Intracranial mycotic aneurysms of extravascular origin

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Six patients with intracranial mycotic aneurysms of extravascular origin are reported. Four had aneurysms of the intracavernous portion of the internal carotid artery associated with thrombophlebitis of the cavernous sinus, and two had aneurysms of the cerebral arteries associated with meningitis. An aneurysm of this type may rupture, producing subarachnoid hemorrhage, or it may become thrombosed and decrease in size or spontaneously disappear. In some patients it may persist and develop calcification in the wall.

KEY WORDS: mycotic aneurysm, thrombophlebitis of the cavernous sinus, meningitis, infections, arteritis

The adjective "mycotic" has a dual meaning in medicine: the first deals with a group of diseases caused by fungus, the second applies to those aneurysms that arise from inflammatory destruction of the arterial wall. The second meaning can be traced back to Osler who, in 1885, referred to infectious endocarditis with vegetation and ulceration as malignant (mycotic) endocarditis. He also described a patient with associated "mycotic" endarteritis producing multiple aneurysms, which presented the appearance of fresh fungus vegetations. Earlier, in 1847, Virchow recognized the occurrence of embolism and noted the destruction of the arterial wall at the origin of the embolism. Tufnell, in 1853, was the first to describe the formation of a peripheral aneurysm by embolic transfer of infected material from an endocardial growth. As classified by Karsner, there are three forms of mycotic aneurysm. The first and most common arises as a result of embolization from bacterial endocarditis; the second by extension from a neighboring focus of infection; the third, so-called "primary or cryptogenic mycotic aneurysm," occurs in the absence of an obvious inflammatory lesion elsewhere in the body.

In a postmortem series of 51 aneurysms of the cerebral arteries, Fearnsides found 15 mycotic aneurysms, whereas in another postmortem series by McDonald and Korb, 70 of 1125 aneurysms were found to be mycotic. The incidence is less in the more recent reports, being 2.5% to 4.5%. Most of the intracranial mycotic aneurysms reported in the literature are of embolic type. The extravascular origin of intracranial mycotic aneurysms is so rare that its occurrence is not mentioned in most reports.

We are reporting six such patients.

Case Reports

Case 1

Aneurysm of the Left Internal Carotid Artery; Thrombosis of the Right Internal Carotid Artery with Cavernous Sinus
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Thrombophlebitis. A 6-year-old boy was bitten by a centipede on his right lower eyelid which became inflamed and swollen for a few days and then gradually improved. Five days after the injury he developed fever, nausea, malaise, and progressive swelling of the left eyelids. On admission 2 weeks after the bite, the child appeared toxic and dehydrated. There were cutaneous pustules over the trunk and bilateral enlargement of the cervical lymph glands. Protrusion of the eyeballs and injected conjunctiva were noted bilaterally, worse on the left. The right pupil was dilated and fixed, while the left one was normal. No ocular movements were possible in either eye but there was no ptosis. No bruit was audible over the eyes or head. Heart sounds were normal. Fine crepitations were audible at the bases of both lungs. The patient responded well to command, spoke short sentences, and had a spastic left hemiparesis. Both optic discs were blurred. Lumbar puncture produced a cloudy CSF with 822 lymphocytes/mm³, 137.5 mg/100 mL of protein, and 35 mg/100 mL of sugar. Cultures of the CSF showed no growth, but culture of the blood and cutaneous pustules grew coagulase positive Staphylococcus aureus. Skull films showed destruction of the anterior part of the sphenoidal bone.

A diagnosis of cavernous sinus thrombophlebitis and septicemia was made, and he was treated with antibiotics. His general condition improved but the left hemiparesis, exophthalmos, and ophthalmoplegia persisted. Right brachial and left carotid arteriography were performed 17 days after admission and revealed complete occlusion of the right internal carotid artery about 2 cm above its origin (Fig. 1 upper left) and a $1.5 \times 2$ cm aneurysm of the intracavernous portion of the left internal carotid artery. Irregularity in the wall of the left internal carotid artery was also noted (Fig. 1 upper right). Antibiotic and supportive treatment was continued. The patient slowly improved with less protrusion of the eyes and return of some ocular movements. Bilateral carotid arteriography repeated 6 weeks after the first study revealed a decrease in the size of the aneurysm (Fig. 1 lower left). The right internal carotid artery filled up to the cavernous portion.

Case 2

Aneurysm of the Internal Carotid Artery; Cavernous Sinus Thrombophlebitis. A 6-year-old girl, hit by a blunt object on her right eye, developed swelling of the eyelids without an open wound. Three days later she had a fever, chemosis of the conjunctiva of the right eye, and a maculopapular rash. Despite penicillin therapy she developed a pericardial friction rub and pleural effusion. The rash became pustular and a culture showed coagulase positive Staphylococcus aureus. Blood cultures also grew the same organism. Oxacillin was given, and the patient improved. The swelling of the eyelids disappeared, but she was left with moderate exophthalmos. Ptosis, dilated pupil, and total ophthalmoplegia on the right were still apparent. There was no bruit or other neurological deficit. Right carotid arteriogram showed a $2.5 \times 3$ cm aneurysm of the intracavernous portion of the internal carotid artery.

Under prolonged antibiotic therapy the ocular abnormality gradually improved. An arteriogram repeated 2 months later showed that the aneurysm was no longer present. Physical examination 6 months after the initial episode revealed no abnormality.

Case 3

Aneurysms of the Internal Carotid, Middle Cerebral, and Pericallosal Arteries; Cavernous Sinus Thrombophlebitis. A 10-year-old boy had conjunctivitis following removal of a small foreign body from his right eye. He was admitted because of a high temperature, swelling and chemosis of both eyes, particularly the right one, drowsiness, stiffness of the neck, and a mild left hemiparesis. Meningitis was found at lumbar puncture; culture of the blood and CSF revealed coagulase positive Staphylococcus aureus. Cavernous sinus thrombophlebitis and septicemia were diagnosed. He improved with oxacillin therapy, but total ophthalmoplegia and moderate exophthalmos of the right eye persisted. A right brachial arteriogram showed a $1.5 \times 2$ cm aneurysm of the intracavernous portion of the right internal carotid artery and small aneurysms at the ascending frontal branch of the right middle cerebral artery and at the right pericallosal
artery. His parent refused further treatment and he was lost to follow-up.

**Case 4**

*Calcified Aneurysm of the Internal Carotid Artery 10 Years After a Probable Cavernous Sinus Infection.* A 33-year-old man was admitted because of exophthalmos and impairment of vision in his right eye which dated to an eye infection 10 years previously. He gave a history of a serious illness with elevated temperature and marked swelling of his right eye during that episode of eye infection. The eye condition improved and then remained stationary. Examination at this admission revealed a moderate exophthalmos, limitation of ocular movements in all directions, and a scotoma involving the right eye. The left eye and the rest of the examination were normal. Skull films showed an oval area of abnormal calcification in the right parasellar region (Fig. 2 left) carotid arteriography proved to be the wall of an aneurysm of the intracavernous portion of the internal carotid artery (Fig. 2 right). The right common carotid artery was ligated. Six months postoperatively there was no change in his condition.
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Case 5

_Aneurysm of the Middle Cerebral Artery Adjacent to Osteomyelitis of the Skull; Purulent Meningitis._ A 10-month-old boy had an abscess of the frontotemporal scalp 25 days before admission. He fell and the abscess ruptured. He then had a low-grade fever and occasional vomiting. Two days before admission he became lethargic with opisthotonic attacks. When examined he was toxic, and had a bulging fontanel and elevated temperature. A 1.5 cm area of depression and a small scar were noted in the right frontotemporal region. The heart was normal.

Blood cultures showed no growth. Ventricular puncture revealed bloody CSF with a pressure of 238 mm H2O. Lumbar puncture produced turbid fluid with 25,000 white blood cells/mm³, 24,800 being polymorphonuclear leucocytes and 200 lymphocytes. No sugar was found in the CSF. Cultures of the CSF grew coagulase positive _Staphylococcus aureus_. Roentgenograms of the skull showed an area of bone defect at the right frontotemporal region (Fig. 3 upper left). Cerebral arteriogram revealed an aneurysm of the ascending branch of the middle cerebral artery in close proximity to the skull defect (Fig. 3 lower left and right). There was no space-occupying lesion. The patient rapidly improved with oxacillin therapy, and an arteriogram repeated 10 days after the first one showed that the aneurysm was no longer present.

Case 6

_Multiple Calcified Aneurysms of the Cerebral Arteries; Tuberculous Meningitis._ A 22-year-old woman was admitted because of headache and drowsiness for 2 months. She had recovered from tuberculous meningitis at the age of 2 years but her physical development had been retarded. On physical examination hemiparesis and underdevelopment of the right side were apparent. There was mild elevation of temperature and stiffness of the neck. Constriction of visual fields was present bilaterally. The CSF had 12 lymphocytes/mm³ and a sugar content of 20 mg/100 mL. Skull films showed dense spots of calcification in the suprasellar region (Fig. 4 upper left). Fusiform dilatation of the right anterior cerebral artery as well as hydrocephalus were demonstrated by cerebral arteriography (Fig. 4 lower left).

The suprasellar region was explored through a right frontal craniotomy. Adhesive arachnoiditis was found and calcifications seen on the wall of the dilated anterior cerebral artery. Microscopic examination of the biopsied arachnoid revealed active tuberculous meningitis with tubercles and caseous necrosis. In spite of antituberculous and steroid treatment, the patient had a downhill course and died. At necropsy, multiple aneu-

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**Fig. 2. Case 4. Left:** Roentgenogram of the skull showing an oval calcified area in the parasellar region 10 years after cavernous sinus thrombophlebitis. **Right:** Right carotid arteriogram showing an aneurysm of the intracavernous portion of the internal carotid artery similar in shape with the calcified area seen in plain roentgenogram.
rysms of the arteries at the base of the brain were found: a fusiform aneurysm on the right anterior cerebral artery and saccular aneurysms on the right middle cerebral trifurcation, the left anterior cerebral, and the left posterior cerebral arteries. Roentgenogram of the dissected arteries (Fig. 4 lower left) showed many areas of calcification in the arterial wall, especially at the sites of the aneurysms.

Discussion

Bacterial infections are known to invade the arterial wall from neighboring or contiguous inflammatory foci, attacking first the adventitia and then spreading inward. Thrombosis of the artery may result from diffusion of toxin or involvement of the intima in the inflammatory process. On the other hand, the infection may produce disil-
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Integration of the tissue until the vessel wall is weakened enough to yield, resulting in rupture or a mycotic aneurysm.\textsuperscript{15,19,31} Mycotic aneurysms of the aorta have been found adjacent to a suppurative process in the lungs.\textsuperscript{21} Patients with fatal hemorrhage from pulmonary tuberculosis have been found to have “Rasmussen” aneurysms of the pulmonary vessels passing through tuberculous pulmonary cavities.\textsuperscript{26}

As for the intracranial arteries, thrombosis of the internal carotid artery from infection in the adjacent pharynx, sphenoid sinus, and cavernous venous sinus have been reported.\textsuperscript{3,7,16,22,29} Inflammation in the arterial wall, especially the adventitia, was the usual finding at necropsy. Thrombosis secondary to infective arteritis of the cerebral arteries in patients with purulent or tuberculous meningitis has been demonstrated both pathologically\textsuperscript{1,5,21,30} and angiographically.\textsuperscript{11,20,32,35} Davis, et al.,\textsuperscript{6} recently reported segmental dilatation of the peripheral branches of the anterior cerebral artery in a patient with pneumococcal meningitis, proving that infection at the base of the skull and in the subarachnoid space can spread to involve the internal carotid and cerebral arteries. The anatomical arrangement of the carotid artery within the cavernous sinus makes it vulnerable whenever there is thrombophlebitis of the sinus. Meningitis creates a

\begin{figure}
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\caption{Case 6. Upper Left: Skull film showing dense spots of calcification in the suprasellar region, 20 years after the onset of tuberculous meningitis. Upper Right: Right carotid arteriogram showing fusiform dilatation of the first part of the right anterior cerebral artery. Lower Left: Roentgenogram of the dissected arteries of the circle of Willis showing multiple areas of calcification in the arterial wall.}
\end{figure}
similar situation since the cerebral arteries lie in the subarachnoid fluid.

In reviewing the literature, we have been able to find only two cases of aneurysm of the intracavernous portion of the internal carotid artery secondary to infection in the cavernous sinus. Barker\(^3\) reported the post-mortem examination of a patient in whom mycotic aneurysms were found on both internal carotid arteries in addition to thrombophlebitis of the cavernous sinus. The aneurysm on the left was partially thrombosed; that on the right had ruptured into the middle and posterior cranial fossa and was the cause of death. In 1969, Devadiga, \textit{et al.}\(^9\) described an intracavernous aneurysm of the left internal carotid artery in a 14-month-old child whose onset of illness began with high fever and was followed a week later by chemoisis, total ophthalmoplegia of the left eye, and a left hemiparesis. The CSF had 6 cells/mm\(^2\) and a normal sugar content. The diagnosis of the aneurysm was made from an arteriogram. The patient improved after antibiotic therapy, and an arteriogram repeated 1½ years later showed that the aneurysm was no longer present.

Our Cases 1, 2, and 3 had the classical clinical picture of cavernous sinus thrombophlebitis secondary to infection in the region of the eye, septicemia, ocular venous obstruction, and paralysis of the third, fourth, and sixth cranial nerves. The aneurysm of the internal carotid artery was diagnosed only after arteriography. In Case 1, thrombosis of the opposite internal carotid artery was also found, probably representing another sequel of the arteritis.

In the cooperative study of intracranial aneurysms and subarachnoid hemorrhage,\(^17\) 10 aneurysms were reported associated with infections of the central nervous system. No details, however, were given. In a series of five patients with mycotic aneurysms reported by Roach and Drake,\(^28\) one had a combination of septicemia and meningitis. The meningitis was thought to be the result rather than the cause of the aneurysm. In another report of 36 intracranial aneurysms found among 3080 autopsies, Mitchell and Angrist\(^21\) described a case of mycotic aneurysm in association with influenzal meningitis. He, however, considered it to be an incidental finding. Brown\(^1\) described a case of aneurysm of the basilar and superior cerebellar arteries secondary to tuberculous involvement of the arterial wall adjacent to a tuberculoma in the cerebellar hemisphere. In a postmortem study of a patient with brucellar meningitis who died of subarachnoid hemorrhage, Hansmann and Schenken\(^12\) found an aneurysm of the basilar artery which showed damage to the adventitial connective tissue by heavy infiltration of the inflammatory cells. Heidelberger, \textit{et al.}\(^19\) at autopsy found multiple aneurysms in the vertebrobasilar branches in a patient who was suffering from pseudomonas meningitis. All layers of the aneurysmal wall were heavily infiltrated with polymorphonuclear leucocytes and microorganisms. They also quoted that Margolis had found two cases of mycotic aneurysms secondary to purulent meningeal infection. Ojemann, \textit{et al.}\(^24\) in 1966 reported a patient with arteriographic demonstration of multiple fusiform aneurysms of the cingulate branches of the pericallosal artery in association with severe bacterial meningitis. Our Case 5 illustrates the formation of an aneurysm of the cerebral artery at the site of the presumably most intense meningitis secondary to intracranial extension of the infection from osteomyelitis of the skull.

In conclusion, intracranial mycotic aneurysms of extravascular origin can be found in association with thrombophlebitis of the cavernous sinus and with purulent or tuberculous meningitis. The site of the aneurysm is, as a rule, at the place of most intense infection. Some mycotic aneurysms may rupture, while others under antibiotic treatment may become thrombosed and decrease in size, as in our Case 1. They may even disappear completely, as in our Cases 2 and 5 and those reported by Devadiga \textit{et al.}\(^9\) and Ojemann, \textit{et al.}\(^24\). In some patients the aneurysm may persist, with calcification in the wall (our Cases 4 and 6).

References

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