Neurosurgical forum
Letters to the editor

CSF Pulse Pressure and B Waves


Abstract

**Object.** The appearance of numerous B waves during intracranial pressure (ICP) registration in patients with idiopathic adult hydrocephalus syndrome (IAHS) is considered to predict good outcome after shunt surgery. The aim of this study was to describe which physical parameters of the cerebrospinal fluid (CSF) system B-waves reflect and to find a method that could replace long-term B-wave analysis.

**Methods.** Ten patients with IAHS were subjected to long-term registration of ICP and a lumbar constant-pressure infusion test. The B-wave presence, CSF outflow resistance ($R_{CSF}$), and relative pulse pressure coefficient (RPPC) were assessed using computerized analysis. The RPPC was introduced as a parameter reflecting the joint effect of elastance and pulsatil volume changes on ICP and was determined by relating ICP pulse amplitudes to mean ICP.

**Conclusions.** The B-wave presence on ICP registration correlates strongly with RPPC ($r = 0.91, p < 0.001, 10$ patients) but not with CSF $R_{CSF}$. This correlation indicates that B waves—like RPPC—primarily reflect the ability of the CSF system to reallocate and store liquid rather than absorb it. The RPPC-estimating lumbar short-term CSF pulse pressure method could replace the intracranial long-term B-wave analysis.

The problem of an agreement between ICP parameters derived from long-term monitoring and CSF infusion testing is important because in several institutions these two methods are used alternatively.

In those patients in whom an infusion test was inconclusive we performed ICP monitoring overnight to gain a more comprehensive picture. The criteria of an inconclusive test was the resistance to CSF outflow ($R_{CSF}$) close to the border value of 13 mm Hg per ml/minute and other parameters, such as opening pressure, elasticity, and so forth, not revealing any abnormality in CSF compensation. In the past we studied 28 patients with hydrocephalus (the results were presented during the Third International Hydrocephalus Workshop in Kos, Greece, in 2001). In a manner similar to that used by Lenfeldt and colleagues, we compared the parameters from an infusion study: $R_{CSF}$, slope of the amplitude–pressure regression line (an equivalent of the relative pulse pressure coefficient, which is a new name for the variable described in 1970s, with magnitude and a relative time of occurrence of B waves of given magnitude recorded overnight. The difference in our findings, however, was that we did not find any significant correlation between B waves and the slope of the amplitude–pressure line ($r = −0.21; p = 0.28$). Similarly, $R_{CSF}$ and B waves did not correlate with each other ($r = 0.24; p = 0.21$). Why such a discrepancy? The authors conducted their study in a very small group of well-selected patients. Our group was almost threefold larger (but not all patients had the idiopathic type of normal-pressure hydrocephalus). With such a small group of 10 patients the probability of conducting a Type I error is quite high. (Type 1 is an error that occurs when the statistical test shows that the studied feature is significant, when in fact it is not significant.)

Generally, an investigation into associations between various CSF compensatory and clinical parameters in larger group studies (>25 patients) bring typical absolute $r$ values ranging from 0.3 to 0.6. Strong correlations such as 0.9 are seen extremely rarely.3,5,8 Momjian, et al.7 found the correlation between the CSF $R_{CSF}$ and B-wave recording over a short period during an infusion test equal to 0.61.

Lenfeldt and colleagues used a very precise way of measuring B waves; however, in our method, based on spectral detection of waves within the bandwidth equivalent to the period from 20 seconds to 3 minutes, it is still doubtful that results would be so dramatically different.

Another important point concerns the meaning of B waves. Although the CSF $R_{CSF}$ has been investigated using randomized trials, the descriptors of B waves have never been studied in that way. In fact, only a few early studies2,5 confirm the association between the frequency of B waves and the outcome following shunting. There are data showing that B waves occur particularly intensely during the rapid eye movement phase of sleep. Does the relative time when waves are recorded simply demonstrate how frequently patients undergo rapid eye movement sleep?4,6 Perhaps the magnitude of waves is more relevant. Starting from which amplitude can we draw conclusions about the occurrence of waves?

From what we know about the detrimental role of raised ICP, we can assert that it is not just the amplitude of B waves that is important. Generally, how much ICP may increase during all spontaneous elevations—B waves, plateau waves, waves associated with sleep apnea, or any other phenomenon leading to intermittent ICP hypertension—is more relevant.

ZOFIA CZOSNYKA, PH.D.
MAREK CZOSNYKA, PH.D.
JOHN D. PICKARD, F.MED.SCI.
Addenbrooke’s Hospital
Cambridge, United Kingdom

**References**

5. Graff-Radford NR, Godelsky JC, Jones MP: Variables predicting...


**Response:** We welcome the comments by Dr. Czosnyka and colleagues and provide hereunder our response.

**Type I Error.** Our study is the first of its kind: a perusal of the abstracts book from the Third International Hydrocephalus Conference in Kos, Greece, 2001, does not reveal any results from a comparative study. To rebut speculations on a Type I error, we have provided the B-wave presence–Relative Pulse Pressure Coefficient (RPPC) plot (Fig. 1). It was not displayed in the original paper because the reviewers thought it was redundant. The exact probability value was $2.3 \times 10^{-4}$ and would meet the requirement of a very highly significant result. The data are well distributed without any clusters, and adding or subtracting values would not render the results statistically insignificant. Because of ethical considerations we kept the study size small but homogeneous, with only true idiopathic cases being included; this selection was confirmed by the positive results of shunting. Superficially, the choice of B-wave analysis may seem irrelevant; however, as shown, dissimilar methods yield differing degrees of precision. Thus, the power of our evaluated objective method should not be underestimated. Furthermore, the RPPC is well defined and its method of measurement is plain and simple. It was calculated using a considerable pressure range and when the pump was at rest, which further enhances the credibility of the results. No patients were excluded based on the R$_m$. Based on these facts, it is more likely that the high correlation is the result of B waves and RPPC both actually reflecting the storage capacity of the CSF system and not because of a Type I error.

**The RPPC Designation.** We are fully aware that Avezaat and colleagues have already described the regression method behind RPPC—we have simply given an apt name to the slope. The reference list in our paper states Avezaat as author or co-author in five of seven initial references.

Fig. 1. Plot of B-wave presence (B%) compared with RPPC. The correlation equation reads B% = 81 \times \text{RPPC} – 0.8 (r = 0.91, p < 0.001, 10 patients).

**Neurosurgical forum**

**B Waves and Shunting.** The recurring question of the B-wave examination as a predictive test for shunting was not in the scope of our study; however, our data indicate that it might be replaceable by a short-term lumbar infusion to assess the RPPC. The tenability of this statement must of course be validated in randomized studies. **References**


**Temporal Lobe Epilepsy**


**Abstract**

**Object.** The syndrome of medial temporal lobe epilepsy (MTLE) may occur in patients in whom magnetic resonance (MR) images demonstrate normal findings. In these patients, there is no evidence of hippocampal sclerosis on neuroimaging, and histopathological examination of the resected hippocampus does not reveal significant neuron loss. In this paper the authors describe the distinct clinical features of this MTLE subtype, referred to as paradoxical temporal lobe epilepsy (PTELE).

**Methods.** The authors selected 12 consecutive patients with preoperative findings consistent with MTLE in whom MR imaging did not demonstrate any hippocampal abnormality. Onset of hippocampal seizure was confirmed by long-term intracranial monitoring. There were six female and six male patients with a mean age of 32 ± 11 years (mean ± standard deviation [SD]) at presentation. These patients’ seizure histories, available hippocampal volumetric measurements, and hippocampal cell densities in different subfields were reviewed. Sharp electrode recordings from dentate granule cells that had been maintained in hippocampal slices provided a measure of excitation and inhibition in the tissue. We compared these data with those of a cohort of 50 randomly selected patients who underwent anteromedial temporal resection for medial temporal sclerosis (MTS) during the same time period (1987–1999). The durations of follow up (means ± SDs) for the PTELE and MTS groups were 51 ± 59 months and 88 ± 44 months, respectively.

A history of febrile seizure was present less frequently in the PTELE group (8%) than in the MTS group (34%). Other risk factors for epilepsy such as trauma, meningocerebralitis, or perinatal injuries were present more frequently in the PTELE group (50%) than in the MTS cohort (36%). In patients in the PTELE group the first seizure occurred later in life (mean age at seizure onset 14 years in the PTELE group compared with 9 years in the MTS group, p = 0.09).