Can carotid ultrasound predict the presence of complex atheromatosis of the aortic arch?

Poderá uma ecografia carotídea prever a existência de ateromatose complexa do arco aórtico?

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Abstract

Background: The diagnosis of complex atheromatosis of the aortic arch, a potential source of cerebral emboli, is made by transoesophageal echocardiography (TEE). Although a correlation has been found between carotid and aortic atherosclerosis, it is not known how reliably the results of the carotid ultrasound evaluation can predict the presence of atheromatosis of the aortic arch.

Methods: We prospectively studied all patients referred to our laboratory simultaneously for TEE and carotid ultrasound, with the diagnosis of acute ischemic CVA. We evaluated the capacity of an increased carotid intimal-media thickness (IMT) or the presence of carotid high-risk atherosclerotic plaques to predict the presence of complex atheromatosis of the aortic arc.

Results: A total of 101 ischemic stroke patients were sent to our laboratory for TEE and carotid ultrasound. Considering the presence of complex atheromatosis of the aortic arch as the dependent variable, increased carotid IMT had a sensitivity of 42% and a specificity of 78% (positive predictive value 41%, negative predictive value 80%), and carotid high-risk plaques had a sensitivity of 22% and a specificity of 95% (positive predictive value 60%, negative predictive value 77%).

Conclusions: In this study, a carotid ultrasound scan with an abnormal IMT or high-risk plaques had a high specificity for the presence of complex atheromatosis of the aortic arch, with a low sensitivity.

Key words: acute ischemic stroke, transoesophageal echocardiography, carotid ultrasound, complex atheromatosis of the aortic arch, high-risk carotid plaques.

Resumo

Introdução: O diagnóstico de ateromatose complexa do arco aórtico, uma fonte potencial de embolismo cerebral, é feito por ecocardiografia transesofágica (ETE). Embora se tenha demonstrado uma correlação entre aterosclerose carotídea e aórtica, não é conhecido com que fiabilidade poderão os resultados da avaliação ecográfica carotídea predizer a existência ou não de ateromatose complexa do arco aórtico.

Métodos: Estudámos prospectivamente todos os doentes referenciados ao nosso laboratório simultaneamente para ETE e para ecografia carotídea, com o diagnóstico de acidente vascular cerebral (AVC) isquémico agudo. Avaliámos a capacidade de um aumento do índice íntima-média (IIM) ou a presença de ateromatose carotídea de alto risco predizerem a presença de ateromatose complexa do arco aórtico.

Resultados: Um total de 101 doentes com AVC isquémico agudo foram referenciados ao nosso laboratório para ETE e ecografia carotídea. Considerando a presença de ateromatose complexa do arco aórtico como a variável dependente, um aumento do IIM teve uma sensibilidade de 42% e uma especificidade de 78% (valor preditivo positivo 41%, valor preditivo negativo 80%), e a ateromatose carotídea de alto risco teve uma sensibilidade de 22% e uma especificidade de 95% (valor preditivo positivo 60%, valor preditivo negativo 77%).

Conclusões: No nosso estudo, uma ecografia carotídea com aumento do IIM ou ateromatose carotídea de alto risco teve uma elevada especificidade para a presença de ateromatose complexa do arco aórtico, com uma baixa sensibilidade.

Palavras chave: acidente vascular cerebral isquémico agudo; ecocardiografia transesofágica; ecografia carotídea; ateromatose complexa do arco aórtico; ateromatose carotídea de alto risco.

INTRODUCTION

The presence of complex aortic atheroma in ischemic stroke patients is considered a probable source of cerebral emboli, with therapy implications, as anticoagulation is usually used for secondary prophylaxis in these patients.[1,2] The diagnosis of complex aortic atheroma is made by transesophageal echocardiography (TEE), a semi-invasive procedure that, besides being time-consuming, expensive and associated with some

TABLE I

Baseline characteristics and risk factors of the study patients

Characteristic/Risk factor	Study patients (n=101)
Age, years (mean ± SD)	59 ± 14
Male sex	58 (57%)
Hypertension	65 (64%)
Present smoking	23 (23%)
Hypercholesterolemia	30 (30%)
Diabetes mellitus	23 (23%)

discomfort, had a 0.24% risk of serious complications and a mortality rate of 0.0098% in one study.[3]

Correlation between carotid (evaluated by carotid triplex scan) and aortic (evaluated by TEE) atherosclerosis has been found,[4,5] suggesting that cervical triplex scan (a non-invasive procedure) might avoid the performance of TEE (a semi-invasive procedure) for the evaluation of aortic atheroma, in some patients.[5]

The aim of our study was to determine if carotid triplex scan findings can predict the presence of aortic complex atheroma in ischemic stroke patients.

METHODS

This was a prospective observational study, from April 13, 2004 to October 11, 2005.

The study was approved by our hospital ethics committee. Informed consent was obtained from all patients.

PATIENTS

All patients referred to our laboratory simultaneously for TEE and carotid triplex scan were enrolled in the study. Patients were excluded if the diagnosis was not acute ischemic stroke.

The diagnosis of stroke was made by the referring physicians, based on clinical data and brain CT.

ECHOGRAPHY

All the echographic studies were performed by the authors, on a Vivid 3 System, General Electric.

The person performing and reporting the TEE was blinded to the duplex and transcranial ultrasound results.

DUPLEX AND TRANSCRANIAL ULTRASOUND

Carotid intimal-media thickness (IMT) was measured 1 cm distal to the carotid bulb, on the carotid far wall, according to the method of Pignoli et al.[6] Carotid atherosclerotic plaques were considered high-risk if they were considered types 1 or 2, using the classification of Gray-Weale[7] and Geroulakos.[8]

Transesophageal echocardiography was performed using a multiplane 3.5 to 6.5-MHz probe, according to standard protocols.[9] After a complete standard TEE examination, the aortic root, initial ascending aorta and the distal aortic arch were examined for atheroma. Atheroma that were mobile, pedunculated, or protruding ≥ 5 mm into the lumen were classified as complex atheroma.[10,11] All other sessile atheroma <5 mm in thickness were classified as simple atheroma.

STATISTICAL ANALYSIS

The program Statistical Package for the Social Sciences version 12.0 for Windows was used as a data base. The chi-square test (Fisher test, when necessary) was used for comparison of categorical variables (complex aortic atheroma versus abnormal carotid intimal-media thickness or high-risk carotid atherosclerotic plaques).

RESULTS

During the study period, 101 patients with acute ischemic stroke were sent to our laboratory for both TEE and carotid triplex scan.

The baseline characteristics and risk factors of the study patients are shown in *Table 1*.

We considered the presence of aortic complex atheroma (detected by TEE) as the dependent variable. Increased carotid IMT had a sensitivity of 42% and a specificity of 78%, with a corresponding positive predictive value of 41% and a negative predictive value of 80% (*Table 2*). Carotid high-risk plaques had a sensitivity of 22% and a specificity of 95%, with a corresponding positive predictive value of 60% and a negative predictive value of 77% (*Table 3*). The correlation between the presence of carotid high-risk plaques and the presence of aortic complex atheroma had weak statistical significance (*p*=0.021).

DISCUSSION

Our study showed that carotid triplex scan findings (IMT and plaque type) can predict the presence of aortic complex atheroma, with a low sensitivity

TABLE II

increased carotid intima-media thickness as a test for the presence of aortic complex atheroma detected by transesophageal echocardiography

Increased carotid IMT	Aortic complex atheroma	
	Present	Absent
Test positive	11	16
Test negative	15	58
		p=0.07
Sensitivity 0.42	Specificity 0.78	
Positive predictive value 0.41	Negative predictive value 0.8	

TABLE III

Presence of carotid high risk atherosclerotic plaques as a test for the presence of aortic complex atheroma detected by transesophageal echocardiography

Carotid high risk plaques	Aortic complex atheroma	
	Present	Absent
Present	6	4
Absent	21	70
		p=0.021
Sensitivity 0.22	Specificity 0.95	
Positive predictive value 0.6	Negative predictive value 0.77	

(42% for IMT and 22% for plaque type) and a high specificity (80% for IMT and 95% for plaque type).

Other studies have found a significant association between carotid and aortic ultrasound findings,[4,5] with higher significance of the negative predictive value of a normal carotid IMT. Our present study not only confirms the higher negative than positive predictive value of carotid IMT, but also found a high specificity (95%) and negative predictive value (77%) of high risk carotid plaques, a finding not previously described.

Our study patients were a selected group who were referred for TEE by the attending physician. We have determined that only approximately 20% of all acute ischemic stroke patients admitted to our hospital are referred for simultaneous TEE and carotid triplex scan (unpublished data). Although these selected patients might have had clinical, neuro-imaging or transthoracic echocardiographic clues for an embolic stroke, we do not know if carotid-aortic atheroma correlation would differ in these patients, when compared to other ischemic stroke patients.

In ischemic stroke patients, the selection of imaging studies that should be performed to guide secondary prophylaxis is an important issue, far from settled. Carotid triplex scan is considered an emergent diagnostic test by the European Stroke Initiative 2003 guidelines,[12] but not by the American Stroke Association 2003 guidelines.[13] We have previously reviewed the controversy regarding the performance of transthoracic echocardiography in ischemic stroke patients.[14] Likewise, the selection of patients for transesophageal echocardiography is also unsettled. While some studies conclude that TEE should be mandatory on all ischemic stroke patients, based on its cost-effectiveness[15] or sensitivity for findings that change clinical management (coumadin instead of aspirin),[16] others find that TEE abnormalities are found mostly on patients already with clinical, electrocardiographic or transthoracic echocardiography (TTE) data that would justify anticoagulation, and are rare on patients in sinus rhythm and with a normal TTE.[17,18,19] As a consequence, the usefulness of TEE findings for the clinical management of ischemic stroke patients has been challenged, but not defined, with some authors defending TEE only on patients with abnormal TTE,[19] with a normal TTE,[20] on an individual patient basis,[18] or questioning its usefulness on the management of any ischemic stroke patient.[21]

The capacity of cervical and transcranial triplex scan to diagnose disorders that used to be mainly diagnosed by TEE, as a patent foramen ovale,[22] and, in this study, complex aortic atheroma, are new data to be incorporated in decision making algorithms. Nevertheless, the fact that TEE can evaluate other sources of cardioembolism has been used to argue against the use of cervical and transcranial triplex scan as a substitute of TEE in the evaluation of acute stroke patients.[23]

In conclusion, in our study, carotid triplex scan with an abnormal IMT or high risk plaques had a high specificity for the presence of aortic complex atheroma, with a low sensitivity. These findings should be reproduced in other studies and, if confirmed, incorporated in algorithms concerning the selection of imaging studies to be performed on ischemic stroke patients. ■

References

1. Amarenco P, Cohen A, Tzourio C et al. Atherosclerotic disease of the aortic arch and the risk of ischemic stroke. N Engl J Med 1994; 331: 1474-9.

2. Jones EF, Kalman JM, Calafiore P, Tonkin AM, Donnan GA. Proximal aortic atheroma: an independent risk factor for cerebral ischemia. Stroke 1995; 26: 218-224.

3. Daniel WG, Erbel R, Kasper W et al. Safety of transesophageal echocardiography: a multicenter survey of 10,419 examinations. Circulation 1991; 83: 817-821.

4. Pearson A, Peterson JW, Orsinelli DA et al. Comparison of thickness and distensibility in the carotid artery and descending thoracic aorta: in vivo ultrasound assessment. Am Heart J 1996; 131: 655-662.

5. Harloff A, Handke M, Geibel A et al. Do stroke patients with normal carotid arteries require TEE for exclusion of relevant aortic plaques? J Neurol Neurosurg Psychiatry 2005; 76 (12). 1654-1658.

6. Pignoli P, Tremoli E, Poli A, Oreste P, Paoletti R. Intimal plus medial thickness of the arterial wall: a direct measurement with ultrasound imaging. Circulation 1986; 74 (6): 1399-1406.

7. Gray-Weale AC, Graham JC, Burnett JR et al. Carotid artery atheroma: comparison of preoperative B-mode ultrasound appearance with carotid endarterectomy specimen pathology. J Cardiovasc Surg 1988;29:676–681.

8. Geroulakos G, Ramaswami G, Nicolaides A et al. Characterization of symptomatic and asymptomatic carotid plaques using high-resolution real-time ultrasonography. Br J Sur. 1993;80:1274–1277.

9. Seward JB, Khandheria BK, Oh JK, Abel MD, Hughes RW, Edwards MD, Nichols BA, Freeman WK, Tajik AJ. Transesophageal echocardiography: technique, anatomic correlations, implementation and clinical applications. Mayo Clin Proc 1988; 63: 649-680.

10. Katz ES, Tunick PA, Rusinek H, Ribakove G, Spencer FC, Kronzon I. Protruding aortic atheromas predict stroke in elderly patients indergoing cardiopulmonary bypass: experience with intraoperative transesophageal echocardiography. J Am Coll Cardiol 1992; 20: 70-77.

11. Karalis DG, Chandrasekaran K, Victor MF, Ross JJ Jr, Mintz GS. Recognition and embolic potential of intraaortic atherosclerotic debris. J Am Coll Cardiol 1985; 17: 73-78.

12. Hack W, Kaste M, Bogousslavski J, Brainin M, Chamorro A, Lees K, Leys D, Kwiecinski H, Toni P, Langhorne P, Diener C, Hennerici M, Ferro J, Sivenius J, Gunnar N, Bath P, Olsen TS, Gugging M; European Stroke Initiative Executive Comittee and the EUSI Writing Comittee. European Stroke Initiative Recommendations for Stroke Management: update 2003. Cerebrovasc Dis 2003; 16: 311-337.

13. Adams HP Jr, Adams RJ, Brott T, del Zoppo GJ, Furlan A, Goldstein LB, Grubb RL, Higashida R, Kidwell C, Kwiatkowski TG, Marler JR, Hademenos GJ; Stroke Council of the American Stroke Association. Guidelines for the early management of patients with ischemic stroke: a scientific statement from the Stroke Council of the American Stroke Association. Stroke 2003; 34: 1056-1083.

14. Tribolet de Abreu T, Mateus S, Correia J. Therapy implications of transthoracic echocardiography in acute ischemic stroke patients. Stroke 2005; 36: 1565-1566.

15. McNamara RL, Lima JAC, Whelton PK, Powe NR. Echocardiographic identification of cardiovascular sources of emboli to guide clinical management of stroke: a cost-effectiveness analysis. Ann Intern Med 1997; 127: 775-787.

16. Blum A, Reisner S, Farbstein Y. Transesophageal echocardiography vs. transthoracic echocardiography in assessing cardio-vascular sources of emboli in patients with acute ischemic stroke. Med Sci Monit 2004; 10: CR521-523.

17. Agmom Y, Khandheria BJ, Gentile F, Seward JB. Clinical and echocardiographic characteristics of patients with left atrial thrombus and sinus rhythm. Circulation 2002; 105: 27-31.

18. Cabral S, Oliveira F, Pereira S, Caiado L, Oliveira A, Torres S, Gomes L. Transesophageal echocardiography in the assessment of patients presenting with ischemic cerebral events without previous evidence of a cardiac source of emboli. Rev Port Cardiol 2001; 20: 247-258.

19. Leung DY, Black IW, Cranney GB, Walsh WF, Grimm RA, Stewart WJ, Thomas JD. Selection of patients for transesophageal echocardiography after stroke and systemic embolic events: role of transthoracic echocardiography. Stroke 1995; 26: 1820-1824.

20. Nighoghossian N, Perinetti M, Barthelet M, Adeleine P, Trouillas P. Transesophageal echocardiography in patients less than 60 years of age without obvious cardiac souce of embolism. Neurol Res 1995; 17: 368-372.

21. Warner MF, Momah KI. Routine transesophageal echocardiography for cerebral ischemia. Is it really necessary? Archives of Internal Medicine 1996; 156: 1719-1723.

22. Kizer JR, Devereux RB. Patent foramen ovale in young adults with unexplained stroke. N Engl J Med 2005; 353: 2361-2372.

23. Albin MS, Wills J, Schwend RM, Mazzucco S, Anzola GP, Kizer JR, Devereux RB. Patent foramen ovale and unexplained stroke. N Engl J Med 2006; 354: 1753-1755. Correspondence.