D et al.**[8]

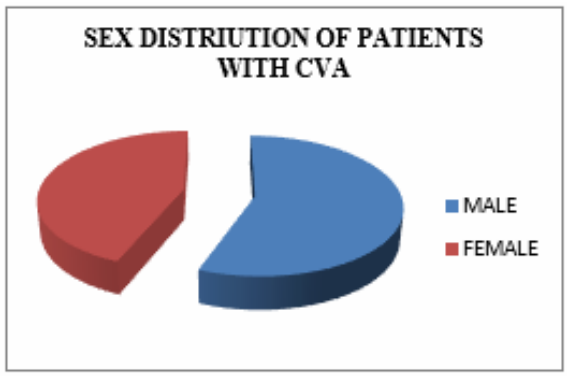
Plaques with soft consistency were 68.91% on right side and 61.84% on left side. Calcified plaques 38.15% were seen on left side and 31.08% were seen on right side. Echopattern of plaque was classified into hyperechoic and hypoechoic. Out of 51 soft plaques, hyperechoic plaques were 74.5% on right side and 68.10% on left side. Similarly hypoechoic plaques were 25.49% on right side and 31.91% were on left side. These results corroborate with the studies done by **Bluth E I et al.**[9]

The maximum numbers of plaques were seen in the range of 0-30% area stenosis on right side (50%) and on left side (42.10%). In the range of 31-40% there were 16.21% arteries on right side and 11.84% arteries on left side. In the range of 41-50% area stenosis, there were 25% arteries on left side and 10.81% arteries on right side. In the range of 51-60% area stenosis, there were 9.45% arteries on right side and 9.25% arteries on left side. In the range of 61-70% area stenosis, there were 9.45% arteries on right side and 6.57% arteries on left side. In the range of 71-80% area stenosis, there were 1.35% arteries on right side and 3.94% arteries were seen on left side. In the range of 81-90% area stenosis, there were 2.70% arteries were seen on right side only. In the range of more than 91-100% area stenosis, 1.31% arteries were seen on left side only. Almost similar results were found in studies done by **Jacobs N M et al.**[10]

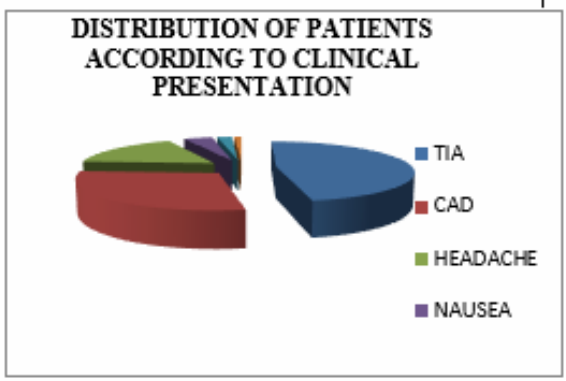
Out of the 200 vertebral arteries which were examined during the study, 2 vertebral arteries showed dampened blood flow, 1 artery on each side and 3 vertebral arteries showed bunny wave pattern, 2 arteries on right side and 1 artery on the left side.

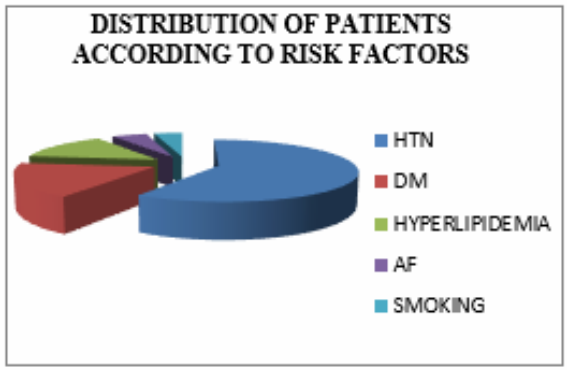
It was seen that as the degree of stenosis increases the various velocities and their respective ratios (ICA PSV/ CCA PSV, ICA EDV/CCA EDV, ICA PSV/CCA EDV) tend to increase in proportion to the stenosis suggestive of a positive correlation between them.



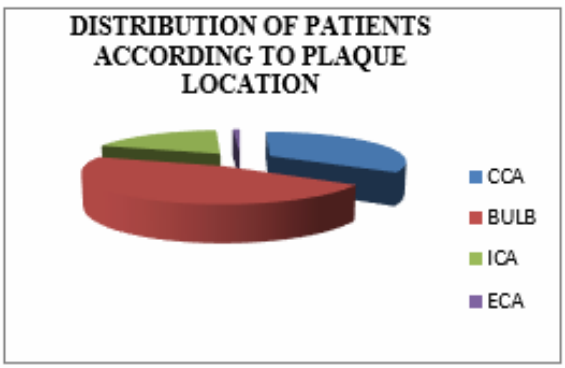


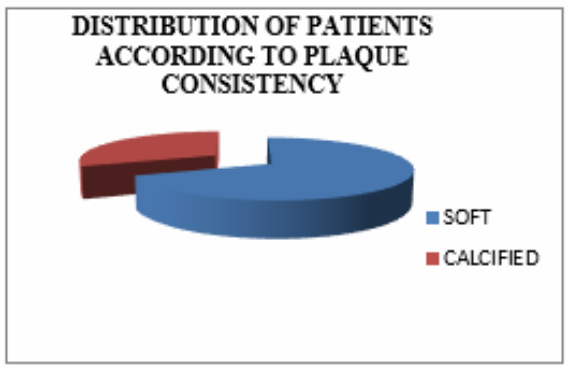
BAR DIAGRAMS SHOWING AGE DISTRIBUTION AND SEX DISTRIBUTION OF PATIENTS WITH CERERO-VASCULAR ACCIDENTS (CVA)



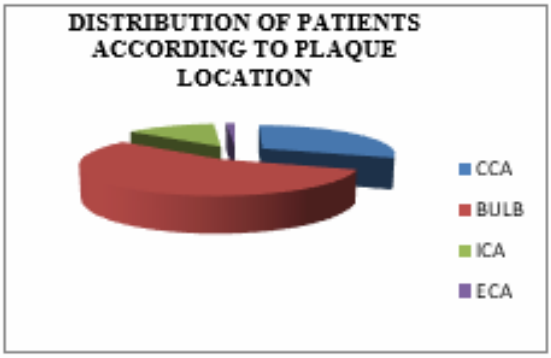


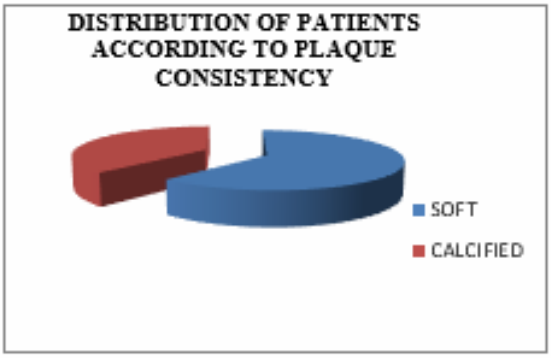
BAR DIAGRAMS SHOWING DISTRIBUTION OF PATIENTS WITH CVA ACCORDING TO CLINICAL PRESENTATION & RISK FACTORS RESPECTIVELY



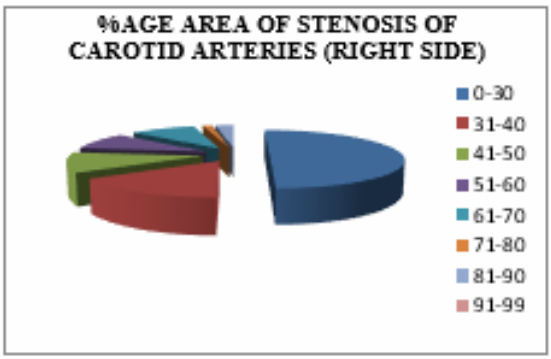


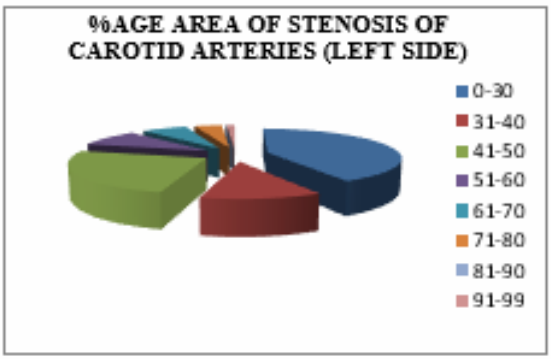
BAR DIAGRAMS SHOWING PLAQUE CHARACTERISTICS (LOCATION AND CONSISTENCY) DISTRIBUTION OF PATIENTS WITH CVA (RIGHT SIDE)



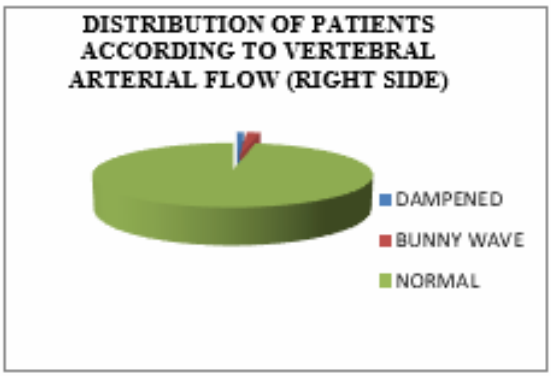


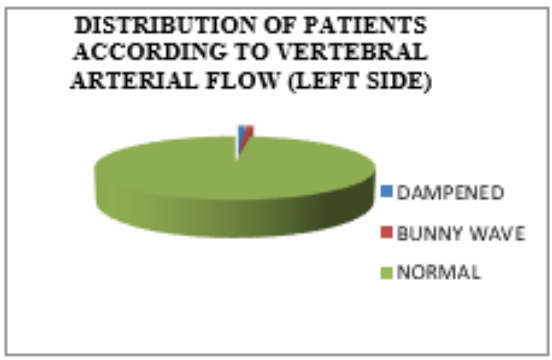
BAR DIAGRAMS SHOWING PLAQUE CHARACTERISTICS (LOCATION AND CONSISTENCY) DISTRIBUTION OF PATIENTS WITH CVA (LEFT SIDE)





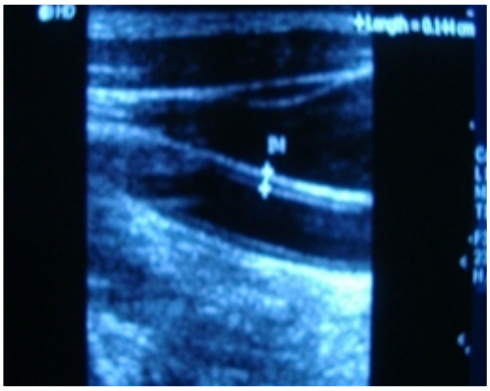
BAR DIAGRAMS SHOWING PERCENTAGE AREA OF STENOSIS OF CAROTID ARTERIES IN PATIENTS WITH CVA (RIGHTAND LEFT SIDE RESPECTIVELY)

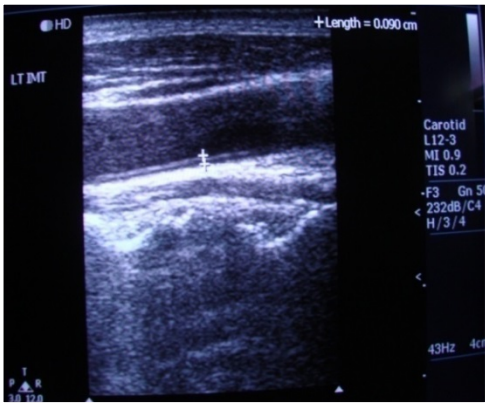




BAR DIAGRAMS SHOWING CHANGES IN VERETEBRAL ARTERIAL FLOW IN PATIENTS WITH CVA (RIGHT AND LEFT SIDE RESPECTIVELY)

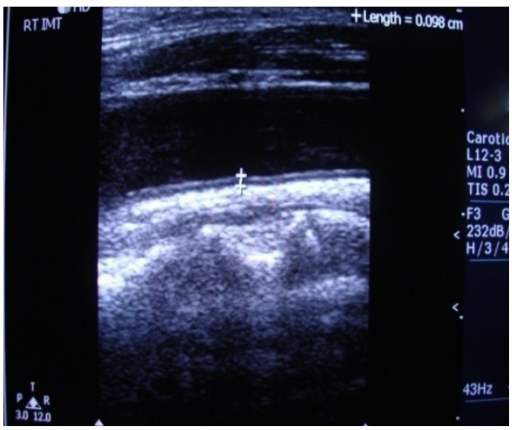
INTIMA MEDIA THICKNESS (IMT)

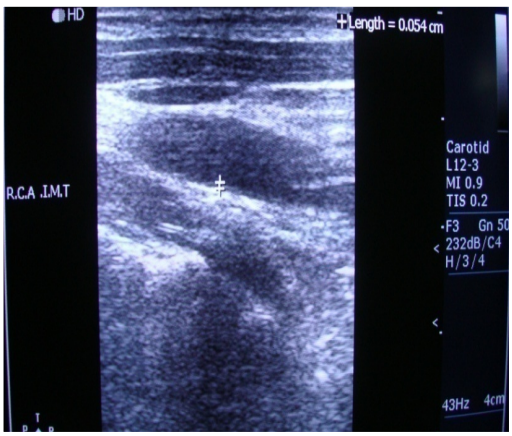




ESS LCCA-

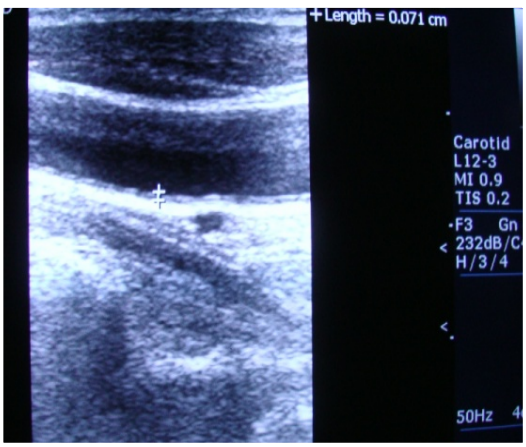
NORMAL IM THICKNESS RCCA-0.06 CM

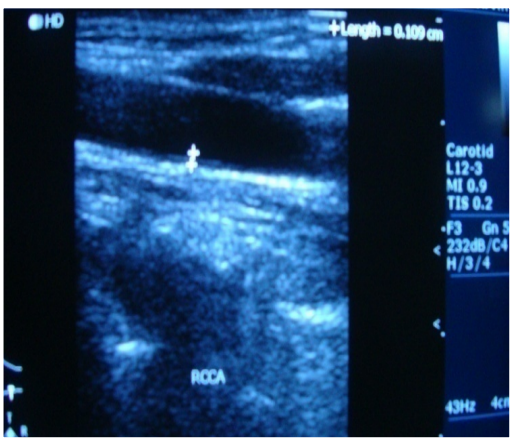




ICKNESS M

INCREASED IM THICKNESS RCCA-0.10 CM

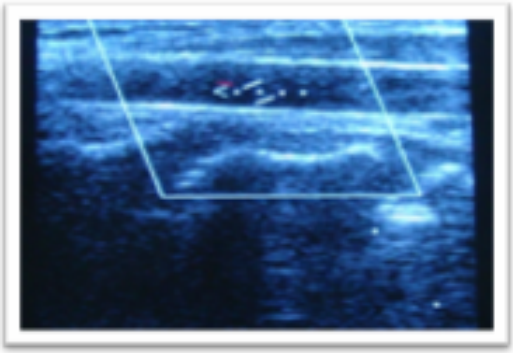




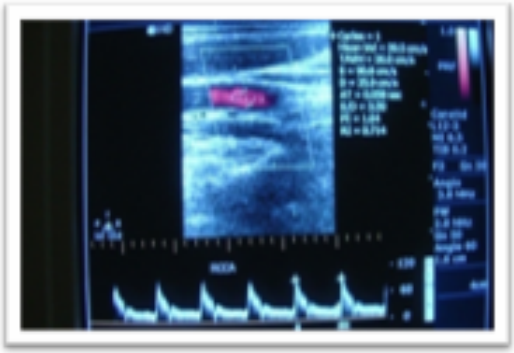
8 CM RCCA

INCREASED IMT-0.09 CM LCCA

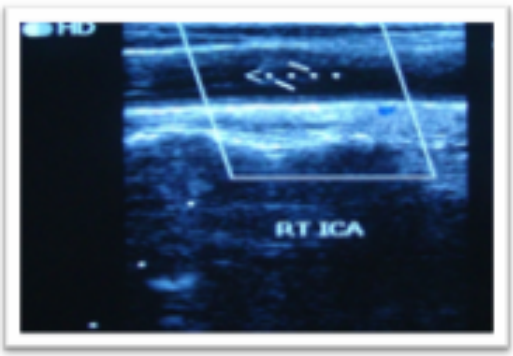
NORMAL DUPLEX IMAGING OF CCA, ICA & ECA



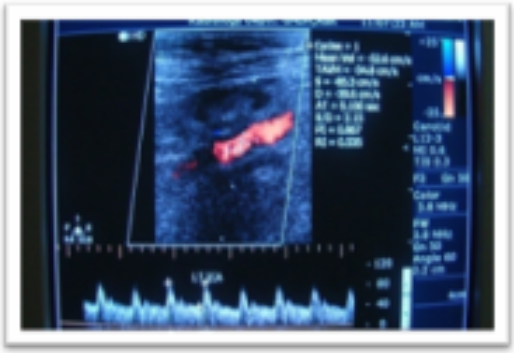
CCA ON GREY SCALE



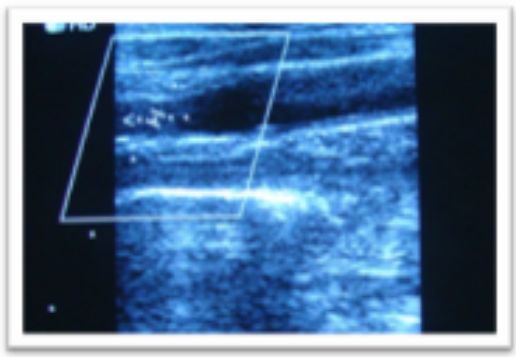
CCA ON CDFI



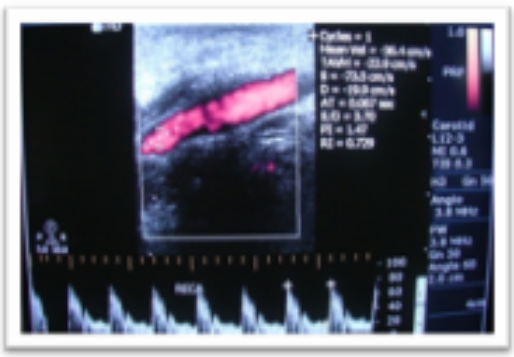
ICA ON GREY SCALE



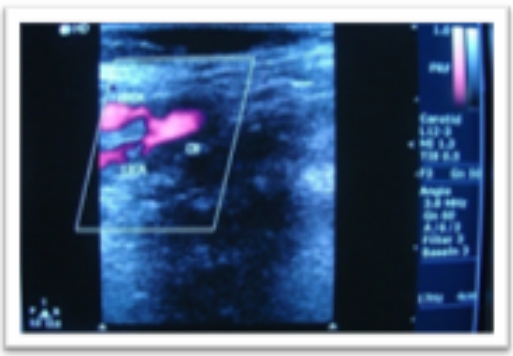
ICA ON CDFI



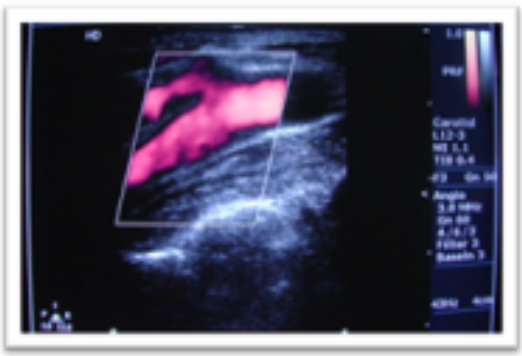
RECA ON GREY SCALE



RECA ON CDFI

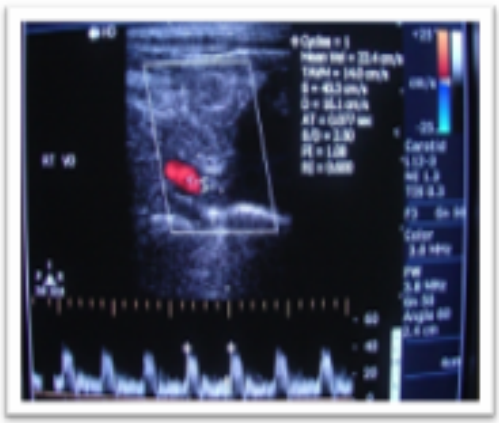


CCA, CB, ICA, ECA (AT BIFURCATION)

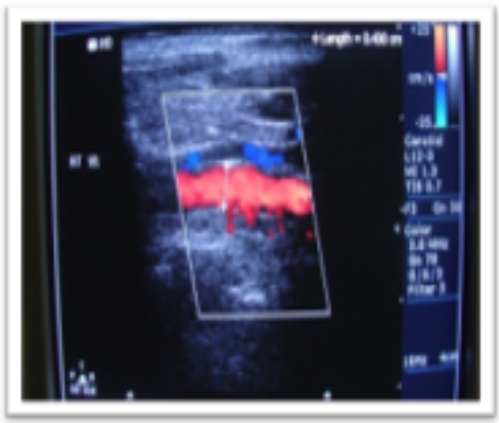


CCA ,CB ,ICA, ECA (AT BIFURCATION)

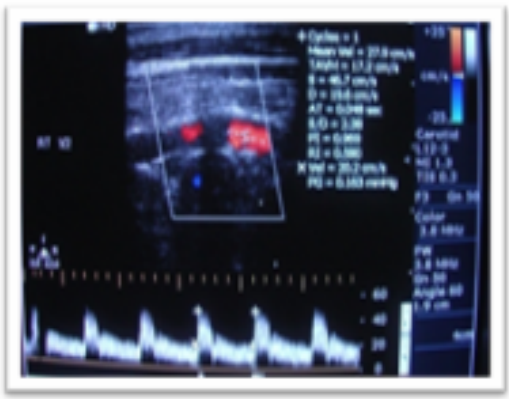
VERTEBRAL ARTERY



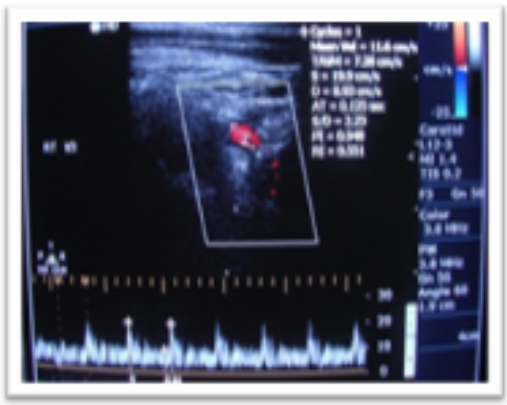
VERTEBRAL ARTERY AT V0



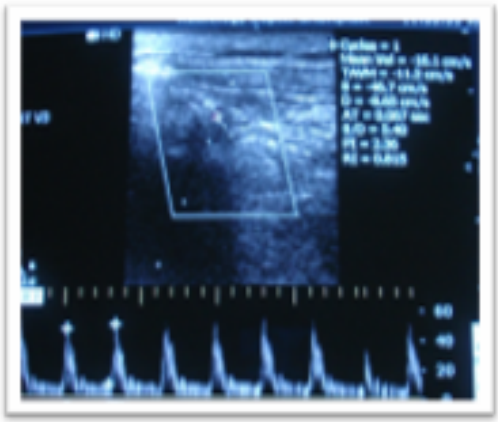
VERTEBRAL ARTERY AT V1



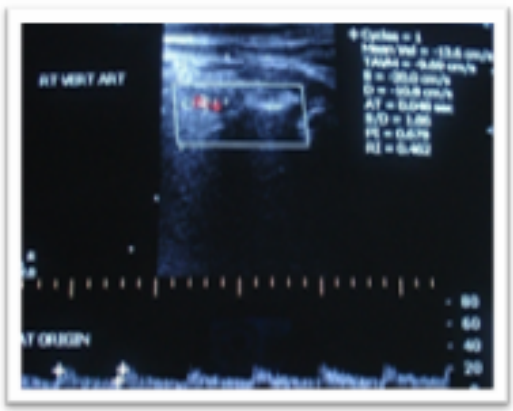
VERTEBRAL ARTERY AT V2



VERTEBRAL ARTERY AT V3

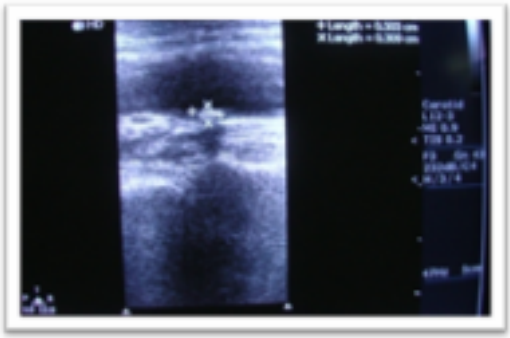


INCREASED RI IN RIGHT VERTEBRAL ARTERY



DAMPENED BLOOD FLOW IN RIGHT VERTEBRAL ARTERY

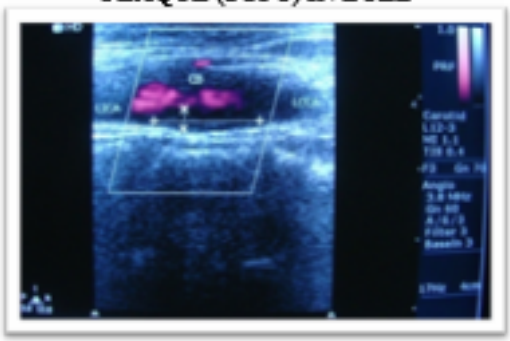
PLAQUE LOCATION AND CHARACTERISTICS



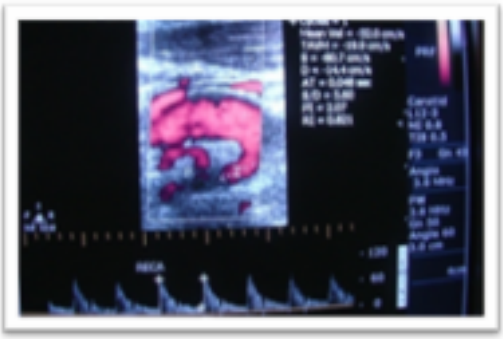
PLAQUE (CALCIFIED) IN CCA

PLAQUE (SOFT) IN BULB

CAROTID BULB PLAQUE ON CDFI

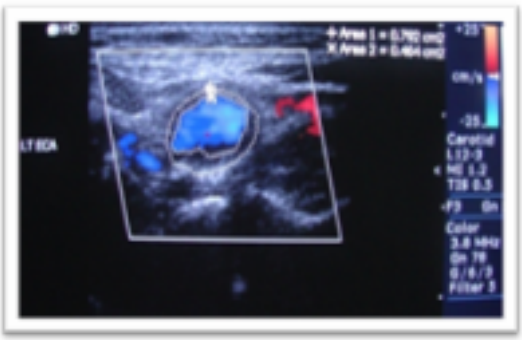


CAROTID BULB PLAQUE EXTENDING INTO ICA



PLAQUE IN ECA

PLAQUE AT BIFURCATION



PLAQUE (SOFT) IN ECA

V. Conclusion

Caroto-vertebral duplex ultrasonography provides a "road map" for carotid endartectomy and/or carotid angioplasty and stenting due to direct visualization of plaque morphology & surface configuration, measurement of the length of stenosed segment, precise determination of grade of stenosis and to get an insight into hemodynamic disorders thereby aiding early diagnosis & prompt management with subsequent decrease in human morbidity and mortality.

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