Clinical evaluation of the MMS-10 tympanic membrane displacement analyser
in the non-invasive assessment of raised intracranial pressure

Kathryn Banister*  
Sian Chambers  
David Mendelow  
* Regional Medical Physics Department  
Department of Neurosurgery  
University of Newcastle, Newcastle upon Tyne

Summary
Shunt malfunction in hydrocephalus is a common problem and the insertion revision rate is high. Intracranial pressure (ICP) measurement is invaluable in the assessment of shunt malfunction but it is highly invasive, poorly tolerated and involves extensive inpatient episodes. A non-invasive ICP assessment technique (Marchbanks Measurement Systems) has recently become available which measures tympanic membrane displacement (TMD) after stimulation of the acoustic reflex and is easily repeatable.

Objectives
To evaluate independently the use of TMD measurements in predicting raised ICP in patients with normal CSF pathology.

Introduction
This non-invasive technique is based upon the fact that the resting position of the stapes depends on ICP. This is because ICP is transmitted to the middle ear via the cochlear aqueduct. An assessment of ICP can then be obtained by measuring the tympanic membrane displacement after stimulation of the acoustic reflex. The direction and amplitude of the tympanic membrane displacement can therefore give an indication of ICP. High ICP is characterised by a more negative tympanic membrane displacement.

Methods
Patients:
Those requiring CSF pressure measurement as part of their clinical management were recruited into the study.

Data collection:
Tympanic membrane displacement measurements were obtained at the time of invasive pressure measurement for direct comparison. Patients were excluded if a postural test indicated that the cochlear aqueduct was obstructed.

Stimulus:
1 kHz tone of 300 ms duration repeated 10 times 10–20 dB above acoustic reflex threshold (max 100 dB).

Data analysis:
Receiver Operator Characteristic (ROC) curves were plotted to determine a threshold of TMD for detection of raised ICP. The sensitivity and specificity were calculated using a threshold of TMD from +350um to +360um in 50um steps.

Conclusions
In the patients studied, there is a difference between the TMD in patients with high ICP compared to normal ICP.

A threshold of –550um detected raised ICP with maximum specificity.

The TMD test may be useful for detection of raised ICP in hydrocephalus.

A larger series of measurements is required to define more accurately the sensitivity and specificity of this technique.

References
1. K. Banister & D. Mendelow. 2005
2. M. McWhinney & D. Mendelow. 2006

Tympanic membrane displacement testing in regular assessment of intracranial pressure in eight patients with hydrocephalus, Neurosurgery 58: 856–862.