

Carotid Duplex Imaging is Better Modality than Angiography to Diagnose Carotid Artery Stenosis in Patients for Endarterectomy

N R ZAIDI N A KHAN K DODHY K MAHMOOD.

Radiology Department Jinnah Hospital /Allama Iqbal Medical College Lahore.

Correspondence to Dr. Naeem Ahmad Khan, Registrar Radiology Deptt.

Carotid duplex imaging is now recognized as the best non-invasive screening test for carotid artery stenosis. The evidence for its use as the sole diagnostic imaging modality prior to carotid Endarterectomy is examined. Providing it is carried out by experienced trained operators using validated duplex criteria, carotid duplex imaging is safe, highly sensitive and specific, and superior to angiography at plaque characterization & evaluation of flow disturbance. Cerebral CT & MRI should be performed if symptoms are atypical or if there is an evolved stroke. Angiography is required when duplex imaging is sub optimal or equivocal, in the presence of atypical symptoms or uncommon vascular abnormalities. In the majority of patients requiring Endarterectomy for symptomatic high grade ICA stenosis, angiography seldom adds relevant information, clinical assessment & carotid duplex imaging alone can be safely used in preoperative assessment.

Key words: Carotid duplex imaging, carotid endarterectomy, internal carotid artery, common carotid artery

Carotid Endarterectomy reduces the risk of stroke in symptomatic patients with severe (>70%) internal carotid artery (ICA) stenosis, provided that the operating centre has a postoperative morbidity & motility rate less than 6%. The optimal diagnostic study before CEA remains a subject for debate. There is a growing trend towards pre-operative assessment with carotid duplex imaging only. Carotid angiography is no longer routinely used prior to surgery in many centers. There is still disagreement as to the accuracy of duplex imaging for grading ICA stenosis and a variable standard of duplex imaging between different institutions.

Disadvantages of Angiography:

The use of cerebral angiography is declining, but it has been considered the gold standard and is still widely used for evaluation of carotid stenosis. However, cerebral angiography carries a complication rate of 2-4%. Symptomatic patients are at higher risk, the highest risk being associated with stroke in-evolution or bilateral severe stenosis. Angiography is expensive, costing approximately 7-10% more than duplex imaging. Angiography has limitations when used in the assessment of carotid stenosis.

Accuracy of Duplex:

Color flow duplex has become the most frequently used method for evaluating extra-cranial carotid artery disease. It is undoubtedly the most accurate non invasive diagnostic modality available for carotid artery stenosis. Numerous studies have validated duplex imaging against angiography, with sensitivities & specificities of between 90 and 95 % for detection of greater than 50% ICA stenosis, although duplex tends to underestimate lower grade (30-49%) stenosis. Sensitivities & specificities for differentiating high grade stenosis from occlusion are now well over 90% and have been significantly improved by color flow and power Doppler. The duplex is markedly

superior to angiography in detecting intimal surface and plaque abnormality. Duplex is therefore advocated as the new reference standard for assessing carotid disease.

Patients & Material:

The use of carotid duplex imaging as the sole pre-operative imaging modality is still questioned by some operators. Recent studies have attempted to ascertain whether clinical evaluation and duplex imaging alone provide enough information to proceed safely. Study was carried on 94 patients with duplex imaging and angiography prior to CEA. Duplex was diagnostic in 87(93%) cases. Angiography altered management in only one patient (1.1%) of seven patients incompletely assessed by duplex imaging. Nearly all errors of duplex evaluation in these studies occurred for two reasons. Anatomical abnormalities, kinking or calcified plaque some times rendered suboptimal scans. The need for angiography was easily identified in these cases. The error was almost always due to operator inexperience when stenosis was misdiagnosed as occlusion or degree of stenosis was wrongly estimated. Carotid duplex is unable to assess directly the arch, proximal brachiocephalic and intracranial circulation. This is often quoted as a mandatory reason for angiography.

The degree of carotid stenosis was the sole discriminating factor in selecting patients for CEA in majority, there is considerable evidence that plaque morphology is an important determinant of risk for symptoms of stroke. Heterogeneous plaque is implicated in embolic disease and acute thrombosis. Patient with intra-plaque hemorrhage and ulceration are more likely to be symptomatic. The determination of high risk changes in asymptomatic patients or in patients with low grade stenosis may identify a subgroup that is more likely to benefit from endarterectomy. Plaque characterization seems likely to assume a greater importance in carotid duplex imaging.

Carotid Duplex Imaging is Better Modality than Angiography to Diagnose Carotid Artery Stenosis

MRA (Magnetic resonance angiography) is increasing being used as a non-invasive method of analyzing the carotid bifurcation.

Age group (years)	
Age group (years)	No.
<30	0
31-40	03
41-50	12
51-60	28
61-70	38
>71	13
Male: 55	Female: 39

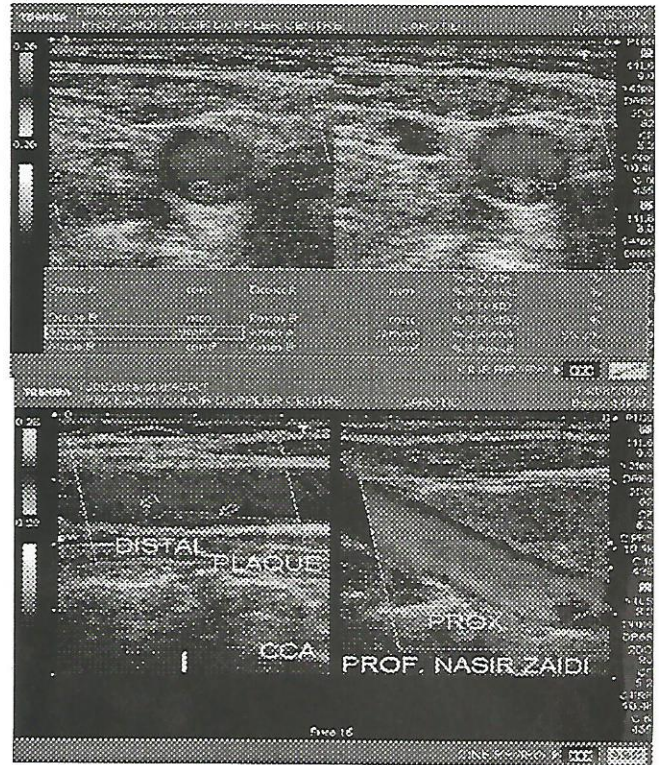
Stenosis	
Stenosis	No.
<40%	38
40-60%	27
61-80%	17
>80%	12

Plaque	
Plaque	No.
Unilateral plaques	12
Bilateral plaques	72
No plaques	10

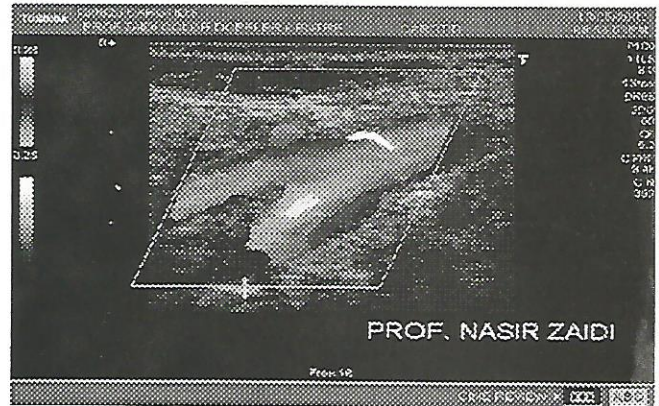
Thrombus	
Thrombus	No.
Thrombus	03
Calcified plaque	60
Both	21
Normal	10

Results:

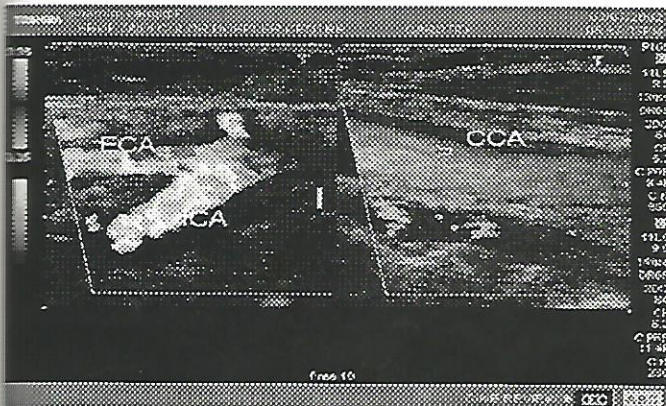
In our study there is characteristic male preponderance over females. The maximum age group in which TIA or fully developed CVA presented was between 61-70 years. In ages after 50, calcified plaques at the carotid bulb or proximal ICA were a common occurrence. These usually are the source of intracranial emboli. Non calcified thrombi are acute in nature & cause a more serious threat for emboli. Degree of ICA stenosis was maximum of 41-60% range. While > then 80% of narrowing was encountered in only 12 individuals. These were the serious candidates for immediate Endarterectomy.



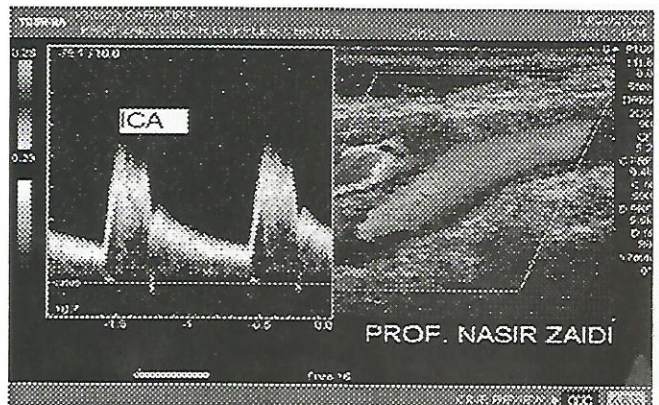
Acute thrombus CCA



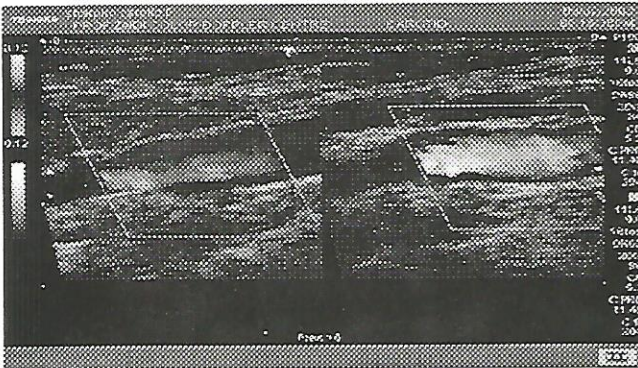
Normal Carotid Bulb.



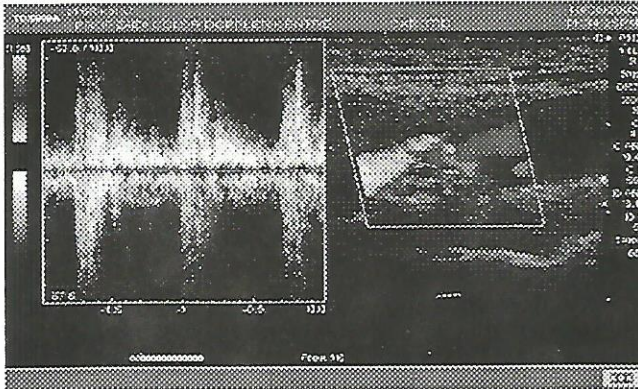
Normal CCA, ECA, ICA.



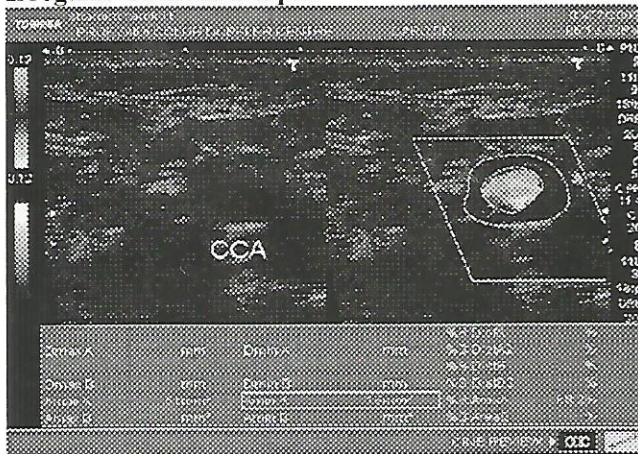
Acute Thrombus CCA



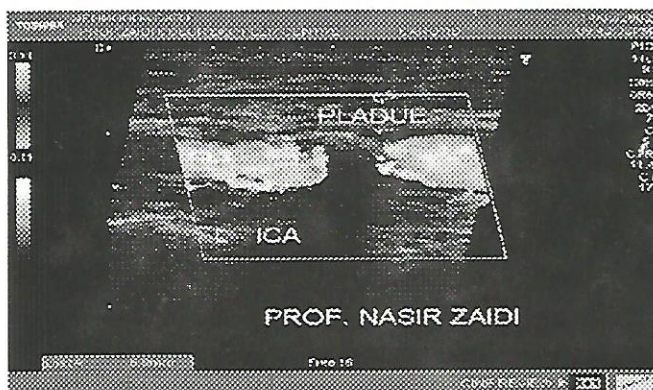
Acute Thrombus ICA



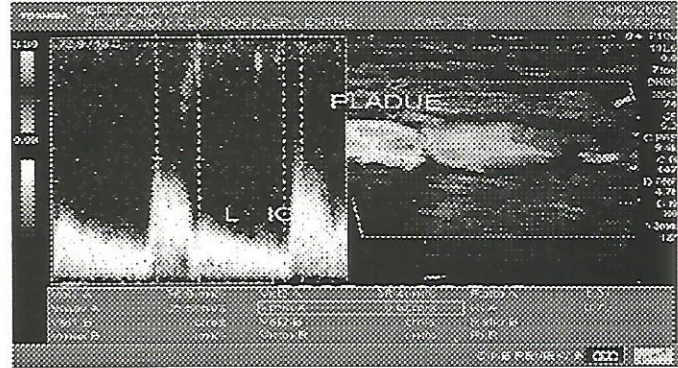
Irregular Calcified Plaque.



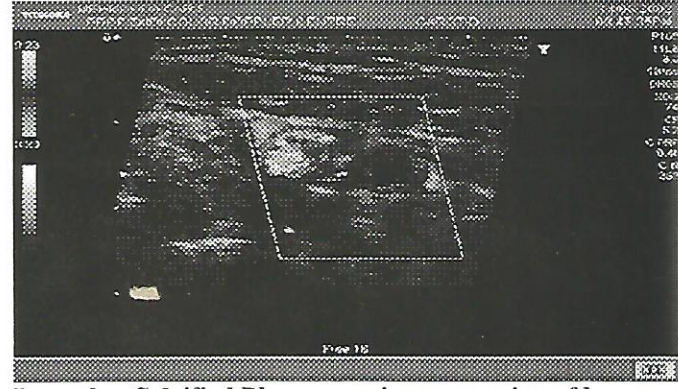
Circumferential Narrowing



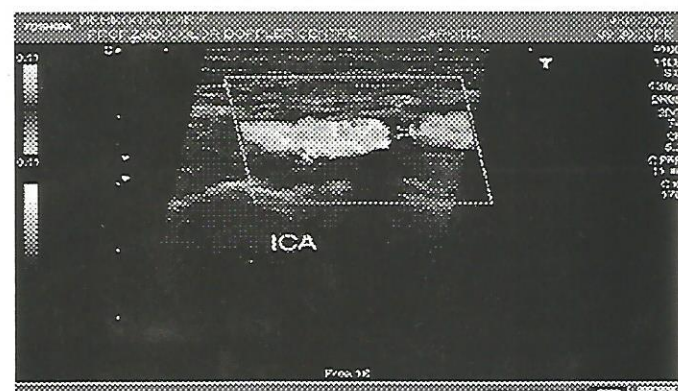
Calcified Plaque



Calcified Plaque



Irregular Calcified Plaque causing narrowing of lumen.



Calcified Plaque.

Conclusion:

Duplex provide information about the degree of carotid stenosis, the velocity and character of blood flow, and plaque morphology. It is cheap and non-invasive with significant implications for risk reduction and financial expenditure. It is superior to angiography in evaluating the carotid bifurcation and proximal ICA. So preoperative angiography is not mandatory in majority of patients before CEA. However the duplex is highly operator dependent. The pre-operative scan must be of good quality and performed by experienced and trained Radiologist.

Cerebral CT and MRI should be performed if the patient has a stroke or if symptoms are atypical, in order to exclude hemorrhage, tumor, large intra-cerebral aneurysms. Angiography is required when the duplex

study is of sub-optimal quality and if there is any doubt about total occlusion. It should also be performed when clinical symptoms are atypical or in the presence of uncommon vascular abnormalities such as fibro-muscular dysplasia or spontaneous dissection.

When these requirements are met, clinical evaluation and carotid duplex imaging alone can safely be used as the main diagnostic modality for assessment to carotid endarterectomy, with angiography being performed in selective cases.

References:

1. European carotid surgery trialist collaborative group: MRC European carotid surgery trial. Interim results of patients with severe (70-90%) and or mild carotid stenosis. *Lancet* 1991;337: 1235-43.
2. Hankey GJ, warlow CP, sellar RJ. Cerebral angiography risk in mild cerebrovascular disease. 1990; 21: 209-22.
3. Taylor DC, strandness De. Carotid artery duplex scanning J clin ultrasound 1987; 15: 635-44.,
4. Roederer GO, Langlois YE, yaeger KA, et al. A simple spectral parmeter for accurate classification of sever carotid disease. *Bruit* 1984;8:174-8.
5. Heiserman JE, Dean BL et al. Neurologic complications of cerebral angiography. *AJNR* 1994; 15:1401-7.
6. Kuntz KM, Skillman JJ et al. Carotid Endarterectomy in asymptomatic patients—in contrast angiography necessary? A modality analysis *J Vase Surg* 1995;22:706-714.
7. Mattos MA, Hodgson KJ, faought WE. Carotid Endarterectomy without angiography: is colour flow duplex sufficient? *Surgery* 1994;116:776-83.
8. Alexandrov AV, Baldin CF, Maggisano R, Norris JW. Measuring carotid stenosis—time for a reappraisal. *Stroke* 1993;24:1292-6.
9. Chikos PM, Fisher LD, Hirsch JH, et al. Observer variability in evaluating extra cranial carotid artery stenosis. *Stroke* 1983;14:885-92.
10. Slot HB, Strijbosch L, Greep JM. Intraobserver variability in single plane angiography. *Surgery* 1981;90:497-503.
11. Nicolaidis AN, Shifrin EG, Bradbury A, et al. Angiographic & duplex grading of internal carotid stenosis: can we overcome the confusion? *J Endovasc Surg* 1996:158-65.
12. Roederer GO, Langlois YE, Yaeger KA, et al. A simple spectral parameter for accurate classification of severe carotid disease. *Bruit* 1984; 8:174-8.
13. Taylor DC, Strandness DE, Carotid artery duplex scanning. *J Clin ultrasound* 1987; 15:635-44.
14. Moneta GL, Edwards JM, Papanicolaou G, et al. Screening for asymptomatic internal carotid artery stenosis: duplex criteria for discriminating 60-99% stenosis. *J Vasc Surg* 1995;21:989-94.
15. Hunink MGM, Polak J, Barlan MM, O Leary DH. Detection & quantification of carotid artery stenosis: efficacy of various Doppler velocity parameters. *AJR* 1993;160:619.
16. Erickson SJ, Mewissen MW, Foley WDet al. Stenosis of the internal carotid artery: assessment using Colour Doppler imaging compared with angiography. *AJR* 1989;152:1299-1305.
17. Londrey GL, Spadone DP, Hodgson KJ, et al. Does colour flow imaging improve the accuracy of duplex carotid evaluation? *J Vasc Surg* 1991;13:659-62.
18. Hames TK, Humphries KN, Ratliff DA, et al. The validation of duplex scanning & continuous wave Doppler imaging: a comparison with conventional angiography. *Ultrasound Med Biol* 1985;11:827-34.
19. Goodson SF, Flanigan DP, Bishara RA. Can carotid duplex scanning supplant arteriography in patients with focal carotid artery symptoms? *J Vasc Surg* 1987;5:551-7.
20. Weintrob MI, Lambert D, Rothman AL. Carotid Ultrasonography —the new standard: surgical & angiographic correlation. *Angiography* 1985;36:19-22.
21. O'Donnell TF, Erdoes L, Mackey WC, et al. Correlation of B mode ultrasound imaging and arteriography with pathologic findings at carotid Endarterectomy. *Arch Surg* 1985;120:443-449.
22. Fontenelle LJ, Simper SC, Major U, Hanson TI. Carotid duplex scan versus angiography in evaluation of carotid artery disease. *Am Surg* 1994;60:864-868.
23. Eliasziw M RN et al. Accuracy & prognostic consequences of Ultrasonography in identifying severe carotid artery stenosis, NASCET Group. *Stroke* 1995;26:1747-52.
24. Dawson DL, Zierler RE et al. The role of duplex scanning and arteriography before carotid Endarterectomy: a prospective study. *J Vasc Surg* 1993; 18:673-83.
25. Mattos MA, Hodgson KJ, Faught WE. Carotid Endarterectomy without angiography: is colour flow duplex sufficient? *Surgery* 1994;116:776-83.