ORIGINAL ARTICLE

Profile of Extracranial Cerebrovascular Disease in Kelantan: A Study by Continuous Wave Doppler Ultrasonography

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Summary

The present study outlines the clinical profile and patterns of extracranial vascular abnormalities detected by continuous wave doppler ultrasonography (CWDU) in 100 patients with cerebrovascular insufficiency states. Males outnumbered females (65:35); completed stroke (CS) was a more common mode of presentation than transient ischaemic attacks (TIA); carotid strokes were more common than vertebro-basilar ones; and hypertension was the most common predisposing factor. The CWDU evaluation revealed extracranial vascular disease in 73% of patients. Vascular occlusions were more common in patients with TIA. Overall, 33% of the patients had evidence of proximal obstruction of the cerebral vessels below the neck. The clinical prediction of vascular territory (carotid or vertebro-basilar) matched with the findings on CWDU, but evidence of subclinical multiple-vessel involvement could be detected in 48% of the patients.

Key words: Cerebrovascular disease, doppler ultrasound.

Introduction

In approximately two-thirds of patients with symptoms of cerebrovascular insufficiency (CVI), the vascular lesion lies in the extracranial carotid arterial system, primarily at the bifurcation of the common carotid artery into internal and external branches[1]. Continuous wave doppler ultrasonography (CWDU) with real time spectral analysis has emerged as a highly sensitive and specific non-invasive diagnostic tool for the detection of extracranial cerebrovascular disease[2,3]. Its reliability has been validated in several studies where results have been compared with findings on angiography and in pathologic specimens obtained by carotid endarterectomy[4-7]. The detection of the extent and distribution of extracranial vascular disease has important diagnostic and therapeutic implications. In the present study, we describe the clinical profile and pattern of extracranial arterial involvement in 100 patients with CVI as assessed by CWDU.

Subjects and Methods

The subjects consisted of 100 consecutive patients with symptoms or signs of CVI, referred to the Hospital Universiti Sains Malaysia, during the period April 1986 to April 1988. These patients were assessed clinically as well as by bi-directional CWDU (Sonicaid-Vasoscan) system with facility for on-line real time spectral frequency analysis and colour-coded arterial flow mapping. The doppler probes used were:

1. 4 MHz probe for common, internal and external carotid, subclavian, vertebral and ophthalmic arteries;
2. 4 MHz probe linked to a 'writing arm' for colour-coded flow mappings; and
3. 8 MHz probe for superficial temporal, supratrochlear and origin of vertebral arteries.

The above arteries were insonated with sites of probe placement as described by Spencer and Reid and a flow map of common, internal and external carotid arteries was done[8]. The scan time was 3 cm/sec and frequency band pass was 1-10,000 KHz. The doppler spectra in each of the above arteries were analysed by an on-line frequency analyser and the results were recorded. The subclavian steal routine was done in cases where the clinical features or doppler spectrum of the vertebral artery indicated steal[8]. In all cases, compression tests of ipsilateral superficial temporal and facial arteries were done while imaging the supratrochlear artery. Reduction or reversal of flow (positive compression test) in the supratrochlear artery during this maneuver indicated collateral flow from external carotid to internal carotid artery through branches around the orbit.

The criteria for abnormality (as described by Hames and Humphries[5]) were as follows:

1. Total occlusion — failure to image the artery in its expected anatomical site.
2. Proximal obstruction — damped, low velocity doppler spectra.
3. Calcification (non-stenotic plaque) — asonic gaps or sudden reversal in the direction of doppler spectrum.
4. Haemodynamically significant stenosis (for internal carotid arteries using 4 MHz probe angled at 60°).
5. >50% stenosis — peak systolic frequency shift >3.8 KHz, yellow or white colour on the flow map (Fig 1).
6. >75% stenosis — the above changes plus positive compression test over the ipsilateral supratrochlear artery.

Results

The age distribution of the patients ranged from 20 to 80 years (mean 53.8). There were 65 males and 35 females, with 79 Malays, 16 Chinese and 5 Indians. Of the 100 patients, 56 had completed stroke (CS), 40 had transient ischaemic attacks (TIA) and 4 had asymptomatic bruits (AB). Based on characteristic constellations of symptoms and signs, 68 patients were diagnosed to have CVI in the carotid territory and 32 in the vertebro-basilar territory. Predisposing factors for CVI in these patients are shown in Table I.

The types of vascular abnormalities detected and their distribution in the extracranial arteries are shown in Table II. The comparison of clinical prediction of the vascular territory of CVI to CWDU findings is shown in Table III. The clinical prediction and doppler abnormalities were closely matched for carotid and vertebro-basilar territories.

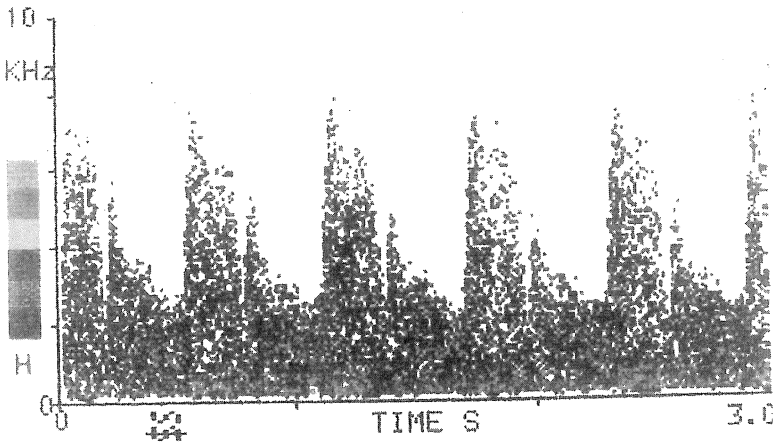

Fig 1: Doppler spectrum in a patient with significant cartoid artery stenosis. The peak systolic frequency shift is 8.8 Khz

In a large proportion (48%) of the patients, the CWDU could detect multiple vascular involvement that was not evident on clinical examination. The types of vascular abnormalities detected by CWDU in the different subgroups of patients with CVI are shown in Table IV.

Discussion

The clinical profile of CVI in the present series shows male preponderance in contrast to other epidemiological studies which have shown similar frequency of occurrence in both sexes[9]. The increased occurrence in ethnic Malays probably reflects the population ratio in the state of Kelantan, where the racial distribution is 90% Malays, 7% Chinese and 3% Indians. Epidemiological data on the patterns of CVI indicate that TIA as a presenting feature is more common than CS[10]. In the present series, CS was a more common mode of presentation than TIA. CVI in the carotid territory was about twice as common as in the vetebro-basilar territory. As in previous studies, hypertension was the commonest predisposing factor for CVI (Table I).

Analysis of the distribution of vascular abnormalities revealed that the common carotid arteries were chiefly affected by proximal obstructive disease, while the internal carotid arteries were chiefly affected by stenotic lesions (Fig 1). The vertebral arteries had similar degrees of occlusive and proximal obstructive lesions (Table II). The commonest vascular

Table I
Predisposing factors in 100 patients with cerebrovascular insufficiency

No.	Predisposing factors	No of Patients
1.	Hypertension	60
2.	Smoking	39
3.	Obesity	19
4.	Ischaemic heart disease	13
5.	Diabetes mellitus	12
6.	Hyperlipidemia	5
7.	Cervical spondylosis	4
8.	Gout	2
9.	Takayasu's disease	3
10.	No predisposing factor	8
11.	Multiple (>1) predisposing factors	50

Table II
Distribution of vascular abnormalities in extracranial cerebral arteries

	No of arteries with abnormality			
Artery	Stenosis	Occlusion	Proximal obstruction	Calcification
Common carotid	0	2	28	3
Internal carotid	17	7	3	4
External carotid	3	1	1	0
Subclavian	0	1	5	0
Vertebral	0	16	18	0

Table III
Vascular territory affected

Territory	Clinical prediction	Doppler abnormalities detected
Carotid	68%	62%
Vertebro-basilar	32%	35%
Multiple vessels	14%	48%

Table IV
Vascular abnormalities detected by doppler

	No of patients		
Abnormality	TIA	CS	AB
Occlusions	4	14	0
Stenosis	10	6	1
Proximal obstruction	13	18	2
Calcification	1	3	1

TIA=Transient ischaemic attack; CS=Completed stroke; AB=Asymptomatic bruit

lesion affecting the extracranial vessels was proximal obstruction, resulting in damped low velocity arterial flow. About one-third of all patients had this pattern of proximal obstruction (Table IV), indicating probable stenosis of the large extracranial arteries close to their origin from the arch of aorta.

Thus, it could be said that these patients had a subclinical form of the aortic arch syndrome. Innominate, common carotid artery and subclavian artery stenotic and occlusive lesions have been mentioned in other studies, though not as a predominant abnormality[11,12]. In our geographical setting, proximal arterial obstructive disease seems quite common and recognition of this fact has important implications for vascular surgery.

Vascular occlusions were more common in patients with completed stroke, while haemodynamically significant stenosis was more common in patients with TIA (Table IV). Vascular abnormalities were detected in 28 of 40 patients with TIA, 41 of 56 patients with CS and all patients with AB. Overall, in 73% of the patients, extracranial vascular disease could be detected by CWDU (Table IV). The ability of CWDU to pick up clinically undetected multiple vessel disease in 48% of the patients is noteworthy (Table III). This would have a significant influence on management decisions and underscores the importance of a complete doppler evaluation in all patients with CVI.

References

1. Jackson VP, Bendick PJ, Becker GJ. Duplex carotid ultrasound. Indiana Med J 1984;77 : 22-4.
2. Johnston KW, De Morais D, Kassam M, Brown PM. Cerebrovascular assessment using a doppler carotid scanner and real time frequency analysis. J Clin Ultrasound 1981;9 : 443-9.
3. Yao JST, Flinn WR, Bergan JJ. Noninvasive vascular diagnostic testing. Techniques and clinical applications. Prog Cardiovasc Dis 1984;26 : 459-94.
4. Call GK, Abbot WM, MacDonald NR, Magerman J, Davis K, Heros RC, Kistler JP. Correlation of continuous wave doppler spectral flow analysis with gross pathology in carotid stenosis. Stroke 1988;5 : 584-8.
5. Hames TK, Humphries KN. Techniques employed in a non invasive doppler ultrasound vascular laboratory in the examination of the extra cranial arteries. Ultrasound 82, 3rd meeting of the world federation of ultrasound in medicine and biology, 74.
6. Spencer MP, Reid JM. Quantitation of carotid stenosis with continuous wave doppler ultrasound. Stroke 1979;10 : 326-30.
7. Zweibel WJ, Zagzebiski JA, Crummy AB *et al.* Correlation of peak doppler frequency with lumen narrowing in carotid stenosis. Stroke 1982;3 : 386-91.
8. Spencer MP. Technique of doppler examination. In: Cerebrovascular evaluation by doppler ultrasound. Spencer MP, Reid JM (eds). The Hague, Boston, London: Martinus Nijhoff Publishers 1981;69-87.
9. Kanel WB, Wolf PA. Epidemiology of cerebrovascular disease. In: Vascular disease of the central nervous system. Ross Russel RW (ed). 2nd edition, Edinburgh: Churchill Livingstone 1983;1-24.
10. Toole JF. Cerebrovascular disorders. New York: Raven Press 1984;60-1.
11. Spencer MP, Thomas GJ. Obstructive lesions diagnosed by doppler ultrasound. In: Cerebrovascular evaluation by doppler ultrasound. Spencer MP, Reid JM (eds). The Hague, Boston, London: Martinus Nijhoff Publishers 1981;170-91.
12. Moossy J. Morphology, sites and epidemiology of cerebral atherosclerosis. In: Cerebrovascular disease. Millikan (ed). Baltimore: Williams and Wilkins 1966;1-22.