Technique for Exposure of the Entire Circle of Willis in the Dog

Technical Note

TAKASHI IWABUCHI, M.D., AND WILLIAMINA A. HIMWICH, PH.D.
Thudichum Psychiatric Research Laboratory, Galesburg State Research Hospital, Galesburg, Illinois

Many hemodynamic studies of the brain have been reported, but the inaccessibility of the circle of Willis has made the study of that structure especially difficult. Physiological studies of small segments of the circle have recently been reported in cats and in dogs. The ability to observe the circle under direct vision, to make simultaneous measurements of pressure and flow in different segments, or to implant electrodes from the ventral surface of the brain would be valuable not only from a neurological but also from a physiological point of view. An improved technique for the surgical exposure of the entire circle of Willis in the dog will be described in this paper.

Materials and Methods

Twenty-four male and female mongrel dogs, weighing from 8 to 22.5 kg, were premedicated with atropine sulfate, 0.05 mg/kg, and anesthetized with pentobarbital sodium (Nembutal), 24 mg/kg, intravenously. A tracheal tube was inserted; additional atropine and Nembutal were given as needed. The dog was fixed on a table in a supine position, and the cranial part of the table was tilted up about 45°. This position seemed to reduce intracranial venous pressure and thus facilitated the procedure of dissection of the cavernous sinus.

A longitudinal skin incision was made in the median portion of the neck from the mentum to the sternal manubrium. The carotid sheath was preserved bilaterally at the medial side of the sternocleidomastoid muscle. The sternothyroid muscle was cut from its origin together with the stylohyoid bone. The medial surface of the digastric muscle was dissected. After tracheostomy and replacement of the endotracheal tube, the trachea was cut together with the esophagus and the sternohyoid and omohyoid muscles.

The area anterior to the upper cervical vertebral column and the basi-occipital portion of the occipital bone were exposed by blunt dissection. Both the medial and lateral surfaces of the pterygoid bone were dissected up to the posterior nasal spine of the palatine, and the pterygoid bone was rongeured with care to avoid injury to the vessels of the optic canal and the orbital fissure. From the anterior rim of the foramen magnum, the basi-occipital portion of the occipital bone was rongeured out as widely as possible. The internal carotid arteries especially in the region near the carotid canal and the foramen lacerum were preserved. As the dissection progressed rostrally the dorsum sellae appeared, surrounded by the cavernous sinuses and by the posterior and anterior intercavernous sinuses. With meticulous care, it was possible to dissect this dorsum sellae from the thin-walled dilated venous sinuses. Thus the anterior medial portion of the skull base was removed by rongeur from the foramen magnum to the anterior clinoid process and the dura mater exposed (Fig. 1).

When the dura mater had been opened and the intercavernous sinuses clipped or sutured to the edges of dura mater, the basilar artery, both posterior cerebral arteries, the posterior communicating arteries, the intracranial portion of the internal carotid, and the first portion of the middle and anterior cerebral arteries could be clearly viewed (Fig. 2). If the optic nerves were pushed aside, the anterior communicating artery also could be seen. In 21 out of 24 dogs the entire circle was exposed in good condition while the animals maintained normal blood pressure and showed no evidence of shock. The surgery usually required about 4 hours, and the dogs could be maintained in a stable condition as judged by blood pressure and heart rate for at least 4 more hours.

Received for publication November 25, 1968.
Exposure of Circle of Willis in Dog

Discussion

Exposure of the basilar artery through an anterior approach has been utilized in many animal experiments, but we have been unable to find a report of the entire circle of Willis having been exposed by craniotomy in the living animal. Although attempts to study brain circulation without surgical intervention have been fruitful, many studies require a direct view of the circle of Willis. In the dog because of collaterals between the extra- and intracranial arteries it is imperative to use the main intracranial arteries for definitive studies of brain circulation.