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Radiation-induced Cerebral Aneurysms

D. J. Scodary[1], J. M. Tew, Jr.[2], G. M. Thomas[3], Th. Tomsick[1], and B. H. Liwnicz[3]

[1] Department of Neurosurgery, University of Cincinnati Medical Center, [2] Mayfield Neurological Institute, Cincinnati, Ohio, [3] Department of Pathology and Laboratory Medicine, University of Cincinnati Medical Center, Cincinnati, Ohio, U.S.A.

Summary

The association between vasculopathy and radiation is well recognized. Generalized arterial disruption and subsequent stenosis and occlusion is most often described. Additional vascular phenomenon, such as pseudoaneurysm formation, aneurysmal dilatation and aneurysmal rupture, are less common. We document a case of a cerebral aneurysm formation and rupture in the field radiated for cerebral neoplasm.

Keywords: Radiation; aneurysm; central nervous system; subarachnoid haemorrhage.

Introduction

Radiation-induced large vessel vasculopathy is a well documented clinical entity[1, 3–6, 8–12, 14–17, 19, 21–23]. Central nervous system consequences are most often due to vascular occlusion. Intracranial aneurysm formation related to radiation is rare. Three previous cases have been reported; one case was associated with subarachnoid haemorrhage[2, 7, 13].

We document a similar occurrence in a patient who developed an anterior cerebral aneurysm and subsequently a subarachnoid haemorrhage in the radiation field of a grade III astrocytoma resected and radiated 12 years previously. The massive subarachnoid haemorrhage led to the death of the patient. Autopsy disclosed no residual tumour, and documented a ruptured aneurysm with radiation-induced changes.

Case Report

A 47-year-old right-handed male physician underwent craniotomy for resection of a left temporal parietal astrocytoma in 1972. A cerebral arteriogram showed no evidence of cerebral aneurysm or pre-aneurysmal lesions. The studies were interpreted by neuroradiologists at Walter Reed Army Hospital and University of Cincinnati Medical Center. Postoperatively the patient received 6500 rads of whole brain irradiation. The patient entered part-time employment for several years.

In 1987, the patient developed a grand mal seizure, a right hemiplegia and expressive aphasia. CT scan demonstrated a large clot in the region of the cingulate gyrus with rupture into the lateral ventricle (Fig. 1). Angiography demonstrated an aneurysm of the anterior cerebral artery, a second aneurysm of the distal pericallosal artery associated with segmental dilation of the distal pericallosal artery and irregular fusiform widening and narrowing of the posterior cerebral artery (Figs. 2 and 3). The patient expired and a complete brain examination was performed.

Postmortum

Examination of the brain demonstrated a large clot in the previous tumour cavity and panventricular haemorrhage. Clot was present in the anterior septal region. In the midst of this clot, the ruptured dome of the anterior cerebral artery aneurysm was found. A second,

Fig. 1. CT Scan showing large septal-callosal haemorrhage and intraventricular blood in the area of previous tumour radiation

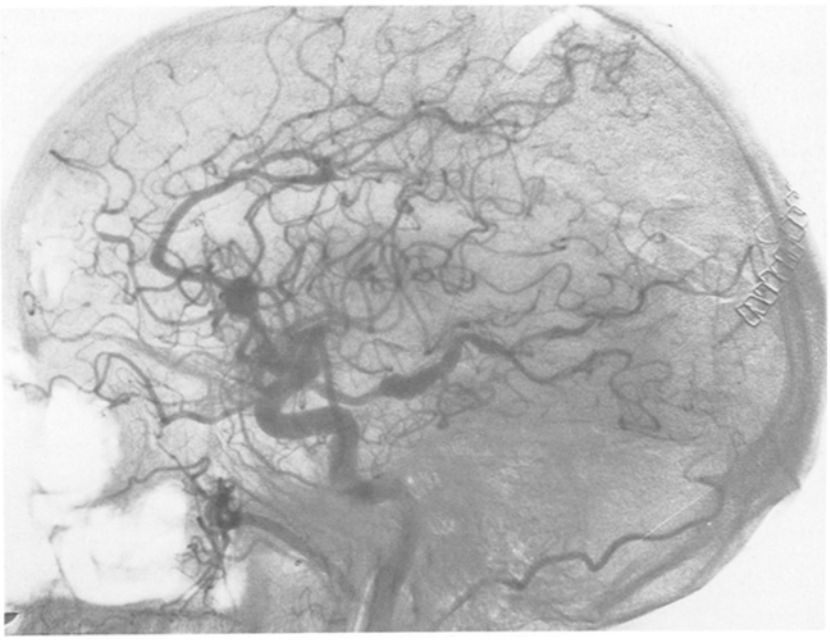

Fig. 2. Lateral left carotid injection reveals an 8 mm anterior cerebral artery aneurysm at the junction of the main trunk and internal frontal from the branch origin and marked posterior cerebral and pericallosal irregularily and aneurysmal dilatation

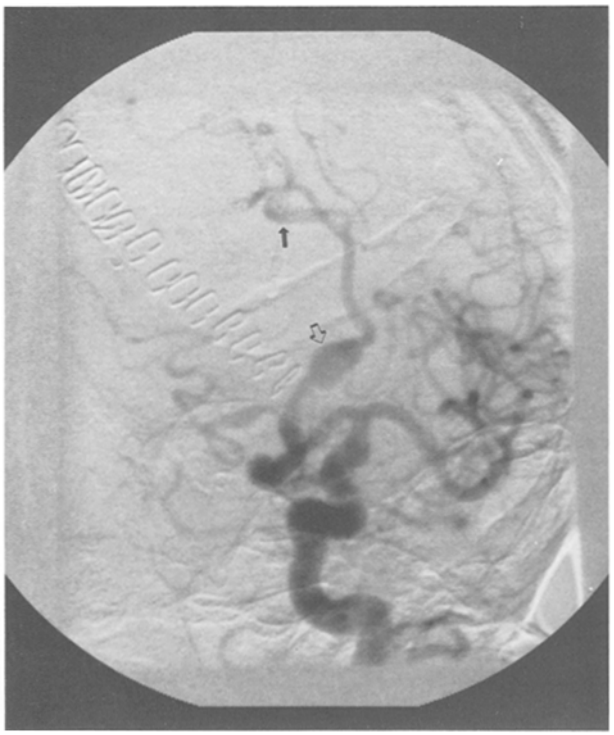

Fig. 3. Oblique left carotid injection shows anterior cerebral artery aneurysm (open arrow) and pericallosal artery aneurysm (arrow)

unruptured aneurysm was found on the pericallosal artery adjacent to the superior surface of the corpus callosum.

Histopathology

The aneurysms of the anterior cerebral artery and the pericallosal artery show similar features. The walls were thickened and the lamina elastica showed disarrangement and degeneration characteristic of atheromatous plaque. The anterior cerebral artery aneurysm was 1 cm × 1 cm and contained a large tear in the wall. Partial intraluminal thrombosis was present (Fig. 4).

Discussion

Radiation-induced vasculopathy has been well described in the literature[1, 3–6, 8–12, 14, 16–19, 21–23]. In a study of arterial injuries due to radiation in 20 patients, McCready *et al.* found two basic patterns of clinical presentation[11]: Arterial disruption and stenosis or occlusion. Arterial disruptions are seen most frequently in the cervical carotid arteries in patients with head and neck cancer. The disruption occurs early (< 20 weeks) and is frequently associated with necrosis of the skin flaps. Stenosis or occlusion may occur relatively early (several months) secondary to direct arterial injury[4, 11, 18] or delayed (7–24 years) secondary to arterial injury and accelerated atherosclerotic changes[3, 18].

Aneurysm formation after radiation has been rarely reported. In McCready's series, one patient developed a pseudoaneurysm of the cervical carotid after an arterial disruption. Three cases of intracranial fusiform aneurysms associated with cranial irradiation have been reported[2, 7, 13]. Azzarelli *et al.*[2], reported a subarachnoid haemorrhage secondary to rupture of a radiation induced aneurysm. In our case, the ruptured aneurysm was saccular, consistent with radiation effects in other vessels and in the ruptured vessel.

The interval between neoplasm radiation and the

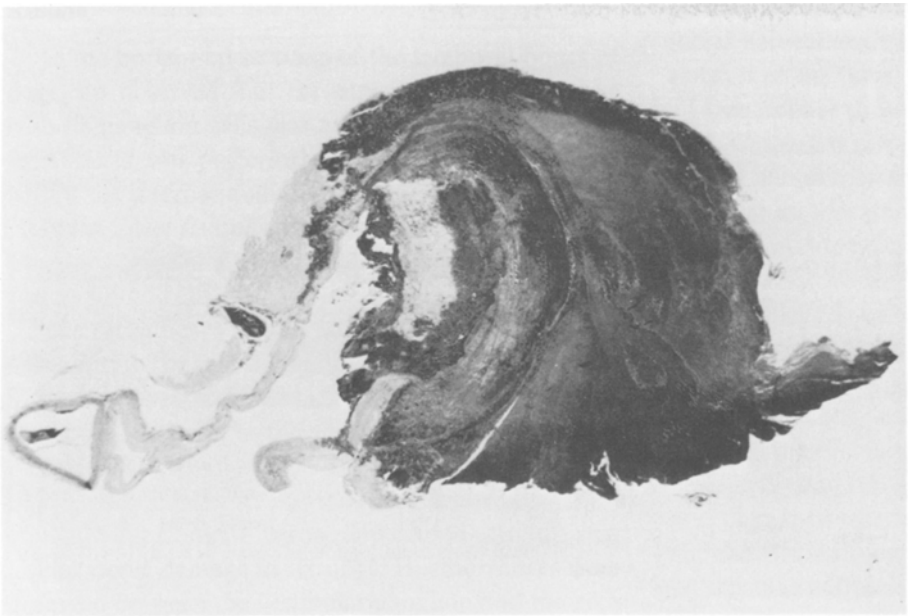

Fig. 4. Cross-section of the anterior cerebral aneurysm (H & E, original magnification × 1)

first appearance of the aneurysms varied from three to fifteen years.

The pathogenesis of radiation vasculopathy is not fully understood. Effects on multiple constituents of the arterial wall lead to eventual intimal thickening and medial fibrosis[3–5]. Atherosclerotic changes may be intensified by hyperlipidemia and hypertension. Gomori speculated that tumour infiltration or compression of the involved vessel may contribute to aneurysmal dilatation[1]. Moreover, conditions in which patients receive cranial irradiation may not be associated with sufficient survival to allow vascular consequences to become manifest.

Emphasis should be placed on sequential follow-up of possible vascular involvement in long-term surviving patients who have had radiotherapy.

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Correspondence and Reprints: Daniel J. Scodary, M.D., University of Cincinnati, College of Medicine, Department of Neurosurgery, 231 Bethesda Avenue, Cincinnati, OH 45267-0515, U.S.A.