Endocarditis-Related Cerebral Aneurysms: Radiologic Changes with Treatment

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PURPOSE: To document the response of mycotic aneurysms to antibiotic therapy and correlate these findings with patient outcome. **METHODS:** Clinical findings, CT studies, and serial cerebral angiograms of patients with endocarditis related aneurysms seen over 10 years were retrospectively reviewed. **RESULTS:** In 14 patients infective endocarditis was diagnosed. The patients presented with subarachnoid haemorrhage (4 patients), stroke (9 patients), and seizure (1 patient). CT findings were intracerebral hematoma (5 patients), infarcts (4 patients), subarachnoid hemorrhage (4 patients), and aneurysms (2 patients). On angiography, 10 (71%) patients had single aneurysms, and 4 (29%) patients had multiple aneurysms. Eighteen aneurysms were detected, of which 6 (33%) were centrally located, and 12 (66%) were located peripherally. The most common site was the peripheral middle cerebral artery (56%). Serial angiography during antibiotic treatment demonstrated complete resolution of 6 aneurysms (33%), with 12 aneurysms remaining after 6 weeks of treatment. Of the latter, there was no change in size in 6 aneurysms (33%), a decrease in size in 3 aneurysms (17%) and an increase in size in 3 aneurysms (17%). No new aneurysms appeared. Surgery was performed on 10 patients with residual aneurysms, 11 aneurysms being excised or clipped. After 6 weeks' treatment, there was complete recovery in 7 (50%) patients, permanent neurologic deficits in 6 patients, and death from aneurysm rebleed in 1 patient. **CONCLUSION:** Follow-up angiography is recommended in all patients with mycotic aneurysms to assess response to antibiotic therapy, to detect new aneurysms, and to identify those aneurysms with no response or with enlargement.

Index terms: Aneurysm, mycotic; Heart; Cerebral angiography

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Neurologic complications of infective endocarditis are common, occurring in 20% to 40% of patients (1). Two thirds of complications result from cerebral emboli presenting as strokes (2). However, documented endocarditis-related aneurysms (mycotic aneurysms) are uncommonly reported in larger series, with an incidence varying from 1.2% to 5.4% (1). The true incidence is probably much higher, because some aneurysms remain totally asymptomatic, are undetected, and resolve on antibiotic therapy (3). In as many as 30% of patients with endocarditis, neurologic signs develop during antibiotic treatment (2).

The purpose of our study was to document the history of mycotic aneurysms on serial angiograms during antibiotic therapy and correlate these findings with the neurologic outcome.

Methods

We retrospectively studied all patients with documented infective endocarditis-related cerebral aneurysms detected by angiography in our department over a 10-year period (1983 to 1992). All these patients had angiography performed because of the presence of neurologic signs.

Patients were included only if the clinical criteria of infective endocarditis were established. The core requirement for diagnosis was the presence of valve vegetations on cardiac ultrasound in a patient with a history of valve disease or cardiac murmur on auscultation. Secondary criteria were a positive blood culture and pyrexia. All patients were treated with 6 weeks of intravenous antibiotics. Neurologic symptoms and signs of subarachnoid hemor-

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TABLE 1: Clinical background of patients

Patient	Age, y	Presenting Symptoms	Valve Lesion	Blood Culture
1	22	SAH	MS, MI	*Staphylococcus aureus*
2	39	Stroke	MI	*Streptococcus mutans*
3	27	Stroke	MI	*Streptococcus mitis*
4	22	Seizure	AVR	*S aureus*
5	12	Stroke	MI	*S mutans*
6	21	SAH	AI	Coagulase-negative staphylococci
7	45	Stroke	MI	. . .
8	20	Stroke	MI	. . .
9	21	Stroke	AVR, MVR	. . .
10	14	SAH	AI	. . .
11	53	Seizure	MVR	*S mitis*
12	25	Stroke	AI	*S aureus*
13	34	SAH	MI	*Streptococcus pyogenes*
14	19	Stroke	MI	*S pyogenes*

Note.—SAH indicates subarachnoid hemorrhage; MS, mitral stenosis; MI, mitral incompetence; AI, aortic incompetence; AVR, aortic valve prosthesis; and MVR, mitral valve replacement.

rhage, meningitis, stroke, or seizures were recorded on admission.

Computed tomography (CT) studies were performed on all patients within 24 hours of admission (Elscint 2400, Haifa, Israel and Siemens DRH, Erlangen, Germany). Contrast studies were performed if there was no intracerebral hematoma on the unenhanced scan. CT section thickness was 10 mm. Cut-film selective internal carotid angiography was performed on all patients within 1 week of presentation and repeated at 2 and 4 weeks. All patients had three studies performed over the 6-week treatment period. "Aneurysm search" projections were routinely included in all studies.

The original radiologic reports were retrospectively reviewed by one of us (P.C.). The original angiogram studies were reviewed by two neuroradiologists (L.C.H., M.W.) blinded to the patients clinical progress and outcome. Angiographic findings included aneurysm dimensions (measured in all three planes), location, number, and change in size on antibiotic therapy. Aneurysms were considered to be centrally located if involving segment 1 and peripheral if involving segments 2, 3, or 4 of the intracerebral arteries.

Results

Fourteen patients (6 male and 8 female; average age, 21 years; range, 10 to 45 years) were studied (Table 1). All patients had documented valve vegetations on cardiac ultrasound studies, although only 10 patients had positive blood cultures attributable to antibiotic therapy before admission. Thirteen patients had rheumatic valve disease, and one patient had an aortic valve prosthesis. There were no signs of rheumatic fever, such as chorea, in any patient. In 9 (64%) patients neurologic complications after endocarditis were the presenting complaints. Two patients had acute staphylococcal endocarditis. Patients had the following neurologic signs: subarachnoid hemorrhage (5 patients), stroke (8 patients), and focal seizures (1 patient).

Unenhanced CT findings on admission included intracerebral hematomas (5 patients), subarachnoid hemorrhage (4 patients), and cerebral infarcts (4 patients). Contrast enhanced CT scans performed on the 9 patients without intracerebral hematomas showed peripheral aneurysms in 2 (22%) patients.

Eighteen aneurysms were detected in 14 patients (Table 2). Ten (71%) patients had single aneurysms, whereas multiple aneurysms were present in the other 4 patients. Twelve (66%) aneurysms were peripheral and 6 (33%) aneurysms were central in location. In patient 3, the aneurysm was at the origin of the posterior communicating artery and was indistinguishable from a berry aneurysm. Patient 10's anterior cerebral artery aneurysm of the A-1 segment was proximal to the origin of the anterior communicating artery and was not typical of a congenital aneurysm. Thirteen aneurysms had an irregular contour, whereas 5 aneurysms were saccular. In the 9 patients with clinical and CT evidence of aneurysm rupture, the aneurysms were slightly larger than those in patients without aneurysm rupture (mean maximum dimension, 8.3 mm versus 6 mm). Four patients had branch vessel occlusions in the middle cerebral artery territory, and in one patient thrombosis of the internal carotid artery developed.

Repeat angiographic findings at 2 and 4 weeks after the first angiogram were: no change in aneurysm size in 6 (33%) aneurysms, decrease size in 3 (17%) peripheral aneurysms (Fig 1). There was complete resolution of 6 (33%) aneurysms (4 peripheral and 2 central aneurysms) and increased size in 3 (17%) aneurysms. No new aneurysms were detected. After 6 weeks of antibiotic treatment, 10 patients had a total of 12 residual aneurysms requiring surgical excision or clipping. Eleven of these aneurysms were discovered at surgery. Six aneurysms were excised, and 5 aneurysms were clipped. In one patient with a peripheral M-4 segment aneurysm, the aneurysm could not be detected at surgery despite preoperative angiographic location with radiopaque markers.

TABLE 2: Angiographic and CT findings of aneurysms and response to 6 weeks of antibiotic treatment

Patient	CT Findings	Site	Size, mm	Response, mm	Surgical Findings	Outcome
1	SAH	MCA M-4	6×6×7	2×3×2	Excise	Recovered
		MCA M-4	6×8×20	3×4×5	Excise	
2	ICH	Ant Ch	5×5×5	No change	Trap	Hemiparesis
		MCA M-4	7×8×8	No change	Trap	
3	Infarct	PComm	5×7×5	Occlusion	. . .	Hemiparesis
4	Infarct	MCA M-3	5×5×7	5×5×5	Excise	Recovered
5	ICH	MCA M-4	5×6×7	. . .	. . .	Died
6	SAH	PCA Occ	4×5×6	No change	Clip	Recovered
7	ICH	MCA M-1	4×4×5	Occlusion	Not seen	Hemiparesis
8	ICH	MCA M-4	5×6×6	8×8×9	Excise	Dysphasia
9	Infarct	MCA M-4	2×3×3	Occlusion	. . .	Recovered
		MCA M-4	3×3×3	Occlusion	. . .	
10	SAH	ACA A-1	5×7×9	No change	Clip	Recovered
11	Aneurysm	MCA M-4	5×6×7	Occlusion	. . .	Recovered
12	Infarct	MCA M-4	2×3×3	Occlusion	. . .	Recovered
13	SAH	MCA M-4	5×5×7	No change	Excise	Hemiparesis
		ACA A-3	5×5×6	No change	Clip	
14	ICH	MCA M-2	5×6×7	6×6×8	Clip	Hemiparesis

Note.—SAH indicates subarachnoid hemorrhage; ICH, intracerebral hemorrhage; Ant Ch, anterior choroidal; PCA Occ, posterior distal occipital branch; MCA, middle cerebral artery; PComm, posterior communicating artery; ACA, anterior cerebral artery; trap, trapped between liga clips; and clip, occluded by aneurysm clip.

Seven (50%) patients made a complete recovery. Four (28%) of these patients had single peripheral unruptured aneurysms. Three of these patients' aneurysms resolved on antibiotic therapy alone, but in one patient the residual aneurysm required excision.

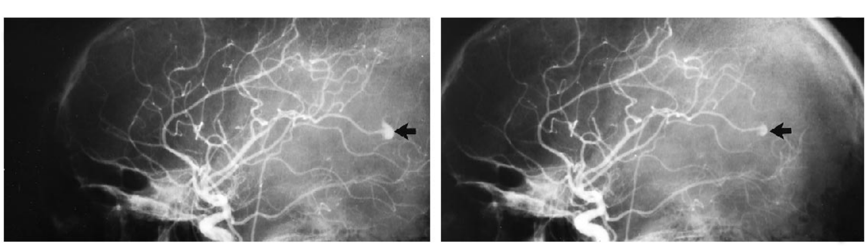
Six patients with ruptured aneurysms had permanent neurologic deficits (5 patients with hemiplegia, 1 with dysphasia). Two of these patients had acute endocarditis. All of these patients had clinical and CT evidence of aneurysm rupture on CT (5 patients had intracerebral hematomas, and 1 patient had a subarachnoid hemorrhage). These patients' aneurysms showed no change or an increase in size on antibiotic therapy. This group of patients had slightly larger aneurysms than the group that recovered (mean maximum diameter, 8 mm versus 6 mm in the recovery group).

Three patients were lost to clinical follow-up after hospital discharge. These patients all had 6 weeks' antibiotic treatment and two serial follow-up angiograms during their hospital stay. One patient with a peripheral middle cerebral artery aneurysm rebled 2 weeks after the initiation of antibiotic therapy and died before the first follow-up angiogram.

Discussion

There is considerable controversy in the literature concerning the detection and management of endocarditis-related intracerebral aneurysms. These lesions are associated with a high mortality rate if they rupture (4).

Thirteen of our patients with endocarditis had chronic rheumatic valvular disease and were relatively young compared with patients in the developed world, where the average age of patients with endocarditis has increased to 55 years (5). Whereas the incidence of rheumatic heart disease has declined in the developed



A B

Fig 1. *A*, Admission carotid angiogram demonstrates a peripheral M-4 middle cerebral artery aneurysm (*arrow*).

B, Follow-up angiogram after 6 weeks of antibiotic therapy demonstrates a decrease in luminal size.

world, the increasing use of prosthetic valves, intravenous drug abuse, and degenerative valve disease have counterbalanced this decline, and endocarditis remains a relatively common cardiac disease (1, 4).

The true prevalence of aneurysms is unknown. However, in a series of 35 patients with neurologic complications arising from endocarditis studied by CT and angiography aneurysms developed in 11 (31%) patients (6). Our study was restricted to patients with neurologic signs only. A prospective study examining patients with and without neurologic complications from endocarditis using magnetic resonance angiography may provide more accurate epidiemologic data.

In this study, the aneurysms most commonly were located on the peripheral branches of the middle cerebral artery (55%), usually at vessel branchings. These findings are consistent with other studies (4, 7). Whenever an aneurysm is detected in this location, endocarditis must be actively excluded (8).

One third of the aneurysms in our study were found in the proximal or segment 1 of the cerebral arteries. It may be impossible to distinguish mycotic aneurysms from congenital berry aneurysms in these locations, as in patient 3. Multiple aneurysms commonly are detected with an incidence of 18% to 25% in the literature (4, 7). In our series, the incidence was slightly higher at 28%.

Unlike other authors, we did not detect any new aneurysms during antibiotic therapy (4, 7). Pathologically, there is septic embolization of the vasa vasorum or lumen of the artery with resultant focal arteritis, necrosis, and aneurysm formation (9). These lesions develop extremely fast and are angiographically detectable within 10 days of embolization (9). Many unruptured peripheral aneurysms will resolve on antibiotic therapy alone (4, 10). Surgical excision of peripheral aneurysms is made easier after antibiotic therapy, because the aneurysm wall is much thicker from fibrosis and less likely to rupture on handling (11).

Patients with unruptured single peripheral aneurysms had the best outcome; patients with ruptured aneurysms, multiple aneurysms, or acute endocarditis had a worse outcome. Investigation of endocarditis-related aneurysms remains a difficult problem both for the clinician and radiologist. We found contrast-enhanced CT scans useful for detecting peripheral aneurysms if the admission unenhanced scan was normal or if an infarct was present.

MR angiography may be an adequate initial screening investigation to detect mycotic aneurysms in asymptomatic patients with endocarditis, although this point is unproved. Four-vessel angiography remains the standard form of investigation and should be performed if an aneurysm is clinically suspected even if the CT scan is normal. Follow-up angiography is recommended to assess aneurysm response to antibiotic therapy and to detect new aneurysms that may develop.

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