HYPOTHERMIA IN THE SURGICAL TREATMENT OF Ruptured INTRACRANIAL ANEURYSMS*

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Hypothermic anaesthesia for cerebrovascular surgery was begun in the Toronto General Hospital in the summer of 1954. This followed upon the general physiological studies of hypothermia by Bigelow and his co-workers,1,2 the experimental studies of Lougheed and Kahn7 regarding the effects of hypothermia in the prevention of cerebral anoxia, and the clinical experience of Lougheed et al.8 using hypothermic anaesthesia for one case of arteriovenous malformation and one hemispherectomy for glioblastoma multiforme.

Cerebrovascular surgery presents all the difficulties encountered in the surgery of large vessels throughout the body and there are problems inherent in the relatively small size of cerebral vessels; even the internal carotid artery is small in proportion to the aorta, pulmonary artery or subclavian artery. The accurate repair of a ruptured aneurysm is facilitated by partial or complete interruption of the circulation, as described by Hamby,3 so that surgery may be done in a dry field. The resultant cerebral ischemia may cause infarction of the brain. Hypothermic anaesthesia provides protection against anoxia and infarction, allowing occlusion of the blood flow for longer, though still short periods. Additionally, dissection of an aneurysm and manipulation of the cerebral artery bearing it may cause arterial spasm and traction damage to the perforating vessels with resulting anoxia. The deleterious effects of spasm may be avoided when hypothermia outlasts the spasm. The reduction in brain volume accompanying hypothermia provides a “slack” brain, facilitating exposure of an aneurysm of the circle of Willis.

The results of the treatment of ruptured aneurysms by intracranial repair two or more weeks following bleeding as reported by Norlén and Barnum,19 Norlén and Olivecrona11 and Falconer4 show a low mortality and morbidity rate. The results of the direct surgical treatment of a large group of patients with ruptured aneurysms, approximating a consecutive series, within days following bleeding have not yet been reported. The value of early surgical treatment is difficult to assess for the natural history of a consecutive series of angiographically verified aneurysms is not yet available as a control.

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McKissock and Walsh\(^3\) have most nearly achieved a control series and have made a strong case in support of very early surgical treatment. Logue\(^6\) has reported encouraging results in the early treatment of anterior cerebral aneurysms by clipping the anterior cerebral artery.

It is the primary purpose of this paper to report our experience with hypothermic anaesthesia in the management of ruptured aneurysms at varying stages and particularly in the first week following haemorrhage.

**TECHNIQUE OF HYPOTHERMIC ANAESTHESIA**

Between the summer of 1954 and January 1, 1957, no major change was made in the method of surface cooling described by our group in 1956.\(^3\) Pre-operative medication consisted of Laborit’s lytic cocktail, chlorpromazine, promethazine, and Demerol, 50 mg. of each. This was administered the night before operation and was repeated approximately 2 hours before operation. At the time anaesthesia was induced, a slow intravenous drip of normal saline containing 50 mg. each of these three drugs in 250 cc. was started. Anaesthesia consisted of nitrous oxide and trichlorethylene administered by a continuous high-flow, non-rebreathing, non-carbon dioxide absorption technique. Surface cooling in a bath using crushed ice and water followed, and re-warming by means of warm water was commenced as soon as the intracranial operation was completed.

Various rates of re-warming have been carried out. Certain modifications evolved in this technique and practised during the later cases may be summarized here. With a view to avoiding systemic hypotension and the administration of norepinephrine (Levophed) the dosage of chlorpromazine has been reduced and promethazine has been eliminated as a pre-operative sedative. Re-warming has been achieved by filling the tank with water at approximately 38.0°C. and as soon as the patient’s temperature is above 30°C. and is rising, the patient is removed from the bath, carefully dried, placed in a bed and covered with flannelette sheets and surrounded with water bottles at a temperature of 37°C. The patient is kept in a recovery room immediately adjoining the operating room and oxygen is administered by nasal catheter. The foot of the bed is elevated, and careful watch is kept on the blood pressure.

Shivering has been minimized by increasing the depth of anaesthesia and small doses (25 mg.) of chlorpromazine are used during the operation and postoperatively as required.

In elderly patients, or patients with evidence of atherosclerosis, arteriosclerosis and hypertension, our aim has been to avoid lowering the temperature below 30°C. In younger patients with no apparent cardiovascular disorder, the minimum temperature has commonly ranged between 28.6°C. and 30°C.

**RESULTS AND COMPLICATIONS ATTRIBUTED TO HYPOTHERMIA**

Hypothermic anaesthesia has been utilized in 88 cases of cerebral vascular problems consisting of 73 cases following rupture of a berry aneurysm,