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Short Communication

Doppler sonography of extracranial and intracranial vessels in patients with thrombotic stroke

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Abstract

INTRODUCTION: The results of intracranial and extracranial vessel color Doppler sonography, which is now an inseparable part of patient evaluation, vary in different studies. The objective of this study was to evaluate the pattern of vascular involvement in thrombotic stroke and its relationship with risk factors of stroke.

METHODS: One-hundred patients (45 males and 55 females) with thrombotic stroke underwent transcranial sonography and color Doppler sonography of extracranial vessels. The pattern of vascular involvement was analyzed. The risk factors of stroke were also evaluated.

RESULTS: Forty-seven percent of the studied individuals had some variations in their color Doppler sonography of extracranial vessels, 27% had changes in the intracranial vessels and 26% showed changes in both. The most frequently involved vessels among the intracranial and extracranial vessels were the middle cerebral artery and the internal carotid artery, respectively. The pattern of vascular involvement was unrelated to hypertension, cigarette smoking, diabetes mellitus, dyslipidemia or history of ischemic heart disease. Extracranial involvement in patients with positive history of MI was more prevalent than in those without such history.

CONCLUSIONS: Extracranial vessel involvement in thrombotic stroke was found to be more prevalent than intracranial vessel involvement in the city of Rafsanjan; however, intracranial vessel involvement was more prevalent than in western countries.

KEY WORDS: Thrombotic stroke, color Doppler sonography, intracranial vessels, extracranial, cerebrovascular risk factors

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Stroke is a heterogeneous disorder with different etiologies and symptoms. The most common etiology of stroke is the obstruction of cerebral arteries due to thrombosis or emboli [1]. In the first 6 hours after stroke, Doppler sonography and angiographic images can show the obstruction of large vessels in 70% of the patients [2,3]. Emboli are the common causes of obstruction and their sources are mostly proximal to large arteries, aorta or the heart. In 66% of these patients, the source of emboli is atheromatous disease of middle cerebral, basilar, vertebral, carotid, intracranial or extracranial arteries. In 5-8% of the patients with obvious signs of large vessel involvement in the anterior circulation, the involvement is within the intracranial vessels, whereas in posterior circulation involvement, intracranial artery disease reaches 30% [2,4]. Nowadays, transcranial Doppler sonography (TCD) and sonography of extracranial arteries are inseparable components of evaluation of

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the patients with stroke [5]. The applications of this method in the evaluation of stroke are as follows:

1. Diagnosis of vasospasm following subarachnoid hemorrhage.
2. Diagnosis of stenosis and obstruction of intracranial and extracranial arteries in ischemic stroke and TIA.
3. Monitoring the intracranial hemodynamic changes and the emboli during carotid endarterectomy.
4. Monitoring cerebral circulation in neurology intensive care centers [6].
5. Finding the mechanisms responsible for stroke in subacute ischemic stroke [7].

Investigations indicate that the severity and distribution of cerebral vessel involvement are different among various races and areas; e.g. it has been reported that small intracranial vessels are more involved in Asian and Chinese races than in the western and white races, whereas involvement of extracranial vessels is more common in the white race [8-10]. Given the prevalence of stroke, especially thrombotic stroke, and in view of the difference between the involvement of intracranial and extracranial vessels, this study was designed and performed to assess the frequency of involvement of different vessels in thrombotic stroke and any possible association with age, sex and cardiovascular risk factors.

Methods

This cross-sectional study was performed on 105 patients with thrombotic stroke in Ali-Ebn-Abitaleb Educational and Therapeutic Center. Sampling was conducted consecutively during a 6-month period. All patients who had thrombotic stroke based on MRI results were referred to the cardiologist. All suspected cases of emboli were excluded according to patient history, physical examination, echocardiography and electrocardiogram. Only patients diagnosed with thrombotic stroke based on the above procedures remained in the study.

A radiologist performed carotid Doppler sonography of extracranial vessels. Where indicated, a TCD sonography was also performed on patients entering the study using a TCD (DWL) system, between the second and the third weeks of admission. Five patients were excluded owing to technical problems. Information on the age, sex, cigarette smoking, hypertension, dyslipidemia, diabetes mellitus, cardiovascular events, ischemic heart disease and the use of contraceptive pills was also obtained. The data were statistically analyzed using SPSS.

Results

Out of 100 patients studied, 45 were men and 55 women. The average ages of men and women were 64.5 and 67.2 years, respectively, with no statistically significant difference.

The most frequent site of lesion in thrombotic stroke was the occipital lobe (34%). Other sites of lesion were the parietal lobe (17%), the temporal lobe (16%), and the frontal lobe (12%), in the order mentioned (table 1). Twenty-one percent of the patients had more than one site of involvement.

Statistical information on the prevalence of stroke risk factors was as follows: hypertension (69%), history of ischemic heart disease (43%), cigarette smoking (39%), history of previous stroke (33%), dyslipidemia (30%), diabetes (24%), and taking oral contraceptive pills (13% of women). Based on carotid Doppler and transcranial Doppler sonography, 47%, 27%, and 26% of patients had some changes of circulation in their extracranial, intracranial, and both extracranial and intracranial vessels, respectively (table 2). The most commonly involved intracranial and extracranial vessels were middle cerebral (37%) and internal carotid (55%) arteries, respectively. According to statistical analyses, there was no association between the prevalence of the involved vessels and the patients' age and sex. There was also no association between the pattern of vascular involvement and cardiac risk factors (hypertension, smoking, dyslipidemia, history of heart disease and taking oral contraceptive pills), however, the history of cerebrovascular accident had an association with the pattern of vascular involvement, i.e. 66.7% and 3% of individuals

with a history of stroke revealed involvement of extracranial and intracranial vessels, respectively. However, among patients without a history of stroke, 37.4% and 38.8% showed extracranial and intracranial involvement, respectively (P<0.001). In other cases not indicated here, intracranial and extracranial vessels were commonly involved

Table 1. Frequency rate of involved vessels according to the location of thrombotic stoke in 100 patients.

Total	More than one lobe	Parietal	Temporal	Occipital	Frontal	Site
27	6	5	7	7	2	Intracranial Vessels
47	9	10	7	19	2	Extracranial Vessels
26	6	2	2	8	8	Intracranial or Extracranial Vessels
100	21	17	16	34	12	Total

Table 2. Frequency of involved vessels in 100 thrombotic patients with stoke.

Number (100)	Vessels
27	Intracranial Vessels
37	- middle cerebral artery
17	- anterior cerebral artery
17	- posterior cerebral artery
8	- ophthalmic cerebral artery
47	Extracranial Vessels
10	- Common carotid
55	- internal carotid
42	- external carotid
0	- basilar artery
26	Intracranial or Extracranial Vessels
66	More than one artery

Discussion

TCD sonography can provide a rapid non-invasive image of blood circulation in the main cranial arteries. The specificity and sensitivity of this method for diagnosis of homodynamic disorders and stenosis depend on technical problems and the location to be assessed. For instance, the specificity and sensitivity of TCD are 90-99% for detection of obstruction or stenosis of middle cerebral artery, which is technically easier to diagnose. The specificity and sensitivity of TCD for the intracranial part of the basilar arteries are 90-99% and 70-80%, respectively [6]. However, specificity, sensitivity and positive predictive value for Doppler sonography of the carotid artery were reported at 92.3%, 91.4% and 86.4%, respectively [11]. In this study, hypertension, ischemic heart disease and cigarette smoking were the major stroke risk factors. Extracranial vessels were mainly involved in patients with a history of stroke. In a study performed in China, atherosclerosis was more severe in intracranial vessels than in extracranial vessels. The distal branches of the intracranial vessels were also commonly involved. In the same study, hypertension and diabetes mellitus, cigarette smoking, and ischemic heart disease were found to

be associated with intracranial vessel involvement, extracranial vessel involvement, and involvement of both vessels, respectively [9]. In another study conducted in Japan, involvement of the extracranial vessels increased between 1963 and 1989, but involvement of the intracranial vessels remained unchanged. Meanwhile, extracranial vessels were more frequently involved in diabetic patients. The study concluded that the increased involvement of extracranial vessels was due to an increase in the prevalence of diabetes mellitus [10].

Other studies have also highlighted the relationship between race and pattern of vascular involvement. Extracranial and intracranial vessel involvement (especially the middle cerebral artery) have been cited as the main etiologies of ischemia in the white race and Asians, respectively [12,13].

The pattern of involvement in young individuals with ischemic stroke is somewhat similar to that of old patients. In a study conducted on the individuals under 45 year old with ischemic stroke, 225 had involvement of intracranial vessels and the carotid artery.

Hypertension and diabetes mellitus were the most important cardiovascular risk factors for ischemic stroke in individuals above the middle age [14,15]. Our study and others previously mentioned were performed on patients with stroke. Intracranial vessel involvement is more common in individuals with no past history of stroke, but exposed to its risk factors. In a study conducted on symptomatic and asymptomatic individuals with risk factors of ischemic stroke who underwent carotid Doppler sonography and TCD, the intracranial vessels were mainly involved in both groups [16]. It should be noted that an abnormal TCD result is important for diagnosis of vascular disorders; however, a normal result does not exclude such disorders [17]. The negative predictive value of this procedure is inadequate, although it has a good positive predictive value. Nonetheless, during the acute phase of stroke, disorders of blood circulation may be attributable to the hemodynamic changes induced by stress and the size of infarction, and may be unrelated to the real pathologic lesions on the arterial walls [8]. Furthermore, circulation velocity is known to decrease with age, hence hemodynamic changes could also be influenced by aging [18]. Therefore, the results of this study suggest that the pattern of vascular involvement in thrombotic stroke is not associated with age, sex and risk factors such as cigarette smoking, diabetes mellitus and hypertension; this should be noted in the assessment of cerebral vessels in patients with stroke.

In conclusion, extracranial vessels are more frequently involved in thrombotic stroke than intracranial vessels in the city of Rafsanjan, but intracranial vessel involvement in this region is more prevalent than in the West.

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References

1. Mohr JP, Sacco RL. Classification of ischemic strokes. In: Barnett HJM, editor. Stroke: pathophysiology, diagnosis and management. New York: Churchill Livingstone; 1992. p. 271-283.
2. Pessin MS, Adams HP, Jr., Adams RJ, Fisher M, Furlan AJ, Hacke W et al. **American Heart Association Prevention Conference. IV. Prevention and Rehabilitation of Stroke. Acute interventions**. *Stroke* 1997; 28(7):1518-1521.
3. Alexandrov AV, Demchuk AM, Wein TH, Grotta JC. **Yield of transcranial Doppler in acute cerebral ischemia**. *Stroke* 1999; 30(8):1604-1609.
4. Babikian VL, Caplan LR. **Brain embolism is a dynamic process with variable characteristics**. *Neurology* 2000; 54(4):797-801.

5. Aaslid R, Markwalder TM, Nornes H. **Noninvasive transcranial Doppler ultrasound recording of flow velocity in basal cerebral arteries**. *J Neurosurg* 1982; 57(6):769-774.
6. Levi CR, Selmes C, Chambers BR. **Transcranial ultrasound-clinical applications in cerebral ischaemia**. *Aust Prescr* 2001; 24:137-140.
7. Andrei VA, Mathew J. **Transcranial Doppler: An Overview of its Clinical Applications**. *The Internet Journal of Emergency and Intensive Care Medicine* 2000; 4(1): Available URL: http://www.ispub.com/ostia/index.php?xmlFilePath=journals/ijeicm/vol4n1/tcd.xml.
8. Guo Y, Jiang X, Chen S, Zhang S, Zhao H, Wu Y. **Aortic arch and intra-/extracranial cerebral arterial atherosclerosis in patients suffering acute ischemic strokes**. *Chin Med J (Engl)* 2003; 116(12):1840-1844.
9. Leung SY, Ng TH, Yuen ST, Lauder IJ, Ho FC. **Pattern of cerebral atherosclerosis in Hong Kong Chinese. Severity in intracranial and extracranial vessels**. *Stroke* 1993; 24(6):779-786.
10. Nagao T, Sadoshima S, Ibayashi S, Takeya Y, Fujishima M. **Increase in extracranial atherosclerotic carotid lesions in patients with brain ischemia in Japan. An angiographic study**. *Stroke* 1994; 25(4):766-770.
11. Fortea-Cabo G, Fages-Caravaca EM, Tembl JI, Bosca-Blasco I, Lago-Martin A. **[Quality control of Doppler diagnoses in vascular neurology]**. *Rev Neurol* 2003; 37(7):627-631.
12. Gao S, Wong KS, Huang YN, Li SW. **[Diagnosis and epidemiology of large intracranial artery stenosis]**. *Zhongguo Yi Xue Ke Xue Yuan Xue Bao* 2003; 25(1):96-100.
13. Diaz V, Plate L, Erazo S, Cumsille MA, Venegas P. **[Prevalence of carotid atherosclerosis in patients with cerebrovascular occlusive disease]**. *Rev Med Chil* 2001; 129(2):161-165.
14. Razzaq AA, Khan BA, Baig SM. **Ischemic stroke in young adults of South Asia**. *J Pak Med Assoc* 2002; 52(9):417-422.
15. Razzaq AA, Khan BA, Jadoon CK, Baig SM. **Carotid Doppler ultrasonography in young stroke patients**. *J Pak Med Assoc* 1999; 49(4):97-99.
16. Hermes P. **The importance of Doppler studies in asymptomatic intracranial and extracranial arterial disease**. *Keio J Med* 2002; 51(4):189-192.
17. Suwanwela NC, Suwanwela N, Phanthumchinda K. **Comparison of transcranial Doppler ultrasound and computed tomography angiography in symptomatic middle cerebral artery stenosis**. *Australas Radiol* 2000; 44(2):174-177.
18. Akopov S, Whitman GT. **Hemodynamic studies in early ischemic stroke: serial transcranial Doppler and magnetic resonance angiography evaluation**. *Stroke* 2002; 33(5):1274-1279.