Clinical Investigative Studies

Arch Aortogram Fails to Identify Aortic Atherosclerotic Lesions Detected on Transesophageal Echocardiogram

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ABSTRACT

Background and Purpose. Transesophageal echocardiogram is used to evaluate the aortic arch during diagnostic evaluations of ischemic stroke events. Conventional angiography is increasingly used in diagnosing and treating atherosclerotic vascular lesions in patients with ischemic stroke. Although catheter-based aortography can be performed with cerebral angiography, there is limited information about the utility of aortography in identifying atherosclerotic abnormalities of the aortic arch. *Methods*. A retrospective chart review was performed to identify patients who underwent aortography as part of their angiographic study and transesophageal echocardiogram. Both studies were reviewed independently in the absence of knowledge of the results of the other study. The findings of these aortograms were correlated with the findings of transesophageal echocardiogram. *Results*. A total of 34 patients underwent both aortography and echocardiography. Of a total of 34 transesophageal echocardiograms, 29 showed abnormal findings in the aorta (85%) and 5 appeared normal (15%). These aortic abnormalities included mild to moderate atherosclerosis in 18 cases (52%), moderate to severe atherosclerosis in 4 cases (12%), and severe atherosclerosis in 7 cases (21%). None of these abnormalities were detected by aortography. No disease was visualized in the origin of the supraaortic arteries. *Conclusions*. Aortic arch atherosclerosis is common in patients with ischemic stroke; however, aortograms performed during conventional angiography fail to identify abnormalities detected on transesophageal echocardiogram.

Key words: Arch aortogram, angiogram, transesophageal echocardiogram, comparison.

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Atherosclerotic disease of the ascending aorta and aortic arch has been shown to be an independent risk factor for ischemic stroke.[1-5] The size and morphology of the plaque, the presence or absence of ulceration, and presence or absence of mobile components of the plaque determine the risk of cerebral ischemia. Transesophageal echocardiography (TEE) is commonly used to evaluate

aortic atherosclerotic disease. TEE is shown to be superior to transthoracic echocardiography in exploring atherosclerotic lesions in the thoracic aorta.[6] Cerebral angiography is frequently performed in the diagnostic workup of ischemic strokes. Evaluation of extracranial vasculature including the great vessel origins and the aortic arch itself may also be done during angiography. There have been no studies to compare arch aortograms and TEE in the setting of ischemic strokes. We compared the findings of aortograms with the findings of transesophageal echocardiograms to determine the utility of the aortogram.

Methods

Data Collection

Over a period of 8 months, all cerebral angiograms performed during evaluation of ischemic strokes were reviewed. A cerebral angiogram was performed through the transfemoral approach followed by aortography in consecutive patients with ischemic stroke as part of the procedure. TEE and aortograms were performed on the same day in 8 patients (24%), within 7 days of each other in 18 patients (52%), and at the interval of more than 7 days in 8 patients (24%).

Angiography

A 5 French pigtail catheter was advanced over a 0.035-in Terumo glide wire to the descending aortic arch where the wire was withdrawn, allowing the catheter to assume its normal pigtail configuration. Here, the catheter was connected to contrast via a power injector and advanced across the ascending aortic arch. Contrast was injected through the pigtail catheter in the ascending arch using a power injector at the rate of 30 to 60 cc over 15 seconds. Images were acquired using digital subtraction angiography at 25° left antero-oblique projections.

Echocardiography

TEE was performed after local oropharyngeal anesthesia with aerosolized cetacaine in all patients and in conjunction with intravenous injection of midazolam in those who agreed to conscious sedation. Images were obtained using a multiplane TEE probe with a variable resolution of up to 7 MHz, connected to an Acuson Sequoia imaging system. The descending thoracic aorta was defined as extending from the origin of the left subclavian artery to the diaphragm. Distal aortic arch was defined as the portion of the transverse arch visualized proximal to the origin of the left subclavian artery. Atheroma thickness was graded as mild (<1.0 mm), moderate (1.0-3.9 mm), and severe (≥4.0 mm) as previously described by Amarenco et al.[2] In addition, the presence or absence of ulceration and mobile components was noted.

Analysis

Clinical features, radiographic findings, and echocardiographic data were analyzed. The findings of TEE and aortogram were compared in these patients. All TEE studies were performed and interpreted by 1 of the 2 cardiologists specialized in echocardiography who were blinded for all the other study data. The aortographic images were interpreted by an endovascular neurologist. The interpretation of these images was performed by different physicians in the absence of knowledge of the results derived from the other test. Descriptive statistics were used to express the proportion of patients with aortic atherosclerotic lesions and its severity. Continuous and categorical variables were expressed as percentages and means (with range).

Results

A total of 199 angiograms were reviewed, of which 55 included aortograms. Of these 55 patients, a total of 34 patients also underwent a TEE. Fifteen of the 34 patients were men, with a mean age of 69 years (range, 57-88 years); 19 were women, with a mean age of 61 years (range, 21-91 years). Of a total of 34 TEEs, 29 demonstrated abnormal findings in the aorta (85%) and 5 demonstrated normal aorta (15%). The aortic abnormalities included mild to moderate atherosclerosis in 18 cases (52% of total TEEs), moderate to severe atherosclerosis in 4 cases (12% of total), and severe atherosclerosis in 7 cases (21% of total; Figure 1). None of these abnormalities were detected on aortogram. Other abnormalities detected on TEE included patent foramen ovale in 10 patients, mural thrombus in 1 patient, and a mobile thrombus attached to plaque in 1 patient. Ulceration of plaque was seen in 1 patient. A complex atherosclerotic plaque with a protruding thrombus seen on TEE is shown in Figures 2A and 2B. Arch aortogram on the same patient is shown in Figure 2C, which did not show any of the abnormalities seen in Figures 2A and 2B. An ulcerated atherosclerotic plaque in another patient is seen in Figures 3A and 3B. A corresponding arch aortogram as seen in Figure 3C fails to demonstrate the ulcerated plaque. No additional atherosclerotic lesions were detected in the origin of the supraaortic arteries.

DISCUSSION

Cerebrovascular diseases are a major global health problem. Approximately 700 000 new strokes occur per year

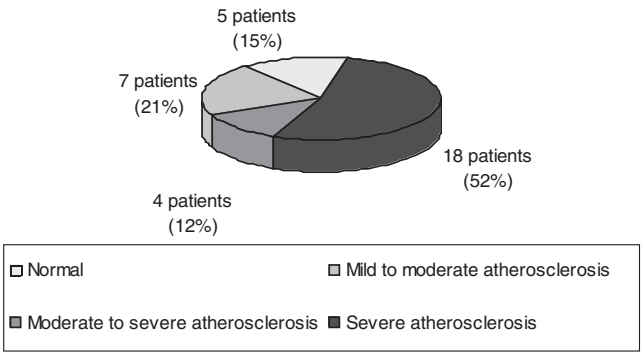

Fig 1. A pie plot representing the distribution of findings detected by transesophageal echocardiogram (TEE) and not detected by catheter-based aortography.

in the United States. Over the past few years, developments in endovascular treatments for cerebrovascular diseases have expanded the horizon of treatment by the use of minimally invasive techniques.[7] This has resulted in a larger number of patients undergoing cerebral angiogram as a part of their diagnostic workup for stroke. Several studies in the past have identified the importance of proximal aortic atherosclerotic disease as a risk factor for ischemic stroke.[1-6,8-9] Several mechanisms have been suggested in the pathogenesis, including aortic plaque acting as a source of embolism, plaque obstructing the origin of carotid or vertebral artery causing hemodynamic cerebral ischemia, and aortic plaque as a marker for generalized atherosclerosis including the extracranial and intracranial cerebral vasculature.[10]

TEE is widely used as a method of evaluating atheromatous disease in the proximal aorta and aortic arch. Very limited data are available on the direct comparison of TEE findings and the findings of aortogram performed during conventional angiography. Marschall et al[11] compared the intraoperative TEE, the calcified aortic knobs seen on chest x-ray, and aortic lumen seen during cardiac catheterization in patients undergoing cardiac surgery. Kirmani et al[12] compared aortogram and TEE in 21 patients. They found abnormalities on TEE in 18 patients (86%), whereas aortogram was abnormal in only 2 cases (10%). We found abnormal TEE findings in 85% of the patients, whereas no aortogram was abnormal. Despite the small number of patients, this study suggests the superiority of TEE over aortogram in detecting the abnormalities in aortic arch. Fairly large and complex lesions can be missed on aortogram, as seen in Figures 2 and 3.

Failure of angiography to identify atherosclerotic disease of the aortic arch found on echocardiography is likely due in part to the 1-dimensional image acquisition in contrast to 3-dimensional data obtained from TEE.

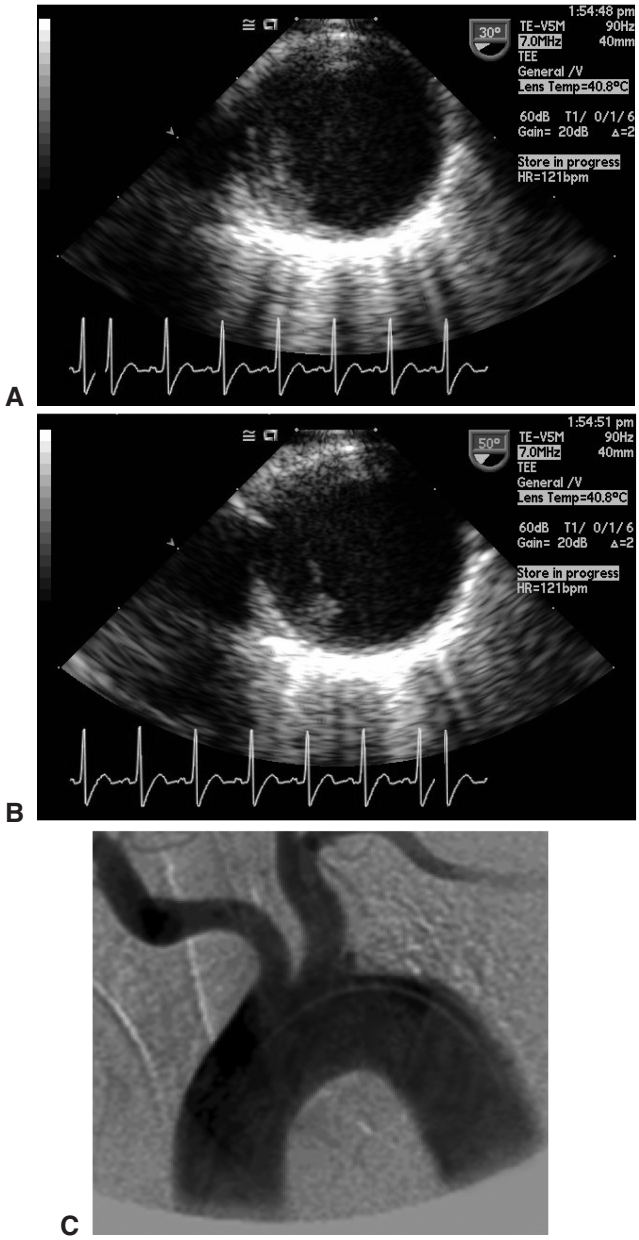

Fig 2. (A) Transesophageal echocardiogram (TEE) showing complex atherosclerotic plaque in the aortic arch. (B) TEE showing mobile thrombus at the edge of the plaque. (C) Arch aortographic image on the same patient showing no significant aortic arch lesions.

Biplane and rotational imaging of the aortic arch is technically difficult due to the image artifact of shoulder structures overlying the thoracic structures in the lateral plane. In addition, rapid washout of contrast through the great diameter of the aortic arch does not allow for study of hemodynamic aberrations that might also indicate the presence of underlying plaques and atheroma.

Reduction in plasma low-density lipoprotein due to treatment with HMG-CoA reductase inhibitors in

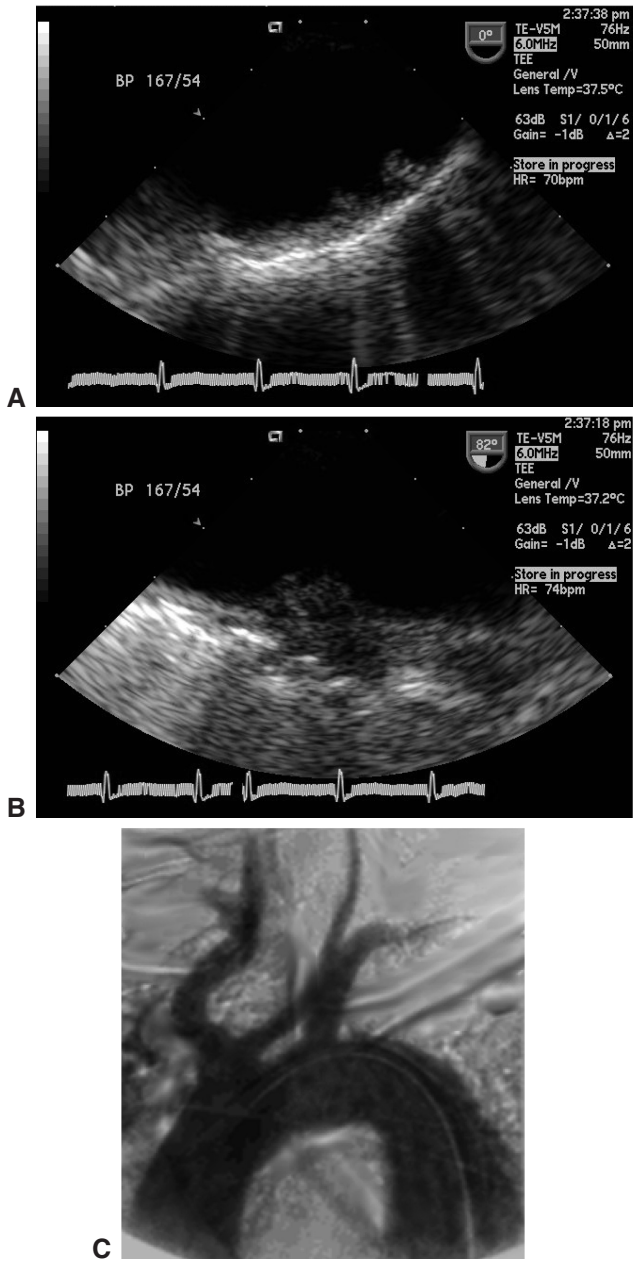

Fig 3. (A) Transesophageal echocardiogram (TEE) showing complex ulcerated plaque in the aortic arch. (B) Another view of the complex ulcerated plaque. (C) Arch aortographic image on the same patient in Figures 3a and 3b does not demonstrate any significant lesion.

patients with aortic atherosclerosis has been shown to result in regression in the size of aortic atheromas.[4] Similarly, the use of anticoagulant therapy has resulted in disappearance of mobile lesions.[4] However, the effectiveness and safety of anticoagulation for the treatment of aortic atheromas has not been proven in randomized clinical trials. Treatment with a lipid-lowering agent or anticoagulation therapy may be a cause of discordance between the results of TEE and aortogram. In our series, 76% of patients had both studies done within 7 days of each other, of which 24% had the 2 studies performed on the same day. Hence, the inability of aortogram to reveal the abnormalities seen on TEE cannot be caused by any treatment effect in our series.

In a prospective study,[13] thoracic aortic atheromas were seen in 59% patients who underwent TEE after suffering stroke or transient ischemic attack. This study found that one third of the plaques were severe and complex in nature and were more frequently present in the descending aorta and the arch of aorta than in the ascending aorta. The size, severity, and morphology of the atherosclerotic plaque are the determinants of relative risk. Plaque size of ≥4 mm[2-4,8] and ulceration of the plaque[14] have been associated with cryptogenic stroke. Di Tullio et al[15] looked at the plaque morphology. They classified the atheromas as small (<4 mm in thickness), large noncomplex (≥4 mm, no ulceration or mobility), and complex (ulcerated or mobile). They concluded that the aortic atheroma complexity rather than size was strongly associated with ischemic stroke in elderly patients. Another study by Cohen et al[16] found that the risk associated with aortic plaque thickness (≥4 mm) is markedly increased by the absence of plaque calcifications. One study looked at the distensibility of aorta and found that the aortic stiffness seen on TEE is associated with ischemic stroke, independent of thickness of aortic arch plaques and other stroke risk factors.[17]

In a review of the imaging modalities for thoracic aortic disease, Urban et al[18] discussed the use of epiaortic ultrasound, TEE, and unenhanced spiral computerized tomography (CT) in detection of protruding aortic atheromas in patients with stroke. Spiral CT and epiaortic ultrasound can evaluate certain portions of the ascending aorta and proximal arch that are blind to TEE. In an extensive review of the techniques, they concluded that CT, magnetic resonance (MR) imaging, and TEE have essentially replaced conventional aortography for imaging the thoracic aorta. In another review, Tatli et al[19] discussed the use of CT and MR angiography in the setting of aortic trauma or dissection and recommended those as first-line diagnostic methods. Our study also shows the inability of conventional aortogram in identifying the lesions that can have serious consequences in patients with ischemic stroke.

We conclude that aortic atherosclerotic disease is common in patients with ischemic stroke, as has previously been shown in the literature.[1,9] TEE can identify the atherosclerotic disease of the ascending aorta and aortic arch and helps in determining the risk of ischemic stroke by characterizing the size, location, and morphology of the plaque. Catheter-based aortography fails to identify the lesions that are detected by TEE in patients with

ischemic stroke. We were also unable to find any significant disease of the origin of the supraaortic arteries. Therefore, catheter-based aortography has a limited role in the evaluation of patients with ischemic stroke. Further studies are required to determine if new techniques such as 3-dimensional reconstructions may improve the diagnostic yield of catheter-based aortography in detecting aortic atherosclerotic lesions.

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