Research Article

Carotid Doppler as a Biomarker to Determine Stenosis in Ischemic Stroke and Management of ICU Patient

Dr. Samia Perwaiz Khan¹, Dr. Sabeeh Jaffrey², Dr. Safia Izhar³ and Prof. Dr. Khwaja Zafar Ahmed⁴

1. MBBS, M.Phil, PhD, APCA Professor & HOD – Pharmacology Jinnah medical & Dental College. Sohail University.
2. M.B.B.S, MPH (USA). Registrar Jinnah medical & Dental College. Sohail University.
3. MBBS, MCPS, DMRD. Senior Registrar, Radiology Department Medicare Cardiac & General Hospital.
4. B.Pharm, M.Phil, PhD (Nottingham, UK) Principal, Jinnah College of Pharmacy, Sohail University.

Manuscript History

Received: 15 August 2020
Final Accepted: 18 September 2020
Published: October 2020

Abstract

Atherosclerosis is a common cause of cerebrovascular diseases. Carotid Doppler is a tool to determine atherosclerotic risk in patients leading to stroke. Carotid sonography is an invasive procedure and is most commonly being used. Proper management of atherosclerotic plaque and thickness could be reducing morbidity and mortality. All those patients with stroke admitted to Medicare cardiac and general hospital will be included in the study. All those patients with stroke due to intracerebral hemorrhage will be excluded from the study. Consent form was filled by the relatives of patients. Carotid Doppler was carried out external, middle, and internal carotid arteries. Performa and consent form was filled by patient/attendant. Pre and post antiplatelet and antithrombotic therapy color Doppler was done. Out of a total of 25 patients with stroke admitted or attending the walk-in clinic of Medicare cardiac 7 general hospital. Intima media thickness was increased in 25 (100%) above 0.1 mm, calcified plaques were found in 20 (90%) patients and stenosis was less than 40% in 19 patients and above 50% in 6 patients. Control shown to have normal intima media thickness 0.1-0.6 mm, no plaques or stenosis. Carotid Doppler is found to be most useful biomarker to determine stenosis in ischemic stroke and plaque morphology also to management of intensive care unit patient.

Introduction:

Stroke is defined as a sudden onset of focal neurological deficit lasting for more than 24 hours with no apparent cause other than vascular origin. The 24 hours threshold in the definition excludes Transient Ischemic Attacks (TIA) [1]. Stroke is classified depending upon underlying cause ischemic stroke (85%) or hemorrhagic stroke (15%) [1,2] about 80% of strokes are thromboembolic in origin and the embolus arises from the carotid plaque [3]. Early detection of the atheromatous changes in the carotid artery by antiplatelet therapy can reduce the stroke-related morbidity and mortality. Sonographic evaluation of the carotid arteries are used for risk assessment; on gray scale, CIMT in common carotid artery is evaluated on gray scale ultrasound [4]. The plaques are characterized as echogenic, calcified or hypoechoic or associated with intraplaque hemorrhage and surface ulceration and percentage stenosis [4]. Carotid
Doppler is a non-invasive, cost-effective and good biomarker for the diagnosis of atherosclerotic changes. Its grey scale is used for measurement of intima-media thickness and plaque characterization. Right common carotid artery arises from right brachiocephalic trunk and left common carotid arises from arch of aorta. Measurement of intima-media thickness by grey scale. Intima media thickness of both carotids, extent of stenosis and presence of plaques in stroke patients as compared to controls. Outcome of antithrombotic will be

Carotid artery Doppler has shown to be most useful in assessment of atherosclerotic changes in carotid arteries (common carotid, bifurcation and internal carotid). It has 2D grey-scale images for measurement of intima-media thickness also identification of plaques and the morphology (soft, calcified, ulceration of plaques). Color-Doppler, and Pulse Wave Doppler are tools for measurement of carotid stenosis.

**Measurement of Intima media thickness by 2D- gray scale:**
Intima-media thickness is in carotid doppler by 2D-gray scale of longitudinal scan of the carotid artery is the most used tool for determining atherosclerotic changes. Gray-scale image shows two bright line, far wall the upper bright line is intima and blood and the lower bright line is between media and adventitia. The distance between upper and lower bright line is measured as the intima-media thickness. Measurement of intima media thickness of right and left carotid arteries (Common carotid, bifurcation or bulb and internal carotid) by 2D Grey scale imaging is most useful in measurement of IMT (intima-media thickness) and any atherosclerotic plaque. Normal limits of intima-media thickness range from 0.01-0.9 mm.

**Atherosclerotic Plaque Morphology & Volume:**
Atherosclerotic plaque is a pathological finding and increases risk of thromboembolic events including stroke. Plaque have various morphological findings (soft, calcified or ulceration). The ulceration of plaque is predictor of embolic events. Reporting the morphology of plaque is most in gray-scale image during carotid-Doppler ultrasound. Detection of plaque ulceration is difficult (is seen as depression of 2mm). Plaque volume has been found to reduce after statin therapy.

**Methodology:**
All the diagnosed patients of stroke ultrasound of carotids in lying down position examination is carried out beyond the head of patient. Right carotid measured by right hand of examiner and left carotid by the left hand of the examiner. Intima-media thickness (figure 1) is measure for the internal carotid artery (ICA), common carotid artery (CCA) and external carotid arteries by B-mode. Carotid Doppler was done to evaluate extent of stenosis (figure 2) in right and left carotids or bilaterally. Plaque is measured for size, volume and echogenicity. Surface of plaque in stroke patients was mostly calcified thus causing stenosis. Immediate management of the patients admitted in intensive care unit include aspirin (low dose), antihypertensive (calcium channel blockers/ ACE inhibitors), intravenous mannitol, dexamethasone and statins. Survival rate was highly improved.

Ethical approval taken from the ERC – Jinnah medical and dental college.

**Statistical Analysis:**
Data was stored in SPSS 21. Students t-test was applied to compare intima-media thickness and stroke cases and controls. Stenosis were reported in percentages in ischemic stroke patients.

**Results:**
Out of a total of 25 patients with stroke admitted or attending the walk-in clinic or admitted patients of Medicare Cardiac & General Hospital, Karachi. In these patients Intima-media thickness was increased in 25 (100%) above 1.0 mm (range 1.0-1.9mm) in table 1, and carotid doppler done bilaterally stenosis was 20-40% in 10 patients and above 50% in 6 patients. Soft and calcified plaques seen were found in 20 (90%) patients in table 3. Normal control shown to have intima media thickness measurements range (0.1-0.5 cm), no plaques or stenosis were observed in the carotid doppler examination.
Figure 1: Intima – Media Thickness Of Common Carotid Artery In Stroke.

Figure 2: Stenosis In Right Common Carotid Doppler In Stroke.

Figure 2: Doppler of Right and Left common Carotid Arteries in controls.
Figure 4:- ICU Management Of Ischemic Stroke.

![Diagram showing management of acute neurological deficit](image)

**Table 1:** Carotid Artery Doppler In Stroke Patients.

| Location Of Carotid Artery | Stroke Patients N=25 | Controls N=25 | p-value |
|----------------------------|----------------------|---------------|---------|
| Common Carotid Artery (CCA) | 1.0 mm (0.9-1.5mm) | 0.3mm (0.2-0.9mm) | 0.5 |
| Bifurcation (Bulb) | 1.1mm (1.0-1.9mm) | 0.5mm (0.3-0.9mm) | 0.05 |
| Internal Carotid Artery (ICA) | 0.9mm (0.9-1.1mm) | 0.3mm (0.3-0.9mm) | 0.05 |

**Table 2:** Ultrasound Images Showing Significant Stenosis.

| Stenosis | Right Side | Left Side | Bilateral |
|----------|------------|-----------|-----------|
| 20-40%   | 3          | 2         | 10        |
| 50-60%   | 2          | 2         | 6         |
| Total    | 5          | 4         | 25        |

**Table 3:** Plaques And Locations In Stroke Patients.

| Location Of Plaque Stroke Patients | Number Of Plaque | Calcified Plaques | Soft plaques |
|------------------------------------|------------------|-------------------|--------------|
| Common carotid artery              | 2 (10)           | 8                 | 0            |
| Common carotid bifurcation         | 2-4 (10)         | 8                 | 5            |
| Internal Carotid Artery            | 1-2 (5)          | 3                 | 1            |
| External carotid artery            | -                | -                 | -            |
Discussion:-
In the study all the patients from March-September 2020 who had developed ischemic stroke or mild paralysis were recommended ultrasound examination of Right and left common carotid, internal carotid and bulb. In the study as intima media thickness was compared to controls was significantly increased as compared to controls. Also multiple calcified plaque were found unilaterally or bilaterally. Bilateral Stenosis upto 20-40% in stroke patients 10 was in as compared to controls. Only 6 patients of stroke had stenosis above 50%. Carotid Doppler has found to be most beneficial in determining the changes in intima-media thickness, detection of morphology of plaques and stenosis of carotid arteries in stroke patients admitted in intensive care units.

Study done on stroke patients, shown the infarct was significantly related to the percentage of stenosis in internal carotid artery. There was also significant association in risk factors profile among stroke and TIA subjects with respect to hypertension, smoking, alcohol, hyperlipidemia and previous history of stroke. Plaque characteristic was found to be soft in both stroke/TIA patients. Plaque location most commonly in stroke was right ICA and in TIA was Left bulb respectively.

Immediate treatment reduces the risk of major stroke in the week after a transient ischemic attack (TIA) or minor stroke, is up to 10%. Medical treatment with antiplatelet agents and statins, as well as blood-pressure control, reduces that risk by 70 to 80%, with the benefit of use of aspirin, although 7-day risk of recurrent stroke is still 2 to 3%. Treatment of acute ischemic stroke include intravenous (IV-PA) alteplase and mechanical thrombectomy. Stroke patients with severe high blood pressure required to be treated with antihypertensive (IV Labetolol/glycerol trinitrate).

European stroke organization (ESO) has prepared a plan for secondary prevention, rehabilitation and improvement in life after survival from stroke from 2018-2030 according this as hypertension, diabetes mellitus, dyslipidemias, smoking, obesity, sedentary lifestyle and atrial fibrillation are the risk factors for stroke. Thus primary prevention includes pharmacological and non-pharmacological such as reducing the risk factors such as smoking, obesity, sedentary and control of hypertension and diabetes mellitus by appropriate medications to reach target blood pressure and blood sugar levels. Studies have shown that thrombectomy within 6 to 12 hours of onset of stroke is highly beneficial in outcome of these patients. Study has shown statin therapy has shown to be highly beneficial in coronary artery plaque regression in cardiac patients with raised baseline cholesterol levels.

Thus carotid doppler is highly beneficial in diagnosis of atherosclerotic changes in stroke patients (common carotid, bifurcation and internal carotid arteries) and providing immediate and appropriate management to reduce the disability and mortality.

Conclusion:-
Carotid Doppler has shown to be most useful biomarker and easy availability for assessment of intima-media thickness, stenosis and plaque in stroke patients. Thus the immediate management can be provided to such patients reducing the high rate of mortality. Primary and secondary preventions are highly recommended to reduce the risk of stroke.

Acknowledgement:-
Patients of Medicare Cardiac & General Hospital in participation in this study.

Conflict of interest:
None.

References:-
1. Haq S, Mathur M, Singh J, Kaur N et al. Colour Doppler Evaluation of Extracranial Carotid Artery in Patients Presenting with Acute Ischemic Stroke and Correlation with Various Risk Factors. Journal of Clinical and Diagnostic Research. 2017 Mar, Vol-11(3): TC01-TC05
2. Rumack CM, Wilson SR, Charboneau JW, Levine D. The extracranial cerebral vessels In: Diagnostic Ultrasound (4th ed.) Elsevier-Mosby 2010; 948-49.
3. Donnan GA, Fisher M, Macleod M, Davis SM. Stroke. Lancet. 2008;371(9624):1612-23
4. Lee W. General principles of carotid doppler ultrasonography. Ultrasonography 2014;33:11-17
5. Sharma P, Lohani B, Chaut S. Ultrasonographic evaluation of carotid intima-media thickness in hypertensive and normotensive individuals. Nepal Med Coll J. 2009;11(2):133-35.

6. Rajesh M, Richa T. Carotid doppler evaluation of transient ischemic attack and stroke patients and its correlation with CT scan head: A prospective study. IOSR J Dental Med Sci (IOSR-JDMS). 2013;7:20-25.

7. Patel V, Parmar M, Chudhari M. Carotid doppler evaluation in patients with ischemic stroke and its association with high risk factors. International Journal of Medical Science and Public Health. 2018;7(4):277-81.

8. Chitrah R, Sivarajinie S, Padmareka D, Umamageswari A et al. Correlation of Carotid Artery Doppler with Risk Factors and Computed Tomography Brain in Patients with Ischemic Cerebrovascular Accident. International Journal of Anatomy, Radiology and Surgery. 2019 Jul, Vol-8(3): RO15-RO20.

9. ROTHWELL PM. ANTIPLATELET TREATMENT TO PREVENT EARLY RECURRENT STROKE. N ENGL J MED 2020; 383:276-278.DOI: 10.1056/NEJM2018927

10. Goldstein LB. Modern medical management of acute ischemic stroke. Methodist Debakey Cardiovasc J. 2014;10(2):99-104. doi:10.14797/mdcj-10-2-99.

11. Powers JR. Acute ischemic stroke. N Engl J Med 2020; 383:252-260.DOI: 10.1056/NEJMep1917030.

12. Hurford R, Sekhar A, Hughes TA, Muir KW. Diagnosis and management of acute ischaemic stroke. Pract Neurol 2020;20:306–318. doi:10.1136/practneurol-2020-002557

13. Stroke Association. State of the nation: stroke statistics[Internet]. 2018. Available https://www.stroke.org.uk/sites/default/files/state_of_the_nation_2018.pdf (accessed 22 Feb 2020).

14. Powers WJ, Rabinstein AA, Ackerson T, et al. 2018 guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2018;49:e46–e110.

15. Prasad K, Siemieniuk R, Hao Q, et al. Dual antiplatelet therapy with aspirin and clopidogrel for acute high risk transient ischaemic attack and minor ischaemic stroke: a clinical practice guideline. BMJ 2018; 363:k5130

16. Norrving B, Barrick J, Davalos A, Dichgans M, et al. Action Plan for Stroke in Europe 2018–2030. European Stroke Journal 2018, Vol. 3(4) 309–336

17. Norrving B. Stroke management — recent advances and residual challenges. Nature Reviews Neurology volume 15, pages 69–71 (2019)

18. Nogueira, R. G. et al. Thrombectomy 6 to 24 hours after stroke with a mismatch between deficit and infarct. N. Engl. J. Med. 378, 11–21 (2018).

19. Albers, G. W. et al. Thrombectomy for stroke at 6 to 16 hours with selection by perfusion imaging. N. Engl J. Med. 378, 708–718 (2018).

20. Wakabayashi K, Nozue T, Yamamoto S, Tohyama S, et al. Efficacy of Statin Therapy in Inducing Coronary Plaque Regression in Patients with Low Baseline Cholesterol Levels. J Atheroscler Thromb. 2016 Sep 1; 23(9): 1055–1066. doi: 10.5551/jat.34660.