Histological findings in giant aneurysms treated with Guglielmi detachable coils

Report of two cases with autopsy correlation

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The authors report the pathological and histological findings in two patients with giant partially thrombosed aneurysms who were treated by means of Guglielmi detachable coils with subtotal occlusion of the aneurysms. Autopsies of these patients were performed 2 and 6 months after endovascular treatment. The histological findings revealed coils embedded in largely unorganized thrombus in the aneurysms; there was no clear reduction in size of the aneurysms over the period. There was no evidence of endothelialization of the aneurysm neck demonstrated in either case. The significance of these findings is discussed.

KEY WORDS • cerebral aneurysm • endovascular therapy • detachable coil • electrolysis

Endovascular techniques for the treatment of unclippable intracranial aneurysms have been developing over the last 10 years. Parent vessel occlusion by detachable balloons, intraaneurysmal balloon placement,2,7 platinum fiber coils,1 and more recently the Guglielmi detachable coil device,4,5 have all been used. The effects of coil systems in experimental aneurysms have been the subject of a number of animal studies;3,6 however, the nature of these experimental aneurysms differs fundamentally from giant intracranial aneurysms containing thrombi.

We report two patients who were treated by Guglielmi detachable coil placement. One was killed in a motor vehicle accident 2 months after treatment, and the other died of pneumonia 6 months following treatment with the coil system. This is, to our knowledge, the first report detailing the delayed histological findings in aneurysms treated in this manner.

Case Reports

Case 1

Examination. This 22-year-old man first presented 5 1/2 years prior to his death with an acute subarachnoid hemorrhage (SAH) confirmed on lumbar puncture and computed tomography (CT) scan. Angiography revealed a left internal carotid artery (ICA) aneurysm arising close to the origin of the anterior choroidal artery.

Operation. On surgical exploration, the aneurysm was found to be diffuse and multilobular with marked local adhesions that prevented surgical clipping. It was wrapped with muscle and cotton and 48 hours later the ipsilateral common carotid artery was ligated under local anesthesia.

Postoperative Course. The patient made a complete recovery and was neurologically intact; however, 2 months later he had a further SAH. The presence of SAH and enlargement of the aneurysm were confirmed by CT. He subsequently developed hydrocephalus and a ventriculoperitoneal shunt was inserted. Repeat angiography performed 3 months after original presentation showed collateral filling via the right external and left external carotid arteries to the left ICA with antegrade filling of the aneurysm. There was cross-circulation from the right side to the left middle cerebral artery (MCA). Following a direct puncture of the left internal carotid artery, a balloon occlusion was performed just proximal to the aneurysm. Follow-up contrast-enhanced CT revealed the lumen of the aneurysm to be smaller but not completely obliterated.

The patient made a full recovery with only occasional headaches. He remained well for 5 years but presented...
thereafter complaining of poor vision. He was found to have markedly reduced visual acuity in both eyes; he was only able to see well enough in his left eye to count fingers and had an acuity of 6/36 on the right (formerly 6/9 bilaterally). There were no other signs of neurological deficit.

A coronal magnetic resonance (MR) image was obtained that showed a giant suprasellar aneurysm containing thrombus and causing severe optic nerve and chiasmal compression. Angiography revealed that the aneurysm was filling via the vertebral circulation from the left posterior communicating artery (PCoA) with the aneurysm lumen extending across the midline (Fig. 1 left).

This condition was treated with a GDC Tracker 18 catheter (Target Therapeutics, Freemont, CA) via the left vertebral artery and PCoA. A series of seven Guglielmi coils was placed in the aneurysm, packing progressively from the fundus to the neck. Final angiograms through the microcatheter showed subtotal occlusion of the aneurysm with a wide residual neck and good MCA filling (Fig. 1 center and right). This procedure was well tolerated and 48 hours later, the patient was discharged home, neurologically unchanged. Two months later, after leaving a bar, he was knocked down by a motor vehicle and sustained a fatal head injury.

Neuropathological Findings. External examination of the brain showed severe generalized brain swelling with recent extensive left frontotemporoparietal contusions and SAH covering a substantial fraction of the lateral aspect of the left hemisphere. In addition there was an old operative defect of the orbitofrontal gyri of the left frontal lobe. In the right hemisphere there were focal temporal lobe contusions but no frontal contusions. A small (2-cm diameter) focus of SAH was also present in the left cerebral hemisphere close to the vertex.

A large (3.5-cm maximum dimension), lobulated aneurysm was present, arising from the junction of the left PCoA and the left ICA. The aneurysm was largely embedded in the base of the brain and was variably adherent to adjacent brain. There was no evidence of recent bleeding from the aneurysm. The optic chiasm was grossly distorted and only the right optic nerve was identifiable. The left MCA and left anterior cerebral artery were both found stretched over the superior surface of the aneurysm. A section through the aneurysm was made adjacent to a line joining the left PCoA and left MCA that exposed the coils which had been inserted into the aneurysm. The coils were embedded in friable blood clot and were easily removable together with attached blood clot. A small lumen was present where the ICA entered the aneurysm; there was no evidence of clot extending into the lumen of the artery and no evidence of distal emboli.
Microscopic sections of the aneurysm and its contents, which were stained with hematoxylin and eosin (H & E), Masson trichrome, and reticulin, demonstrated that, as suggested by gross examination, the aneurysm fundus was largely filled with unorganized blood clot surrounding the coils. Around the margins of the aneurysm there was a variable degree of organization of the clot with capillary penetration, the presence of macrophages and other inflammatory cells, and some fibrosis, which was only a minor component. The bulk of the fundus was filled with coils and unorganized friable blood clot. Largely unorganized blood clot was present around the residual lumen and there was no evidence of endothelialization of the luminal surface at the neck of the aneurysm.

Case 2

This 69-year-old man presented with a 2-month history of dysphagia and difficulty in walking.

Examination. Ataxia of all limbs and palsies of the right sixth and seventh cranial nerves and bilateral ninth, 10th, and 11th cranial nerves were revealed on examination. Investigation, including MR imaging (Fig. 2 left) and vertebral angiography (Fig. 2 center) demonstrated compression of the brainstem by a giant basilar aneurysm arising adjacent to the origin of the right anterior inferior cerebellar artery.

Operation. Endosaccular embolization was performed in two sessions using Guglielmi detachable coils. Five coils were deployed on the first occasion, which was complicated by postprocedural hypostatic pneumonia; and three coils were placed at the second procedure, which took place 6 weeks later without complication (Fig. 2 right).

Postoperative Course. Despite complete angiographic obliteration of the aneurysm lumen, symptoms caused by the bulbar palsy did not improve, and 6 months later the patient died following another episode of pneumonia.

Neuropathological Findings. Examination of the brain revealed the presence of a large (2.5-cm maximum diameter) aneurysm of the basilar artery extending to the right of the midline and deeply indenting the basis pontis. Creation of a window in the aneurysm fundus enabled us to see that it was filled with solid and semiliquid blood clot in which the coils were embedded (Fig. 3). The coils and a considerable volume of attached blood clot were easily removable from the aneurysm fundus.

The H & E, Masson trichrome, and reticulin stains revealed a histological appearance very similar to that described for Case 1. Much of the fundus of the aneurysm was filled with unorganized blood clot (Fig. 4 left) in which the coils had been embedded. There was a variable degree of clot organization with capillary penetration and fibrous replacement around the margins of the aneurysm fundus and in the older regions of blood clot. By contrast, there was little if any organization of the blood clot asso-

![Fig. 3. Case 2. Photograph at autopsy showing the aneurysm after dissection of the basilar artery and creation of a window in the fundus. The coils are embedded in solid and semiliquid unorganized blood clot that was easily dissected away to reveal the coils.](image)

![Fig. 4. Photomicrographs in Case 2. H & E. Left: Low-power photomicrograph showing the wall of the aneurysm, which is composed of almost avascular fibrous tissue and is permeated by a moderate lymphocytic inflammatory infiltrate. The aneurysm fundus at this point is filled with unorganized thrombus. Original magnification × 25. Center: A portion of the aneurysm contents adjacent to one of the coils. The location of the coil is indicated by the scalloped cavity. The blood clot in the immediate vicinity of the coil and between the coil and the aneurysm wall shows loose fibrous connective tissue containing capillaries. Deeper within the aneurysm, unorganized thrombus is still present. Original magnification × 25. Right: Higher power illustration of the tissue adjacent to the coil. The tissue reaction consists largely of inflammatory and phagocytic cells within a loose fibrous stroma that contains large-diameter capillaries. Original magnification × 100.](image)
associated with the coils (Fig. 4 center and right). There was no sign of endothelialization of the luminal surface at the neck of the aneurysm.

Discussion

Both these aneurysms were large with wide necks that contained substantial amounts of preexisting thrombus. It was anticipated from studies of experimental aneurysms that following successful occlusion of an aneurysm, there would be stabilization of thrombus followed by organization and gradual laying down of fibrous tissue with eventual shrinkage and retraction of the clot and reduction of the mass effect.

The normal mechanism of resolution of blood clot is by the ingrowth of capillaries from the periphery of the clot and invasion by macrophages and other inflammatory cells. There is simultaneous progressive dissolution of the clot and deposition of vascularized fibrous connective tissue scar. The formation of a fibrous connective tissue scar is usually associated with a degree of tissue contraction that in aneurysms is manifested in a reduction of the size of the fundus; their capillary ingrowth takes place by outgrowth from blood vessels in the wall of the fundus.

In the two cases reported here the aneurysms were thick walled and the process of blood clot resolution either did not occur or was proceeding only very slowly. This is most likely to be a result of the virtually avascular nature of the aneurysm wall. The fundus of the aneurysm is composed of the stretched adventitia of the original artery, which is very poorly vascularized in normal circumstances. The presence of blood clot within the fundus excites a relatively low density of capillary ingrowth and therefore only very slow resolution of the clot. In small aneurysms the significance of this weak tissue reaction to the presence of clot may be slight; however, the effect is greatly magnified in large aneurysms in which linear dimensions and volumes of clot are much greater and the process of resolution is correspondingly prolonged.

The lack of endothelialization at the neck of the aneurysm is not surprising given the avascular and acellular nature of the blood clot filling the neck. Endothelial cells would only be expected to grow over this surface when vascularized fibrous connective tissue had been laid down, and this would occur only if there had been substantial or complete resolution of the blood clot within the fundus.

The clinical concern in these patients must be that the lack of organization of the blood clot within the aneurysm fundus may make it liable to dissolution and render the obliteration of the lumen potentially unstable. However, there was no evidence of distal thromboembolism or of any change in the coil position between the final angiograms and death. Thus even when coils are embedded in unorganized thrombus, as in these two cases, the risk of late migration would seem very remote. The necks of both of these aneurysms were wide and the coils extended to the neck, but no endothelialization had occurred over the aneurysm neck from the adjacent arterial wall. It is important that efforts are made to obtain additional autopsy data in patients treated with Guglielmi detachable coils, particularly in smaller thin-walled aneurysms, to see if different mechanisms are operating.

These findings emphasize the need for long-term clinical and angiographic follow up to assess the long-term efficacy of this treatment in the management of patients with intracranial aneurysms.

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References


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