SHORT REPORT

Clinical comparison of the Spiegelberg parenchymal transducer and ventricular fluid pressure

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Abstract

The Spiegelberg brain pressure catheter is a low cost implantable intracranial pressure measuring system which has the unique ability to perform regular automatic zeroing. A new version of the catheter has become available with a subdural bolt fixation to allow insertion of the device into the brain parenchyma. The accuracy of this system has been evaluated in comparison with a ventricular fluid pressure method in a series of patients to determine its accuracy and utility in the clinical environment.

Hourly readings from the Spiegelberg system have been compared with those obtained using a standard pressure transducer connected to an external ventricular drain. Measurements continued while there was a clinical need for CSF drainage.

Eleven patients were recruited to the study and data were recorded for periods ranging from 40 to 111 hours. A good agreement between the two systems was obtained. In 10 cases the mean difference was less than ± 1.5 mm Hg and the dynamic changes in value were contemporaneous. In one case an intracerebral

haemorrhage developed around the tips of the Spiegelberg catheter and significant differences occurred between the two methods of measurement.

In conclusion, the Spiegelberg parenchymal transducer provides an accurate measurement of intracranial pressure when compared with ventricular pressure. The transducer was found to be robust in the clinical environment and very popular with the nursing staff. Further studies may determine whether the complication rate of this system is comparable with other available devices.

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It is important to ensure that new devices for monitoring intracranial pressure are critically evaluated in the clinical environment before they are put into routine clinical service. There have been several different methods employed to evaluate the accuracy of intracranial pressure (ICP) monitors. Comparisons with subdural, parenchymal, extradural, and ventricular pressures have all been used despite the generally accepted belief that ventricular pressure is the gold standard method to which all others should be compared.¹⁻⁴ This study was designed to evaluate the Spiegelberg parenchymal transducer by comparing readings obtained with those from a catheter filled with ventricular fluid. The Spiegelberg parenchymal ICP measurement system is unique in that it is the first such system capable of performing regular automatic zeroing in situ. This is important as concern has been expressed about the long term stability of ICP measurement using parenchymal probes.⁵

The system consists of an air filled catheter with an air pouch at the distal end. This is placed in the parenchyma using a bolt system similar to that used with other ICP devices. Intracranial pressure is transmitted across the wall of the pouch and along the catheter to a pressure transducer sited within an electronic monitor. Once every hour the pressure transducer is opened to the atmosphere to compensate for any drift in the zero level.

Figure 1 Sample recording showing good agreement over time between the Spiegelberg catheter and the transducer connected to the external ventricular drain.

Methods

Eleven patients who required the insertion of an external ventricular drain as part of their routine management had a Spiegelberg transducer inserted into the parenchyma ipsilateral to the ventricular drain. A semiconductor transducer (B Braun Ltd) was connected to the drainage catheter and sited at the level of the external auditory meatus. The transducer zero and calibration were checked twice daily. The ventricular catheter remained in situ for as long as clinically required. Consent or relatives' assent was obtained before the inclusion of each patient in the study. This was approved by the joint ethics committee of Newcastle Health Authority and Newcastle Universities.

Simultaneous readings from the Spiegelberg and external drain transducers were taken every hour. If the ventricular catheter was on open drainage the line was closed and the system allowed to equilibrate for 2 minutes before a reading was taken. Data could have been

recorded at a higher rate, but this would have increased the correlation between successive readings. Using such a time interval between each successive measurement allows for the comparison of readings from the two systems to be made in conjunction with any physiological changes in pressure that may occur during that period. This can be accomplished over extended periods of time.

Results

Data were obtained from 11 patients according to the study protocol. A total of 843 hourly readings were taken (median recording 76 hours, range 40–111 hours). No Spiegelberg transducers failed during the monitoring period and their insertion was not associated with any infection. In one patient, initial ICP monitoring was undertaken using a Camino intraparenchymal transducer and the initial readings were about 30 mm Hg. Forty eight hours after admission a second CT was performed because of persistently raised ICP. This demonstrated hydrocephalus and a ventricular catheter was inserted for CSF drainage. The patient was recruited to the study and a Spiegelberg transducer inserted on the contralateral side to the Camino but ipsilateral to the ventricular catheter. Ten hours after insertion of the Spiegelberg transducer, the readings from the device began to increase. This increase was not seen in the ventricular pressure or the Camino. The difference in the readings between the Spiegelberg and ventricular pressure increased to a maximum difference of 35 mm Hg. At that time further CT showed a small intracerebral haemorrhage (12 ml in size) around the distal tip of the Spiegelberg transducer. The ventricular drain and the Spiegelberg transducer were both then removed. This isolated case has already been reported.⁶

In the other 10 patients there was good agreement between the readings from the Spiegelberg transducer with those from the ventricular drain (fig 1). The complete data set from one patient, recorded continuously over a period of 70 hours, is shown in figure 1. Over the entire period the absolute difference between the two readings was small, 44% were equal to or less than 2 mm Hg and 87% were equal to or less than 5 mm Hg. A similar pattern was seen in the other nine patients.

From the data collected from each patient the mean difference between all the pairs of readings was calculated, and an Altman-Bland plot produced showing the limits of agreement (fig 2). These are a useful way in which to graphically display the data and show whether there is any bias within the data, particularly at higher values of ICP. This is achieved by plotting the difference of each paired reading against their mean. There was a significant decreasing relation between the mean pressure and the difference (Spearman rank correlation $r = -0.355$, $p < 0.01$)—that is, as the ICP increases the difference between the two measurements decreases.

The absolute difference of each reading for each study recording was calculated and is

Figure 2 Altman-Bland plot showing the limits of agreement and frequency distribution of the difference between the external transducer and Spiegelberg catheter for data from all 11 transducer studies.

Figure 3 Mean (SD) of the absolute difference for each of the studies.

shown in figure 3. Study number 3 was the patient described earlier in whom a small intracerebral haemorrhage developed. It is not surprising, therefore, that the mean difference in this study was much larger in comparison with the values that were seen in all the other studies.

The difference between each pair of readings was also calculated from the data from each patient recording. A frequency histogram showed a normal distribution of the data. A high percentage (79%) of the readings were within ± 5 mm Hg, and 96% were within ± 10 mm Hg. The mean difference between the two readings was less than 0.1 mm Hg (EVD–Spiegelberg) with an SD of 4.9 mm Hg.

Discussion

The data produced in this study support the view that the Spiegelberg parenchymal transducer provides an accurate measurement of intracranial pressure compared with ventricular pressure. This was established over extensive periods of monitoring. The transducer was found to be robust in the clinical environment and very popular with the nursing staff.

A 9% complication rate would be unacceptable for any system of ICP measurement. However, in a small series such as this, any single source of complication is likely to produce such a result. Only in a much larger series, where the system is being used routinely, should such rates be established. We will continue to monitor the use of these catheters, which we have found to be accurate, easy to use, and reliable.

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