COMPARISON OF EXTRACRANIAL WITH INTRACRANIAL CAROTID ARTERY DISEASE IN ISCHAEMIC STROKE

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ABSTRACT

BACKGROUND

Atherosclerotic intracranial large artery stenosis accounts for 20% of ischaemic stroke. Embolism from major arteries is a common source of stroke. The incidence and prevalence of the condition varies accordingly to the population studied. This study compares the concordance and discordance of extracranial and intracranial carotid artery disease in patients with anterior circulation ischaemic stroke by using Doppler ultrasound study, which is a non-invasive study, since most of the studies which compare the intracranial and extracranial atherosclerotic disease are invasive.

MATERIALS AND METHODS

This cross-sectional study was conducted during Jan. 2011 to Oct. 2013 at Madras Institute of Neurology, Rajiv Gandhi Government General Hospital, Chennai. Patients with clinical features suggestive of stroke were enrolled in this study. All were subjected to CT Brain, MRI Brain and Carotid Doppler. Patients with extracranial carotid stenosis were enrolled and subjected to transcranial Doppler.

RESULTS

Risk of stroke occurrence increases with increasing degree of stenosis in carotid artery. It is estimated that the annual risk of stroke occurrence increased by less than 1% in patients with < 80% stenosis and 4.8% in patients with > 90% stenosis. Early intervention in patients with lesser degree of carotid artery stenosis will decrease the risk of future stroke. Transcranial Doppler and Carotid Doppler are the best non-invasive and widely available screening tool for carotid stenosis. But the disadvantage of transcranial Doppler is that it is operator inadequate temporal windows, especially in older individuals. Transcranial Doppler can be used as an initial imaging modality to exclude intracranial carotid artery stenosis.

CONCLUSION

Most of the patients with extracranial carotid artery disease also had coexisting intracranial carotid artery disease, which in turn may further lead to stroke. This emphasises the need to search for intracranial disease in patients with extracranial carotid artery disease. Transcranial Doppler can be used as non-invasive initial screening tool for detecting intracranial carotid artery stenosis before considering any invasive investigation.

KEYWORDS

Transcranial Doppler, Intracranial Carotid Stenosis, Extracranial Carotid Stenosis.

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BACKGROUND

Atherosclerotic intracranial large artery stenosis accounts for 20% of ischaemic stroke. Embolism from major arteries is a common source of stroke. The incidence and prevalence of the condition varies accordingly to the population studied. From Asian studies, intracranial stenosis estimated as 30% to 54% of all strokes in Chinese patients, 46% of Japanese, 48% of Singapore patients, 10% - 25% of Korean patients; however, only 6% - 10% in whites.^(1,2)

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As Hispanics, Asians and blacks constitute the majority of the world's population, it may be inferred that intracranial stenosis is the most common stroke mechanism worldwide.⁽³⁾ Studies regarding combined intracranial and extracranial steno-occlusive disease is comparatively less. Most of the studies which compare the intracranial and extracranial atherosclerotic disease are invasive. This study compares the concordance and discordance of extracranial and intracranial carotid artery disease in patients with anterior circulation ischaemic stroke by using Doppler ultrasound study, which is a non-invasive study.

Aim of the Study

To Assess the following in Patients with Anterior Circulation Ischaemic Stroke-

1. Extracranial carotid artery disease by carotid doppler.
2. Intracranial carotid artery disease by transcranial doppler in patients who showed extracranial carotid artery disease.

3. Comparing the concordance and discordance of carotid artery disease in extracranial and intracranial part of internal carotid artery.
4. Clinical profile, pattern of vascular involvement in carotid stroke.
5. Risk factors involved in carotid stroke.

MATERIALS AND METHODS

This cross-sectional study was conducted during Jan. 2011 to Oct. 2013 at Madras Institute of Neurology, Rajiv Gandhi Government General Hospital, Chennai. Patients with clinical features suggestive of stroke were enrolled in this study. All were subjected to Carotid Doppler and CT Brain or MRI Brain.

The Inclusion criteria were-

1. Patients with clinical features suggestive of stroke.
2. Imaging showing ischaemic infarct in the anterior circulation.
3. Carotid Doppler showing atherosclerotic carotid artery disease and
4. Patients with anterior circulation TIA.

The exclusion criteria were-

1. Haemorrhagic stroke,
2. Posterior circulation stroke,
3. Patients without carotid stenosis on carotid Doppler and
4. Patients with cardiac disease.

Patient's details regarding age, sex, address, occupation, complaints, evolution of symptoms, previous history of transient ischaemic attacks, amaurosis fugax, diabetes mellitus, systemic hypertension, coronary artery disease, peripheral vascular disease, drug intake, family history of vascular event, history of vascular risk factors like smoking, alcohol consumption, other form of tobacco use, high-risk behaviour and other addictions were obtained. All the patients were examined according to proforma that included general and systemic examination. All the patients underwent a basic investigation protocol that included complete blood count, renal function tests, blood sugar, fasting lipid profile, electrolytes, HIV serology, urine routine, CT Brain, chest X-ray, electrocardiogram, echocardiography, carotid Doppler and transcranial Doppler-transorbital window. MRI brain with MRA and DWI, CT angiogram of cerebral vessels had been done wherever indicated. Other laboratory tests such as serum homocysteine, fibrinogen, prothrombin time, partial activated thromboplastin time, antinuclear antibodies, anticardiolipin antibody and lupus anticoagulant were done in selected patients where clinical features indicated their need.

RESULTS

A total of 70 patients admitted in Rajiv Gandhi Govt. General Hospital between Jan. 2011 to Oct. 2013 with clinical features and neuroimaging suggestive of stroke with carotid artery stenosis by Carotid Doppler were enrolled for the study and were further considered for Transcranial Doppler. 83% of total 70 patients were male and 17% were female patients. The study shows mean age of male is 58 and female is 62. The

highest age among male is 86 and that in female is 71. The lowest age in male is 35 and in female is 30.

Figure 1. Stroke Risk Factors

Most common risk factor seen among 70 patients is dyslipidaemia with high rate of 56 (80%) patients being affected. The study also showed that 44 patients had double risk factors. Among 44 patients, 10 patients (15%) had diabetes mellitus and systemic hypertension, 34 patients (49%) had the habit of both smoking and alcohol consumption. Unexpectedly, 5 patients (7%) had all 5 risk factors. Among the clinical presentation of 70 patients, ischaemic stroke is seen in 63 patients (90%), 6 patients (9%) reported of transient ischaemic attack and one patient (1%) reported of ocular stroke. In carotid stroke, most commonly involved territory is middle cerebral artery, which accounted for 45 patients (64%) and the least affected territory is ophthalmic artery which accounted for one patient (1%).

Figure 2. Vascular Territory involved in Carotid Stroke

Out of 70 patients, 27 patients (39%) were affected with territorial infarcts, 21 (30%) patients were affected with subcortical infarcts and cortical and subcortical together accounted for 4 patients (6%). Under watershed infarct subtype external and internal ones accounted for 8 patients (11%) and 4 patients (6%) respectively. Study shows total number of 17 patients (24%) with transient ischaemic attack, out of which 11 patients later reported with stroke and remaining 6 patients' condition was normal without developing stroke. The remaining 53 patients out of 70 patients experienced stroke without preceding transient ischaemic attack.

The study evaluated percentage of stenosis, which resulted in left unilateral stenosis with 28 patients (39%) closely followed by unilateral right stenosis with 23 patients (34%) and the remaining 27% were affected bilaterally. Among 70 patients with varying degree of extracranial stenosis, 10 patients had 100% stenosis to whom intracranial stenosis detection was not possible. In remaining 60 patients, intracranial stenosis was detected in 35 patients and rest of 25 patients did not show intracranial stenosis.

Percentage of Stenosis	Unilateral		Bilateral
	Right	Left	
No Stenosis (IMT > 1)	2 (3%)	0 (0%)	19 (27%)
< 50%	10 (15%)	8 (11%)	
50 - 69%	4 (6%)	12 (17%)	
70 - 99%	2 (3%)	3 (4%)	
100%	5 (7%)	5 (7%)	

Table 1. Extracranial Carotid Stenosis and Stroke

DISCUSSION

A total of 485 patients admitted in Neurology Ward, Madras Institute of Neurology, Rajiv Gandhi Government General Hospital, Chennai. Between January 2011 and October 2013 with clinical features suggestive of stroke, carotid transient ischaemic attack were enrolled in this study. Among 485 patients, 150 patients (30.9%) whose CT brain showed bleed or posterior circulation, or venous infarct were excluded from the study. Remaining 335 patients subjected were for cardiac evaluation. In them 23 patients (6.8%) who showed cardiac abnormalities were excluded from the study. Out of 312 patients, only 70 patients who showed carotid artery disease in Carotid Doppler were enrolled in this study and subjected to transcranial Doppler to study the intracranial carotid artery stenosis. The study revealed that 83% of cases were males and remaining 17% were females. This is in line with another study done by Dr. Chin Sang Chun et al from South Korea⁽⁴⁾ which showed 87.3% of male predominance and 12.7% occurrence in females. The mean age of males and females are 58 years and 62 years respectively. Similarly, the age range in males is 35 - 86 years and that in females is 30 - 71 years. 74% of patients are in the age group of 50 years to 70 years. In the above quoted study in South Korea done by Dr. Chin Sang Chun et al showed mean age was 65.5 years and age range was 43 - 81 years. The varied clinical presentations are- 90% (63 patients) developed ischaemic stroke followed by transient ischaemic attack, which includes 6 patients (9%) and the least being ocular stroke which occurred in 1 patient (1%). On the basis of vascular territory involved, 45 patients (64%) had middle cerebral artery occlusion, in which 12 patients showed multiple lesions in middle cerebral artery territory, which is followed by watershed infarct in 12 patients (17%). 6 patients (9%) had transient ischaemic attack, another 6 patients (9%) had anterior cerebral artery infarct and the least being ophthalmic artery occlusion in 1 patient (1%). As per Lee, Kwon and Kang, lesion patterns and stroke mechanism in atherosclerotic middle cerebral artery disease and early diffusion-weighted imaging study among 63 patients with middle cerebral artery stenosis, 32 patients showed fragmented infarct in the middle cerebral artery territory.⁽⁵⁾ In overall 70 patients, 17 patients (24%) experienced transient ischaemic attack, out of which 11 patients (15%) developed stroke and the remaining 6 patients (9%) did not develop stroke. In this study, among 45

patients who had intracranial stenosis, 12 patients experienced transient ischaemic attack. 5 patients out of 15 patients without intracranial stenosis experienced transient ischaemic attack. This shows incidence of transient ischaemic attack higher in patients with intracranial stenosis as compared to extracranial stenosis. When categorised as subtypes the study revealed that the territorial infarct was the highest accounting for 27 patients (39%) and subcortical infarct in 21 patients (30%) followed by watershed infarct external in 8 patients (11%), watershed internal in 4 patients (6%), negative image (transient ischaemic attack) in 6 patients (9%) and finally combined cortical and subcortical involvement in 4 patients (6%). The study revealed the following based on risk factors. Dyslipidaemia has topped the list with 56 patients (80%) and was followed by smoking in 42 patients (60%), alcohol in 36 patients (51%), Diabetes Mellitus in 29 patients (41%) and finally systemic hypertension in 26 patients (37%). The study also showed that 44 patients had double risk factors. Among 44 patients 10 patients (15%) had Diabetes Mellitus and systemic hypertension, 34 patients (49%) had the habit of both smoking and alcohol consumption. Unexpectedly, 5 patients (7%) had all 5 risk factors. Our study results are comparable with other studies. Arenillas, Molina and Chacon et al,⁽⁶⁾ as per their study intracranial internal carotid stenosis has been associated with dyslipidaemia, specifically with increased total cholesterol and it also revealed that elevated low density lipoprotein is also a risk factor for internal carotid stenosis. The North Manhattan stroke study demonstrated higher prevalence of Diabetes Mellitus in patients with intracranial carotid stenosis when compared with extracranial carotid stenosis.⁽⁷⁾ Impact of Diabetes Mellitus in the development of intracranial carotid stenosis also established in Hongkong Autopsy Study.⁽⁸⁾ Another study conducted in Hispanics and African American population also revealed the greater prevalence of Diabetes Mellitus in intracranial carotid stenosis.⁽⁹⁾ Yet another epidemiological study showed the association of systemic hypertension and intracranial atherosclerotic disease. The main aim of the study being concordance and discordance of extracranial and intracranial stenosis in patients with anterior circulation stroke. Out of total 70 patients examined, 10 patients showed complete occlusion of extracranial vessels, who could not be further assessed for intracranial stenosis. In the remaining 60 patients, 35 patients (58%) showed concordance with extracranial stenosis and discordance with extracranial stenosis was detected in 25 patients (42%). In a similar but invasive study (CT angiogram) performed by Chin Sang Chun et al at South Korea, discordance was observed in 56.3% of patients with extracranial stenosis. Out of 121 patients studied, concordance in 58 patients (47.9%) also revealed intracranial stenosis. In our study 19 patients (27%) had bilateral extracranial internal carotid artery stenosis and 5 patients (7%) had bilateral intracranial internal carotid artery stenosis. Studies regarding combined intracranial and extracranial stenosis occlusive disease is comparatively less. In a study on Taiwan Chinese population by Dr. Lui et al, 42.2% of patients had intracranial and extracranial carotid artery disease. In a study by Dr. Feldmann et al, in Chinese patients 9% of patients reportedly had both intracranial and extracranial occlusions. Another study done on Chinese

revealed intracranial stenosis related strokes constitute upto 33% - 37% of all strokes.

19 patients (27%) had bilateral stenosis as compared to study conducted in Korea, which showed 33%. Less than 50% stenosis were found in 18 patients (26%), 50% - 99% stenosis were found in 21 patients (30%) of which 6 patients (9%) had left-sided stenosis and 15 patients (21%) had right-sided stenosis. 10 patients (14%) had complete occlusion. Only 3% had increased Intima media thickness of more than one without stenosis in the extracranial internal carotid artery. Out of total 70 patients with extracranial-internal carotid artery disease examined, 10 patients showed complete (100%) occlusion of extracranial vessels, who cannot be further assessed for intracranial stenosis. In the remaining 60 patients, 35 (58%) showed associated intracranial stenosis and in remaining 25 (42%) no intracranial stenosis was detected. In a similar but invasive study (CT angiogram) performed by Chin Sang Chun et al at South Korea, discordance was observed in 56.3% of patients with extracranial stenosis. Out of 121 patients studied, concordance in 58 patients (47.9%) also revealed intracranial stenosis. Among the 60 patients 41% (68) had unilateral extracranial stenosis of which 19 (31%) showed unilateral intracranial stenosis, 1 (2%) showed bilateral intracranial stenosis and had middle cerebral artery territorial stroke on the side of intracranial internal carotid stenosis. 21 patients (35%) did not show stenosis in the intracranial part of internal carotid artery. Remaining 19 patients (27%) had bilateral extracranial stenosis of which 5 (8%) had bilateral intracranial stenosis and 10 (19%) had unilateral intracranial stenosis. In them, 8 patients showed right-sided stenosis and remaining 2 had left-sided stenosis. Studies regarding combined intracranial and extracranial steno-occlusive disease is comparatively less. In a study on Taiwan-Chinese population by Lui et al, 42.2% of patients had intracranial and extracranial carotid artery disease. But Feldmann et al reported that only 9% in Chinese population.⁽⁹⁾ Solberg et al studied Cerebral atherosclerosis in Negroes and Caucasians from New Orleans, Jamaica and Norway. They performed 2166 autopsies in Blacks and Whites, which showed the increased occurrence of intracranial stenosis in Blacks 43% compared to 8.5% in Whites.⁽¹⁰⁾ Risk of stroke occurrence increases with increasing degree of stenosis in carotid artery. It is estimated that the annual risk of stroke occurrence increased by less than 1% in patients with < 80% stenosis and 4.8% in patients with > 90% stenosis. Early intervention in patients with lesser degree of carotid artery stenosis will decrease the risk of future stroke. Transcranial doppler and carotid doppler are the best non-invasive and widely available screening tool for carotid stenosis. But the disadvantages of transcranial Doppler is that it is operator inadequate temporal windows, especially in older individuals. Transcranial Doppler can be used as an initial imaging modality to exclude intracranial internal carotid artery stenosis.

CONCLUSION

The common risk factors for carotid artery disease in our study are dyslipidaemia, systemic hypertension, diabetes mellitus, smoking and alcohol consumption in the order of occurrence. Incidence of transient ischaemic attack was high in patients with intracranial carotid artery disease indicating the need for intensive management of these patients to prevent morbidity and mortality. The most common radiological presentation is the territorial infarct involving the middle cerebral artery territory followed by watershed infarcts. Most of the patients with extracranial internal carotid artery disease also had co-existing intracranial internal carotid artery disease, which in turn may further lead to stroke. This emphasises the need to search for intracranial disease in patients with extracranial carotid artery disease. Transcranial Doppler can be used as non-invasive initial screening tool for detecting intracranial internal carotid artery stenosis before considering any invasive investigation.

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