Technique for Continuous Intracranial Pressure Recording*  
Technical Note  
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A continuous, accurate knowledge of intracranial pressure would be of great value as a guide for therapy and as an index of the clinical state in many neurosurgical cases, particularly in recording pressure changes in acute head injury cases. The response of intracranial pressure to hypothermia, fluid deprivation, mannitol or urea, corticosteroids, and improved ventilatory exchange could then be recorded. Intracranial pressure recordings could also be correlated with other physiological measurements, such as blood pressure, cardiac rate, and respiratory rate.

We are describing a technique which we have evaluated in experimental animals and subsequently used in two patients who had anaplastic cerebral tumors treated by cryosurgery. In these two patients, we anticipated that an increase in intracranial pressure would occur following focal freezing of the lesions. We desired to observe the extent and duration of this pressure alteration as well as to have an opportunity to consider the method for further use in patients with severe acute head injuries.

Operative Technique  
A miniature pressure transducer which had been gas-sterilized was introduced through a burr hole into the subdural space through a small slit in the dura. The transducer was placed under the intact bone to provide the necessary resistance (Fig. 1). The transducer leads were brought out through the burr hole and held in position by a small tantalum flange and screw fixed to the edge of the burr hole. Leakage of cerebrospinal fluid through the small dural slit was minimal; however, the burr hole opening was closed with bone wax as an added precaution.

The transducer was immediately connected to a suitable recorder for baseline pressure determination. Cryosurgery was then carried out through a second burr hole. When the scalp incision was closed, the leads were brought out of one end of the wound and further stabilized in the head dressing. The patient and recorder were returned to the ward for continued recording for 1 week postoperatively. The transducer was then removed under local anesthesia through partial reopening of the original incision. No complications related to the recording technique were noted in these two patients.

Recording Technique  
A Scientific Advances (Columbus, Ohio) Model MM-BW pressure-sensitive transducer was used in this study. It was connected to a Grass Instruments Company Model 5B polygraph through a cable and several resistors, to permit the use of a Model 5P1 Low Level DC preamplifier. This MM-BW transducer is a 6.35 mm diameter disc, 0.5 mm thick, containing four arms of a Wheatstone bridge. It is designed to operate at 26 to 35 inches of Hg with a temperature variation of 0.2% of full scale per degree Fahrenheit. Thus, at the pressures expected, there could be as much as a 20% error caused by temperature changes of 1°F.

To compensate, the temperature effect upon the transducer was calibrated in terms

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of the resistance change (balance voltage) required to maintain recorder-pen stability. Following intracranial implantation of the transducer, the “balance voltage” dial could then be adjusted correctly for concurrently measured body temperature in order to afford manual temperature compensation. This permitted temperature correction to within 1% of full scale, using the closest 0.1°C, which is better than the precision of reading the pen recording. With the highest sensitivity used, an error of 0.1°C was equivalent to 6 mm H₂O. An additional 4 mm H₂O error could occur by a one unit error in setting the “balance voltage” dial. Hence, the maximum error was ±10 mm H₂O with a usual precision of ±5 mm H₂O at all sensitivities. To operate the preamplifier at the middle of the “balance voltage” dials (actually precision resistors), and since the numbers are arbitrary for the present purpose, a 10,000 ohm resistor was added parallel to these precision resistors (Fig. 2).

Since the manufacturer’s suggested input voltage of 3.0 V heated the transducer more than necessary, a voltage divider was incorporated in the transducer cable which made available the stable 12 V DC excitation voltage from the preamplifier and decreased the excitation voltage of the strain gauge to below 2 V. With this arrangement (Fig. 2), it was possible to calibrate the transducer against a Statham strain gauge as well as against mercury and water manometers. No additional resistor was added to the “bridge calibration” switch; when it was depressed, a 34.0 mm deflection of the recorder pen calibrated the record to 2000 mm H₂O for full-scale pen deflection (40 mm) at a sensitivity of 0.5 mV/cm. All other calibration settings of the polygraph were done according to the Grass manual. By increasing the sensitivity by a factor of 5, a 200 mm H₂O intracranial pressure could be recorded in the middle of a channel. It should be noted that the calibration deflection and the balance voltage setting will vary slightly when using other 5P1 preamplifiers; therefore, each preamplifier must be individually calibrated.

Following implantation, the amplifier settings were verified twice a day. Further, the preamplifier settings were verified in two ways: 1) a reduction of the sensitivity by one-half should reset the pen one-half of the way towards the baseline, which represents atmospheric pressure; 2) pushing the “bridge calibration” switch at a sensitivity of 1.0 mV/cm should deflect the pen by 17.0 mm. Temperature compensation was, of course, continuously carried out by appropriately setting the “balance voltage” dial. All readings were compared to a second pen, whose galvanometer switch was turned off to eliminate any errors from paper weave. The “half amplitude high frequency” switch may be turned to 15 to reduce any possible 60 cycle hum, to 3 to further reduce pulse waves, or to 0.5 or 0.1 to reduce respiratory