Special report

Summary of First International Symposium on Intracranial Pressure, Hannover, Germany, July 27–29, 1972

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The author, at the invitation of the Journal, reports a symposium on intracranial pressure. Points of view on the various topics discussed are reduced to a consensus so that the article provides a brief summary of current views on this important subject.

—The Editor

The First International Symposium on Intracranial Pressure (ICP) was held in Hannover, Germany, July 27-29, 1972. It had been organized by Prof. H. Dietz and Dr. M. Brock under the auspices of the University of Hannover Medical School. Sixty-four papers were presented and discussed by an invited group of scientists and clinicians from all parts of the world. The scientific material was divided into several categories: 1) methodology; 2) experimental studies of the effects of focal brain damage and brain compression on ICP; 3) the effects of raised ICP on cerebral blood flow (CBF) and metabolism; 4) the relationship of ICP, CBF, and neurological status in patients with acute brain insults and hydrocephalus; and 5) the effects of various drugs on ICP, with particular emphasis on anesthetic agents. At the conclusion of the meeting the organizing committee and chairmen of the scientific sessions reorganized the material and wrote summaries that will be included in the proceedings of the symposium. The proceedings will be published by Springer-Verlag in 1973.

The interpretations and opinions expressed in this brief summary represent a consensus rather than a personal opinion.

Techniques for Measuring ICP

The only reliable method of measuring ICP is directly from the intracranial space. Cerebrospinal fluid (CSF) pressure measurements may accurately reflect ICP in the majority of patients, but increased ICP often is not fully transmitted to the spinal subarachnoid space in patients with brain swelling and intracranial mass lesions. The two principal types of instruments used for continuous recording of ICP are a catheter or cannula inserted into a CSF space, usually the lateral ventricle, and a solid state transducer placed in the epidural or subdural space or occasionally the brain tissue. The advantages of the ventricular cannula, besides its proven reliability in hundreds of cases reported, are that it provides a method for calibration of the recording system in vivo and the ability to withdraw CSF for immediate reduction of ICP or chemical analysis. The disadvantages of the method...
are the necessity of penetrating the brain, the requirement of an external fluid connection that may increase the risk of infection, and the difficulties encountered in establishing or maintaining a pressure recording in patients with small ventricles or ventricles that contain debris that tends to obstruct the cannula. The incidence of intracranial infection in experienced hands is 1% to 2%, and morbidity and mortality directly attributable to the technique appear to be virtually nil. The incidence of recording failure, especially in patients with acute head injuries and brain swelling, has not been established but probably is significant.

Several solid state transducers were described at the meeting. The basic principle in all of them, as in pressure transducers in general, is displacement of a pressure-sensitive diaphragm by a change in ICP. The movement of the diaphragm is converted to electrical energy; the electrical output is proportional to the mechanical input. Most of the transducers are a few millimeters in diameter. They are inserted through a burr hole into either the epidural or subdural space, almost always the former in the studies described at the symposium. The principal advantage of a solid state transducer compared to an intraventricular cannula is that the intradural space is not penetrated, thereby reducing the chances of brain damage and infection. Most, if not all, of the instruments are subject to baseline drift that can be large and cannot be detected during the recording period with the exception of recent models that permit calibration in vivo. Calibration is performed through a length of tubing (snorkel) from the diaphragm to the exterior.

A modification of the "transensor" was also described. It consists of an implantable glass-enclosed tuned circuit that is activated by an external oscillator. There are no external connections, and the device can be left in place indefinitely. However, there are a number of technical problems to be solved, and probably the instrument can record only pulse pressure, not absolute pressure.

**Transmission of Increased ICP**

During expansion of an intracranial mass lesion or brain swelling the rise in pressure in the spinal subarachnoid space tends to lag behind the increasing pressure in the intracranial space due to obstruction of subarachnoid pathways at the tentorial incisura, the foramen magnum, or both locations. This dissociation of pressures has been demonstrated in both experimental animals and man, and occasionally supratentorial pressure may equal the blood pressure at a time when lumbar subarachnoid pressure is normal.

Pressures recorded with extradural solid state transducers are equal to or slightly higher than ventricular and subarachnoid pressures under normal conditions, and as ICP is increased extradural pressure rises out of proportion to CSF pressure. The difference may reach 20 to 30 mm Hg at high pressure levels. Whether this represents a true difference in pressure across the dura or is an artifact of the recording system has not been determined. Bilateral extradural transducers were used to record temporal fossa pressures in experimental animals before and after occlusion of one middle cerebral artery. During the acute phase following the occlusion, large differences in pressure were observed across the supratentorial space. These observations explain reductions in regional CBF in or adjacent to mass lesions and focal brain swelling.

Several methods to measure brain tissue pressure were described including a catheter with a fluted tip and a catheter that contains long, fine strands of wool that protrude from the tip of the plastic tubing as a wick. Tissue pressure measured with these devices may be higher or lower than intraventricular pressure, and the change in tissue pressure with rising extracerebral pressure is uncertain. A problem with these techniques is the necessity of creating a fluid-filled cavity within the brain substance at the tip of the catheter. The cavity pressure might be artifactualy high and thus not bear a predictable relationship to true changes in tissue pressures surrounding it.

**Pathophysiology of Increased ICP**

Pressures waves are fluctuations in ICP that may occur spontaneously or be caused by changes in systemic blood gases. There was agreement at the symposium that the original terminology for pressure waves