Transcranial Doppler Sonography in Patients With Severe Brain Injury

To the Editor: We read with interest the article by Wang et al\(^1\) regarding the use of transcranial Doppler sonography to assess middle cerebral artery flow parameters in patients with serious brain injury. The importance of developing noninvasive techniques to monitor intracranial pressure in patients at risk of developing raised intracranial pressure remains challenging, but if achieved, they have the potential to substantially contribute to early management of traumatic brain injury and improve outcomes. Over the last decade, a number of studies have looked at the correlation between the transcranial Doppler–derived pulsatility index (PI) and changes in intracranial pressure,\(^2–4\) but frustratingly the general consensus has been that transcranial Doppler sonography is of limited use. Wang et al,\(^1\) however, showed a significant positive correlation between certain transcranial Doppler–derived flow spectra, including the PI, with increased intracranial pressure (\(r = 0.9; P < .001\)). They were also able to demonstrate satisfactory accuracy parameters for a cutoff PI value of 1.335 for raised intracranial pressure (defined as ≥15 mm Hg or 20.4 cm H\(_2\)O; sensitivity 0.885; specificity, 0.970). These findings are similar to those we demonstrated in a recent study, which compared the transcranial Doppler–derived PI and cerebrospinal fluid opening pressure after lumbar puncture.\(^5\) We also found that a PI of 1.26 or higher was predictive of opening pressures of 20 cm H\(_2\)O or higher (sensitivity, 0.885; specificity, 0.970). These findings are similar to those we demonstrated in a recent study, which compared the transcranial Doppler–derived PI and cerebrospinal fluid opening pressure after lumbar puncture.\(^5\) Although we share the authors’ optimism that transcranial Doppler sonography has potential as a monitoring tool in patients with suspected raised intracranial pressure, we wish to highlight some of the factors that may influence transcranial Doppler–derived flow dynamics and how they may affect the design of future studies and possible applications in the field.

Although Wang et al\(^1\) replicated our study and showed that there is a positive correlation between the transcranial Doppler–derived PI and intracranial pressure, the strength of this relationship is not enough to accurately assess intracranial pressure in all patients and therefore should not replace current invasive methods if accurate assessment of intracranial pressure is required. It is important to stress, however, that serial assessments with transcranial Doppler sonography do have the potential to be useful monitoring tools. We demonstrated that potential in our recent study, in which we followed the progress of 2 patients with raised intracranial pressure secondary to meningitis and encephalitis.\(^5\) In both cases, changes in intracranial pressure were reflected by changes in the transcranial Doppler–derived PI, yet other patients in the study with similar intracranial pressure measurements had different PI values. In another patient with sinus thrombosis, we also observed a fall in the PI over several weeks, in association with resolution of papilloedema.\(^6\) In a recent study, serial transcranial Doppler assessments and lumbar punctures were performed on children with tuberculous meningitis.\(^7\) Although the PI correlated poorly with the lumbar puncture opening pressure and did not drop despite medical treatment of communicating hydrocephalus, precipitous drops in the PI were observed in all 4 patients who underwent neurosurgical treatment for noncommunicating hydrocephalus.

A number of important factors need to be taken into consideration when interpreting the PI in relation to intracranial pressure.\(^8\) Of these, patients’ ages and blood carbon dioxide levels are probably the most important, as they have a direct relationship with cerebral blood flow. Higher blood carbon dioxide levels cause cerebral vasodilation and therefore falsely depress the PI. This factor is particularly important in the context of head injury, in which changes in breathing patterns related to pain or changes in the level consciousness have the potential to change the PI without necessarily changing the intracranial pressure, as well as in chest injury. A PI–intracranial pressure mismatch is therefore expected in these circumstances. Further studies, however, are still needed to examine the relationship between the PI and intracranial pressure while compensating for changes in blood carbon dioxide levels.

In agreement with Wang et al,\(^1\) we believe that transcranial Doppler sonography has the potential to be used as an intracranial pressure–monitoring device in patients with traumatic brain injury. As there are considerable variations in the degree of brain injury between patients and the time taken for neurosurgical assessment, we propose that transcranial Doppler monitoring should be started as soon as possible after the initial insult and then repeated at regular intervals. This approach would help in minimizing the role of various confounding factors that influence the PI. We reiterate that interpretation of intracranial pressure based on a single absolute reading of the PI may lead to potentially serious errors, and emphasis should be laid on serial recordings. The transcranial Doppler–derived PI could easily be obtained outside the hospital setting by a trained paramedic, as the PI remains independent of the angle of insonation; therefore, acquisition only requires minimal technical expertise.\(^9\) In addition, a portable
capnometer may be used to estimate end-tidal carbon dioxide and adjust the observed PI values for more reliable monitoring.

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