When seen after head trauma, subarachnoid hemorrhage (SAH) often leads to an angiogram to look for vascular injury. Usually the study is negative; sometimes a traumatic aneurysm or dissection is seen. Occasionally, a conventional saccular aneurysm is found. The clinical history, physical examination, and computed tomography (CT) scan in such a patient may suggest that an aneurysmal SAH was the primary event, with the trauma resulting from SAH-associated incapacity. But this scenario is not usually apparent and, if a saccular cerebral aneurysm is found on angiogram after a patient has been injured, it is often difficult to know if the aneurysm is incidental, caused the SAH and trauma, or bled as a result.

Most traumatic aneurysms in the carotid distribution are located at the base of the skull and are associated with skull fractures. Those located inside the cranium proper that result from nonpenetrating injury are less often linked to skull fractures. They are likely caused by contusion of the vessel, in which there is stretching or torsion of the wall. By analogy, similar forces acting on the wall of pre-existing cerebral aneurysms should cause some to bleed. Given a conservative estimate that 2% of the population harbors unruptured saccular aneurysms, a certain percentage of traumatic SAH must be caused by trauma-induced aneurysmal rupture. A couple of published case reports have verified this mechanism, though the intensity of the trauma in these cases was quite severe.

The case presented here suggests that, if SAH is seen after trauma in a pattern suggestive of aneurysmal rupture, there should be a low threshold for looking for and treating “nontraumatic” saccular aneurysms. Mild to moderate trauma should not exclude such consideration.

**CASE REPORT**

A 51-year-old, previously healthy woman hit a deer while driving her car. The airbag deployed. Initial complaints were of headache and neck stiffness, which started after the impact. There was no loss of consciousness or other injuries. Later in the day she was noted to be drowsy and less alert than usual, and this prompted a visit to hospital. There, a CT scan of the head showed a small amount of subarachnoid blood, but no evidence of brain contusion (Fig. 1A, B). Her condition improved and she was discharged home. The patient made a steady recovery.

One month later, however, the patient was found unconscious and taken to our hospital. CT scan showed diffuse subarachnoid blood in the basal cisterns, Fisher Grade III, with acute hydrocephalus (Fig. 2). A ventriculostomy was placed, cerebrospinal fluid was drained, and she regained consciousness. Angiography revealed a left internal carotid artery (ICA) aneurysm, which was treated endovascularly with platinum microcoils (Fig. 3A, B). After initially doing well, the patient developed severe cerebral vasospasm on day 4. Angioplasty, intra-arterial vasodilator medication, and hypertensive/hypervolemic therapy were all administered, but nothing helped the patient; she died on day 10 after admission. A postmortem examination was performed.

**Autopsy**

The patient’s brain showed blood in the basal subarachnoid cisterns. A saccular aneurysm was noted on the ICA near the origin of the left posterior communicating artery (Fig. 4). It contained metal coils, some of which had extravasated through a hole in the aneurysm; others were visible through the very thin wall. Coronal sections of the brain showed evidence of cerebral infarction, but no contusions. Microscopic examination of the wall of the aneurysm demonstrated that it was composed of mature collagen. No internal elastic lamina or smooth muscle layer was noted in the aneurysm wall. The morphologic details of this vascular lesion conformed to all the characteristics of a saccular aneurysm (Fig. 5).

**DISCUSSION**

The initial CT scan of our patient only showed a small amount of subarachnoid blood. This study was, however, consistent with aneurysmal SAH. The clot visible in the suprasellar cistern near the left ICA (Fig 1B), where the aneurysm was located, suggests that the aneurysm was the source of the first SAH. Though traumatic SAH need not be associated with brain contusion, the lack of brain contusion on
this first CT scan and at postmortem examination also suggests that the bleeding that occurred after the car crash was from the aneurysm, not from traumatized, previously healthy vessels or brain. The airbag, while perhaps protecting the patient from serious additional injuries, may have precipitated aneurysmal bleeding by causing sudden acceleration to the head. Alternatively, the airbag may not have fully protected the brain/aneurysm from the trauma. A sudden rise in blood pressure around the time of the crash may have promoted aneurysmal rupture and SAH. Regardless of the mechanism, we have documented that the fibrous dome of the aneurysm was nonelastic, friable, and did not need much inducement to burst. It was likely on the verge of spontaneous rupture. Indeed, a large percentage of cerebral aneurysms bleed with the patient at rest.14

The two published case reports of trauma-induced rupture of pre-existing saccular aneurysms involved harder impacts than our patient suffered. One was a car crash that
resulted in injuries including flail chest and a leg fracture. The other was caused by a blow to the head with a fast-moving, hard object. There is older literature suggesting a correlation between cerebral aneurysm rupture and head trauma, but the evidence for this mechanism in these articles is not compelling. The only reports of airbag-associated cerebrovascular injury have been of ICA dissection.

Traumatologists understand that a patient with “traumatic” SAH may have associated vascular abnormalities. Catheter angiography is not advocated for all of these cases, but neurosurgeons are relatively liberal in ordering angiograms in this situation, especially if the blood is located at the base of the brain. It is of interest that one group found an 8% incidence of saccular aneurysm in patients undergoing catheter angiography for SAH and trauma. However, they did not clearly demonstrate cause-and-effect relationships between the bleeding and the aneurysms in their cases. These authors did advocate catheter angiography for all patients with hemorrhage in the basal cisterns or Sylvian fissure and early treatment of all aneurysms found.

Fig. 4. Postmortem photograph of left internal carotid artery demonstrating aneurysm. Note coils extruded through wall of aneurysm (upper arrow) and coils visible through thin wall of aneurysm (lower arrow).

Fig. 5. Photomicrograph of internal carotid artery/aneurysm transition. (A) This low-power micrograph demonstrates the outpouching of the aneurysmal dome from the thick wall of a large artery (internal carotid artery). The muscularis (dark tissue layer) and adventitia (light tissue layer) are clearly seen in the base of the aneurysm, on one side. The relative positions of plates B, C, and D are indicated. (Movat pentachrome stain, final magnification ×14). (B) The dome of the aneurysm consists of collagen. Blood elements are found on the outside of the wall. (C) Note the abrupt termination of the elastic lamina on each side (arrows) along with the end of the muscularis. (D) The lumen (#) and muscularis of the intact posterior communicating artery (short arrow) lie adjacent to the aneurysm (arrowhead) and its lumen (*). The lack of a dark tissue layer with densely packed nuclei indicates the absence of smooth muscle in the fibrous wall of the aneurysm. (B, C, D: Movat pentachrome stain, final magnification ×64).
We agree with this approach. When a CT scan of a patient with a head injury shows SAH in a pattern suggestive of aneurysmal SAH, it is best to get an angiogram. It is impossible to otherwise determine the cause of the SAH. If an aneurysm is found, it is best to assume that it has bled and treat it. We think that the second SAH in our patient represented a rehemorrhage of the aneurysm that bled after the automobile crash. Our case illustrates that, just as with conventionally ruptured cerebral aneurysms, rebleeding of a saccular aneurysm in this situation can be severe and fatal.

REFERENCES