HYPOTHERMIA, AND INTERRUPTION OF CAROTID, OR CAROTID AND VERTEBRAL CIRCULATION, IN THE SURGICAL MANAGEMENT OF INTRACRANIAL ANEURYSMS

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Dissatisfaction with the results of operative treatment of aneurysms of the circle of Willis using systemic hypotension followed the study of 19 patients, in whom the aneurysm was attacked directly within 14 days of initial or recurrent haemorrhage. These were not consecutive cases, older patients were not operated on, and there were several examples of serious recurrent haemorrhage. They are, however, not suitable for detailed analysis here, save to note that there were 7 deaths, 4 bad, 1 good and 7 excellent results. This experience led one of us (W.M.L.) to study experimentally methods for protecting the brain from anoxia.

Louheed and Kahn found impracticable extracorporeal shunts of arterial blood in experimental animals, with or without local cooling. These authors, following the lead of Bigelow, Callaghan and Hopps, then assessed general hypothermia and found that substantial protection from anoxia was afforded to the brain in dogs. At 25°C. (77°F.) the cerebral metabolic rate was reduced to 25–35 per cent of normal. Louheed et al. used hypothermia in 2 patients, temporarily occluding both common carotid arteries in the course of a hemispherectomy, and carotid and vertebral arteries bilaterally during the removal of an arteriovenous malformation.

The purpose of this paper is to report our experience of operating on 22 patients at varying periods after rupture of an aneurysm using hypothermia to minimize the effects of anoxia. Temporary occlusion of the great vessels of the neck bilaterally in varying combinations was employed when made necessary by bleeding from the aneurysm or an adjoining artery. These patients were operated on between May, 1954 and April, 1955, and the series includes every case of subarachnoid haemorrhage with an aneurysm demonstrated by bilateral carotid angiography, save one middle cerebral aneurysm operated on successfully. One patient died with an aneurysm of the anterior communicating artery, which was not shown by bilateral angiograms and one other patient who recovered had only one negative angiogram. A large aneurysm was not encountered in this series. These cases were referred either
from the Emergency Department of this hospital or from outlying hospitals to the Neurosurgical and Neurological Services, and this accounts for the wide variation in interval between haemorrhage and operation. Additionally, natural selection eliminates certain bad cases during the period required for diagnosis and transfer.

**METHOD**

Induction of hypothermia has followed the procedure outlined previously using a bath containing ice water.\(^{13,14}\) Major changes have evolved in the method of anaesthesia and the control of shivering which seem to make cooling by extracorporeal shunts, as originally described by Delorme,\(^7\) unnecessary.

*Pre-operative Assessment.* Clinical assessment leading to diagnosis of subarachnoid haemorrhage is followed by electroencephalography and blood studies. Serum potassium, calcium, chlorides, CO\(_2\) combining power, non-protein nitrogen and blood sugar studies are done as often as possible. Percutaneous angiography, usually bilateral, is carried out under local anaesthesia. Assessment of the cardiovascular status of each patient who may undergo hypothermia includes special enquiries of the patient or relatives as to the history, together with clinical examination and electrocardiography. Insufficient emphasis was placed upon this part of the pre-operative assessment in the earlier cases. At this stage the surgeon, anaesthetist, cardiologist and physiologist decide as to the suitability of the patient for hypothermia and the optimum minimum temperature. With increasing age hypothermia is tolerated less well: the older the patient, the more vulnerable is the heart to temperatures below 30°C. (86°F.). In infancy and childhood low temperatures are better tolerated. Any evidence of degenerative cardiovascular disease is an indication that the minimum temperature should be 30°C. (86°F.). Operation using hypothermia is undertaken as soon as it is practical and possible, depending upon the acuteness of the situation and, latterly, in cases of recently ruptured aneurysms it has often been undertaken within 12 to 18 hours following admission.

*Anaesthesia.* From the beginning moderately large doses of chlorpromazine (Largactil) and promethazine (Phenergan) have been used to produce sedation, to potentiate other analgesics and anaesthetics and to aid in the production of hypothermia. Chlorpromazine (50 mg.) and promethazine (50 mg.) are given intramuscularly the night before operation if the patient is to wait until the following morning, and this is repeated together with Demerol (50 mg.) at six o'clock in the morning. At seven o'clock the patient is taken to the operating room and a slow intravenous drip is begun of 250 cc. normal saline, containing 50 mg. each of chlorpromazine, promethazine and Demerol. The rate of drip is adjusted according to the level of the patient's consciousness. By this time the patient is very drowsy, unaware of his surroundings and easily intubated under topical anaesthesia and light nitrous oxide, trichlorethylene anaesthesia. The gas is administered by continuous high-flow, non-rebreathing, non-CO\(_2\) absorption technique.