

EARLY EXPERIENCE FROM THE APPLICATION OF A NONINVASIVE MRI-BASED MEASUREMENT OF INTRACRANIAL PRESSURE IN HYDROCEPHALUS

N. Alperin¹, J. J. Niebruegge¹, T. Lichtor², R. Glick²

¹Radiology, University of Illinois at Chicago, Chicago, IL, United States, ²Neurosurgery, Cook County Hospital, Chicago, IL, United States

Introduction

The decision for surgical intervention in hydrocephalic patients presenting with symptoms suggesting raised intracranial pressure (ICP) is challenging, as radiographic ventricular size often lacks the specificity to predict abnormal ICP. Furthermore, the current surgical treatment of a shunt placement is associated with a very high failure and complication rates (over 40% within the first year). Thus, the decision for surgical intervention is an important one with significant long term sequelae. An early assessment of the potential clinical utility of a noninvasive MRI-based measurement of intracranial pressure (MR-ICP) in symptomatic hydrocephalic patients being considered for surgical treatment is reported.

Methods

Twenty six symptomatic hydrocephalic patients, (17 shunted and 9 non-shunted) underwent brain MRI study which included measurements of CSF and blood flows to and from the cranial vault from which a measurement of intracranial pressure was derived using a previously described algorithm [1]. Briefly, the systolic momentary increase in intracranial volume (ICV) is calculated from the difference between arterial inflow, venous outflow and CSF flow between the cranium and the spinal canal. The pulse pressure associated with the systolic increase in ICV is derived from the CSF velocities using the Navier-Stokes relationship [2]. The ratio of the pressure and volume change, intracranial elastance, is linearly related to MR-ICP. The distribution of the MR-ICP values in the hydrocephalic patients was compared with the distribution of 71 MR-ICP measurements from 23 healthy control volunteers [3]. The positive (elevated MR-ICP value) and negative (normal MR-ICP) predictive values of the MR-ICP measurement were determined based on whether the patient underwent a surgical treatment of a shunt placement or shunt revision within a three month period following the MRI study.

Results

MR-ICP values in the hydrocephalic patients spanned a much wider range than in healthy control subjects. Yet, the majority of the patients (21 of 26) had an MR-ICP value within the normal range. The short term follow-up of the patients who had normal MR-ICP measurement reveals that only one of the 21 patient required surgery. Consequently, the MR-ICP measurement has a strong negative predictive value (95% for all patients and 100% for patients without a shunt). Using the need for surgical treatment as the outcome criteria, only two false MR-ICP readings were found: one false negative and one false positive. The overall sensitivity, specificity and predictive values are summarized below.

Conclusions

A finding of a normal MR-ICP values in hydrocephalic patients presenting with symptoms suggestive of abnormal ICP is a strong predictive for resolution of symptoms or stable outcome without surgical intervention.

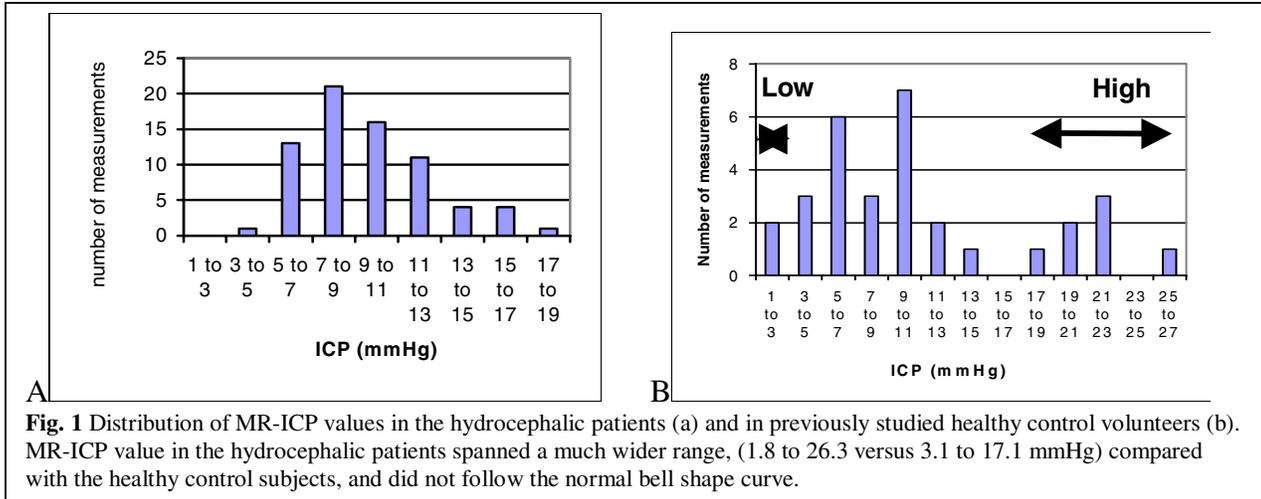


Fig. 1 Distribution of MR-ICP values in the hydrocephalic patients (a) and in previously studied healthy control volunteers (b). MR-ICP value in the hydrocephalic patients spanned a much wider range, (1.8 to 26.3 versus 3.1 to 17.1 mmHg) compared with the healthy control subjects, and did not follow the normal bell shape curve.

Table 1. Sensitivity, specificity, and predictive values of the MR-ICP measurement.

	Sensitivity	Specificity	PPV	NPV
All patients	75%	95%	75%	95%
With shunt	50%	100%	100%	93%
Without shunt	100%	86%	67%	100%

References

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