Elective Circulatory Arrest in Intracranial Surgery

Successful Treatment of an Aneurysm of the Basilar Artery with a Method of Open-Chest Circulatory Arrest

EDGAR M. HOUSEPIAN, M.D., FREDERICK O. BOWMAN, JR., M.D., AND AARON J. GISSEN, M.D.

Departments of Neurological Surgery, Surgery, and Anesthesia of the College of Physicians and Surgeons, Columbia University, and the New York Neurological Institute, Columbia-Presbyterian Medical Center, New York, N. Y.

The obvious advantages of elective circulatory arrest in the treatment of a variety of intracranial vascular conditions has been recognized for sometime. The rapid development in the past two decades of extracorporeal by-passing techniques in cardiac surgery and the development of modified Drew techniques for regional perfusion and oxygenation have given impetus to the adoption of such techniques for intracranial vascular arrest.

MacCarty has summarized the experience at the Mayo Clinic and elsewhere with by-pass methods in neurosurgery. Certain inherent problems of brain perfusion and blood clotting suggest that this approach is not practical at the present and may not be in the future. Levy and Lillehei described a method of fibrillatory arrest which they felt virtually eliminated the hazards of air embolism in open heart surgery. In all of their cases, elective fibrillatory cardiac arrest was used in association with cardiac by-pass on a pump oxygenator.

In 1958 a patient undergoing bifrontal craniotomy under hypothermia for treatment of an anterior communicating artery aneurysm at the New York Neurological Institute suffered a spontaneous cardiac arrest. Open-chest resuscitation involving defibrillation and manual systole for 40 minutes was used successfully, and the patient made an uneventful recovery. Later, another similar case was also successfully completed despite spontaneous cardiac arrest during hypothermia requiring manual cardiac massage for 90 minutes. It was clear from these two cases that the period of fibrillation provided almost ideal intracranial conditions for dealing with the vascular anomaly. Since that time, we have considered using elective circulatory arrest in the treatment of certain basilar artery aneurysms which otherwise have a high surgical mortality in the event of their rupture at operation.

Small reported a successful method of circulatory arrest in intracranial surgery utilizing inflow occlusion. He has also reported on a closed-chest method of circulatory arrest using an artificial pacemaker passed through an arm vein to the apex of the right ventricle.

The following case describes our experience in the successful treatment of an aneurysm of the mid-basilar artery by another method of elective open-chest ventricular fibrillation and circulatory arrest.

Case Report

History. The patient was a 57-year-old right-handed woman with a 30-year history of "migraine" and symptoms of recurrent left occipital headache associated with aberrations in the right visual field. Seven weeks before admission to the New York Neurological Institute, while on vacation, she had a sudden fainting spell followed by a period of confusion and headache. She was admitted to the Victoria General Hospital, Halifax, Nova Scotia, where bilateral carotid and left vertebral arteriograms demonstrated a large aneurysm filling from the basilar system and believed to be on the proximal segment of the posterior cerebral artery between the basilar and the posterior communicating artery on the left (Fig. 1). The large posterior cerebral artery on the left was also the major feeder of an immense arteriovenous malformation in the left occipital lobe. The
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Fig. 1. Preoperative left lateral and anteroposterior vertebral brachial arteriograms showing the aneurysm of the basilar artery which appeared to arise at the junction of the posterior cerebral artery on the left. Early filling of a large left occipital arteriovenous malformation is also shown.

patient made an uneventful recovery. She was asymptomatic at the time of her admission to the Neurological Institute of New York except for a partial right homonymous field defect. It was felt that the size and location of the aneurysm justified surgery; because of the potential intracranial surgical difficulties it was decided to have a cardiac team open the left chest and pericardium and induce fibrillation and circulatory arrest, should the need arise.

Operation. The patient came to the operating room well premedicated with 100 mg of Secobarbital and 0.4 mg of Scopolamine. Anesthesia was induced with intravenous Pentothal; endotracheal intubation was performed following succinylcholine relaxation. Anesthesia was maintained with nitrous oxide-oxygen (2:1 proportion) supplemented by 1 to 0.25% of Halothane and a total dose of 54 mg I.V. d-tubocurarine. Moderate controlled hyperventilation was maintained throughout except at the times of complete circulatory arrest. A radial arterial cannula connected to a liquid manometer was used to avoid electrical interference from the surgical cautery. The patient was rapidly cooled by surface blankets (Thermorite) to a low point of 29.5°C. Only when the patient began to warm up, as shown by the reversal of temperature gradients from the monitoring rectal and esophageal thermometers, was the circulation arrested by cardiac fibrillation. At this time the temperature was 30.0°C.

A thoractomy was carried out to provide access to the left ventricle. A left temporal craniotomy was done, but the dura was not opened until the chest field had been prepared. Spinal drainage, intravenous urea, and gentle elevation of the temporal lobe provided adequate visualization of the tentorial incisura. The tentorium was split and the enlarged left posterior cerebral artery visualized. With gradual expansion of the operative field, it was possible to see the internal carotid and posterior communicating arteries and a large aneurysm originating at the junction of the middle and upper third of the basilar artery obscuring its own neck. The third nerve was displaced and angulated by the sac. The fourth, fifth, and sixth cranial nerves were visualized in the field, as was the mesencephalon. It was then apparent that this thin-walled multilobulated aneurysm could not be dissected free without rupture and the serious consequences of hemorrhage in a tight compartment.

Ventricular fibrillation was induced by electrical stimulation of the left ventricle, and total circulatory arrest was produced. The aneurysmal sac was then dissected and mobilized and did indeed rupture because of a residual, though reduced, arterial blood flow estimated at 20 to 40 mm of mercury