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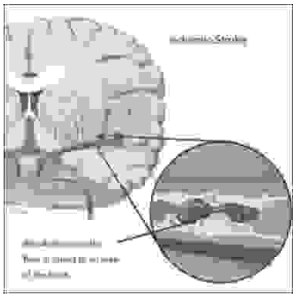
ISCHAEMIC STROKE;
ROLE OF CAROTID DOPPLER.



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ABSTRACT... moazzamatif@hotmail.com. **Objective:** To determine the frequency of carotid atherosclerosis in ischaemic stroke patients in our population using color Doppler ultrasound. **Design:** Observational. **Place and Duration of study:** This study was conducted in Medical Unit II of Jinnah Postgraduate Medical Centre, Karachi from Oct 2002 to Feb 2003. **Subjects and Methods:** All the patients admitted in our ward during this duration with CT scan proof of stroke were included in the study. Risk factors in all these patients were stratified. Complete history and examination was done and carotid Doppler ultrasound was performed on all patients with ischaemic stroke according to the study protocol. **Results:** A total of 100 patients were included in this study following the above-mentioned protocol over a period of five months. 66% of these were having cerebral infarction. Hypertension (72%), diabetes (35%), smoking (29%) and obesity (20%) were the common risk factors in these patients. The frequency of significant carotid atherosclerosis in acute ischaemic stroke patients was 21%. **Conclusion:** Doppler ultrasound is non-invasive, safe and cost-effective modality for evaluation of carotid vessels. In symptomatic and high-risk group, it should be used as first diagnostic modality for management or selecting patients for further investigation.

Key words: Carotid, Atherosclerosis, Doppler ultrasound.

INTRODUCTION

Stroke is the third most common cause of death and chronic disability in elderly patients[1,2,3] Physicians are trying to identify the stroke prone population in whom timely intervention might avert stroke and its accompanying disability[4]. Carotid atherosclerosis is one of the well-known risk factors for ischaemic stroke[5].

Atherosclerosis is derived from a Greek word athero (meaning gruel or paste) and sclerosis (hardness). It involves deposits of fatty substances, cholesterol, cellular waste products, calcium and fibrin in the inner lining of an artery and causes stenosis/occlusion of a lumen. Atherosclerosis can affect the arteries of brain, heart, kidney, other vital organs and the arms and legs. When atherosclerosis develops in the arteries that supply the brain, stroke may occur.

Various diagnostic modalities are available for evaluation of carotid atherosclerosis. Angiography was the first diagnostic imaging modality developed for the evaluation of vessels. The first in vivo arteriograms were achieved

in 1923. But it was in 1953 when Sedenger developed the percutaneous cathetrization which together with the development of organic iodinated contrast media resulted in wide spread use of angiography in medicine. The introduction of ultrasound in 1960's, computed tomography in 1970's, MRI in 1980's and with their subsequent development, color Doppler imaging, CT and MR angiography became available for the non-invasive evaluation of vascular system.

Ultrasound is establishing its role in screening and diagnosis of carotid pathology because of patient comfort, lack of risks, low cost and accuracy in detecting carotid atherosclerosis[4]. Ultrasound is a rapidly growing imaging modality. The history of ultrasound can be traced back to SONAR (sound navigation and ranging), the technique of sending some waves through water and observing the return echoes to characterize submerged objects. This inspired early ultrasound investigators who explored ways to apply the concept of medical diagnosis.

Shortly after the end of World War II, researchers in Japan began to explore medical diagnostic capabilities of ultrasound, building the first equipment with A-mode presentation, which was followed by work in B-mode presentation of two dimensional gray scale imaging. The most recent in the series of major technological achievements in diagnostic ultrasonography is related to the re-evaluation in computer technology of 1980's, which resulted in the development of color Doppler imaging[6].

For carotid ultrasound, a high frequency 5-10 MHz linear probe having facility for image steering is required[7]. B-mode gray scale imaging is used to identify and characterize the plaque. The addition of color helps in easy identification of vessels and accurate measurement of its lumen. The velocity measurements are used to grade the stenosis.

In my study I evaluated the extracranial carotid system with the help of color Doppler ultrasound. The patients whose CT scan showed ischaemic strokes were selected for the study. The purpose of my study is to know the frequency of carotid atherosclerosis in ischaemic stroke patients. This will show the relationship of carotid atherosclerosis with ischaemic stroke.

MATERIALS & METHODS

This study was conducted in Medical Unit II of Jinnah Postgraduate Medical Centre, Karachi from Oct 2002 to Feb 2003 in collaboration of Radiology Dept. All patients presenting with stroke were included in the study. A total of hundred patients were selected for this study without any age, sex, ethnic or socioeconomic discrimination. As our unit deals with adult patients only so all of the patients were 15 years or older. A detailed history and thorough physical examination of all patients were carried out on a questionnaire. Risk factors were also stratified. Every patient underwent a list of investigations including:

- Lipid Profile
- Electrocardiography (ECG)
- X-ray Chest (PA)
- Computed Tomography (CT) scan brain (CT was necessary as it is the only available non-invasive investigation which can differentiate between infarction and hemorrhage, as we have to do carotid Doppler in case of cerebral infarction.)

Those patients whose CT scan showed evidence of cerebral infarction but without any cardiac cause of embolization were further subjected to carotid Doppler ultrasonography to look for the status of carotid arteries. Equipment used to study carotid arteries was Toshiba Ecocce with a linear transducer of 7.5 MHz. After confirmation of internal carotid artery, it was followed as far as cephalad possible. After completion of longitudinal survey, the area of plaque formation was studied in detail. The extent of plaque, its morphological characteristics and degree of luminal narrowing especially were noted. The diameter of the residual lumen and the external diameter of the artery at the same level were measured and the degree of stenosis was calculated using the following relationship:

Percent stenosis = D-d.100/D.
Where D is vessel wall-to-wall diameter

D is vessel open diameter

Our "gold standard" has been angiography and the data that angiography gives us is diameter stenosis therefore, in ultrasound, we also use diameter stenosis.

Results of the study were analyzed using SPSS ver 11.0.

RESULTS

A total of 100 patients were included in this study following the above-mentioned protocol over a period of five months. Sixty-two (62%) patients were male and thirty-eight (38%) were female. Overall mean age was 55±8 years. Most of the patients, as expected, belonged to older age groups. Minimum age noted was 24 years and maximum was 92 years.

Sixty-one (61%) patients presented with sudden onset of symptoms indicating hemorrhagic or embolic stroke while thirty-nine (39%) gave a history of gradual onset indicating thrombotic event.

Thirty five (35%) patients presented with left sided weakness, fifty eight (58%) patients presented with right sided weakness while seven (7%) patients presented without any weakness which were either in deep coma or the area of brain involved was other than the motor area.

Seventy two (72%) patients were hypertensive, thirty five (35%) were diabetic, twenty nine (29%) gave the history of smoking, twenty (20%) patients were obese, sixteen (16%) had a previous attack of stroke, six (6%) patients had some valvular heart disease (mostly with mitral valve replacement) and one patient had Takayasu's arteritis.

Ten (10%) patients had carotid bruit; sixty (60%) patients had evidence of left ventricular hypertrophy as shown by ECG and cardiomegaly on chest x-ray.

CT scan of these patients showed that sixty six (66%) patients had cerebral infarction while thirty four (34%) patients had evidence of intracerebral or ventricular bleed. Mostly involved area of brain in all of these patients was left temporo-parietal region.

When carotid Doppler ultrasonography was done on patients with cerebral infarction, it showed that 32 out of 66 (48.5%) patients had some evidence of carotid atherosclerosis. Ten (31.3%) patients had right carotid artery involvement, thirteen (40.6%) had left sided involvement and nine (28.1%) had both carotid arteries involved.

When luminal narrowing of these involved carotid arteries was calculated, it showed that fourteen (21%) patients had more than 60% stenosis of lumen (as 60% is the cut off value for endarterectomy).

Table-I. Risk factors in stroke.

	Count	%age
Hypertension	72	72%
Diabetes	35	35%
Smoking	29	29%
Obesity	11	11%
Valvular Heart Disease	06	06%
Previous H/O CVA	16	16%

Table-II. Frequency of carotid atherosclerosis.

	Frequency	%age
Yes	32	48.5%
No	34	51.5%
Total	66	100%

Table-III. Involvement of carotid areries.

	Frequency	%age
Right	10	31.3%
Left	13	40.6%
Both	09	28.1%
Total	32	100%

Table-IV. Percent stenosis of carotid arteries		
	Frequency	%age
20-30%	01	3.1%
30-40%	02	6.3%
40-50%	01	3.1%
50-60%	14	43.8%
60-70%	07	21.9%
> 70%	07	21.9%
Total	32	100%

DISCUSSION

The study was conducted in Medical Unit II, Jinnah Postgraduate Medical Centre, Karachi. The stroke patients admitted in our unit were not representative of any specific area or socioeconomic class belonging mainly to middle to lower socioeconomic class. My study included a total of hundred consecutive patients, all presented with recent stroke (involving both ischaemic as well as haemorrhagic stroke) proven by CT scan.

Out of 100 patients, 62 were male and 38 were females (1.6:1). This male preponderance is in accord with most of the local as well as international studies. A M Siddiqi et al have shown a 1.5: 1 male to female ratio in their study conducted at Lahore.[8] Numan et al have shown 1.6:1 male: female ratio.[9] Piravej K et al has documented male: female ratio of 1.2:1 in his study conducted at Thailand [10.] Most of our study subjects were in the age group of 50-70 years (n=56). This is again in accordance with the data already available. Ansari et al, Vohra E et al, Intiso D et al and Piravej K have documented in their respective studies higher incidence as well as poor outcome in elderly people[10,11,12,13] .

Main risk factors involved in this study were hypertension (72%), diabetes mellitus (35%), smoking (29%), obesity (20%) whereas 16% had a history of previous CVA and 6% had some valvular heart disease (mostly mitral valve replacement). The association of these risk factors with stroke has been evaluated in detail by numerous studies carried out all over the world. Incidence of hypertension is more in our study (72%) as well as in other studies carried out in Pakistan as compared to world data. Numan A et al, Zaidi K et al, Ansari AK et al and many others have also shown the same higher incidence of hypertension in our population.[9,10,14]The reason behind this may be the sedentary life style along with improper diet. Baena Diez et al and Intiso D et al, in their studies carried out in the west have shown the same frequency of these risk factors[13,15].

CT scan findings in this study showed that 66% were cerebral infarcts and 34% were intracerebral or ventricular haemorrhages. This higher frequency of haemorrhage is consistent with other studies carried out in Pakistan[8,9,16]. The reason of this much high frequency of cerebral haemorrhage could be better explained by the higher incidence of uncontrolled hypertension as discussed above. Hemorrhagic strokes are more common in Asia as compared to west[10]. Infarction constitutes 80% of strokes over there[2]. Mortality among stroke patients is more common in haemorrhagic strokes than ischaemic strokes as shown in this study.

Carotid Doppler ultrasonography performed on patients with ischaemic strokes showed that thirty-two (48.5%) out of 66 patients have involvement of carotid arteries (right, left or both). Out of these, fourteen (21%) patients had severe stenosis of carotid arteries (defined as more than 60% stenosis). Razzaq A et al have shown 25% incidence of severe stenosis.[17] Bogousslavsky et al have shown 20%, Pessin et al has documented 39%, Balow et al has shown 33%, Colin P Derdeyn has shown 30% incidence of severe stenosis in their respective studies which were all done on symptomatic population[18,19,20,21]. These all studies have been conducted on patients having symptoms of involvement of carotid arteries like stroke. Similarly, a lot of studies have been done on asymptomatic patients, which have documented a very high incidence of involvement of carotid arteries. Hennerici et al, Alexandrove et al, Ahn et al, Luisiani et al and Punjia et al have documented 32.8%, 17%, 14%, 11% and 3.8 % incidence of more than 50% involvement of carotid arteries[22,23,24,25].

The accuracy of Doppler ultrasound increases with high

degree of stenosis. Doppler ultrasound has an overall sensitivity of 96%, a specificity of 86%, a positive predictive value of 89%, a negative predictive value of 94% and an accuracy of 91% for the diagnosis of a stenosis diameter greater than 50%[26].

Despite the use of similar equipment, ultrasound grading of carotid Stenosis is operator dependent and relies on different individually validated criteria. Greater sensitivity of ultrasound screening is achieved by applying diagnostic criteria specific to each laboratory[27,28].

Thus for complete stenosis, color Doppler is helpful because it may show small amount of color flow in above 90% stenosis and may obviate the need for arteriography to identify patients at critical level of carotid stenosis[29].

In one study, conventional gray scale duplex scanning correctly identified pseudo-occluded internal carotid artery in 27% patients compared to 94% patients correct identification by Doppler[29].

Carotid angiography is assumed to have perfect sensitivity and specificity in evaluation of carotid artery stenosis and occlusion. It is the most accurate technique currently available for measuring luminal diameter and is the "Gold Standard" but at a complication rate ranging from 0.3 to 5.2%.

This high incidence of carotid atherosclerosis in symptomatic as well as in asymptomatic individuals calls for a need of screening of all high risk individuals by carotid Doppler ultrasonography as it is a non-invasive technique. Severe carotid stenosis is associated with high risk for cerebrovascular events. In one study, mean annual stroke rates were 6% in symptomatic patients and 2% in asymptomatic patients[30].

The benefit of screening for carotid atherosclerosis and subsequently diagnosing significant stenosis in population depends upon the availability of health care facilities.

Ultrasound followed by angiography is cost-effective way to image patients suspected of carotid artery disease. Ultrasound before angiography is more effective and considerably cheaper than performing angiography in all patients presenting with transient ischemic stroke.[31]The evidence does not support the routine use of serial sonography to determine the risk of stroke in unselected and asymptomatic carotid disease.

CONCLUSION

From my study, it is concluded that carotid atherosclerosis is the most important indicator, predictor as well as an independent risk factor in the development of ischaemic stroke. It can be prevented or controlled by keeping good control of other major risk factors like hypertension, diabetes, dyslipidemia, smoking and obesity.

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