Geeraerts *Critical Care* 2013, 17:187
http://ccforum.com/content/17/5/187

CRITICAL CARE

COMMENTARY

Noninvasive surrogates of intracranial pressure: another piece added with magnetic resonance imaging of the cerebrospinal fluid thickness surrounding the optic nerve

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See related research by Xie et al., http://ccforum.com/content/17/4/R162

Abstract

Optic nerve sheath diameter enlargement measured by ultrasound is known to be associated with raised intracranial pressure (ICP). Magnetic resonance imaging (MRI) of the cerebrospinal fluid (CSF) surrounding the optic nerve has been found, in an elegant study published in *Critical Care*, to correlate well with lumbar CSF opening pressure, confirming previously published studies. A simple and rapid T2-weighted fat-suppressed sequence was used to noninvasively measure the CSF width surrounding the optic nerve, allowing one to predict lumbar CSF pressure with relatively good performances, taking into consideration the body mass index and the mean arterial blood pressure. Based on these results and when brain MRI is indicated in situations at risk for increased ICP, the optic CSF thickness measurement could be systematically performed and used as a surrogate marker of raised ICP.

Several acute life-threatening conditions such as liver failure, bacterial meningitis, meningoencephalitis, posterior reversible encephalopathy, or post-resuscitation syndrome may be associated with a significant risk of raised intracranial pressure (ICP) [1-5]. Brain magnetic resonance imaging (MRI) is often performed in these ICU patients presenting with coma for diagnosis but also for prognosis.

We have known for years that the prognosis in neurocritical patients (traumatic brain injury or stroke) is affected by the incidence of raised ICP, and is particularly affected by the time spent with ICP >25 mmHg [6]. In other medical conditions, however, invasive ICP is rarely measured. Having a noninvasive estimate of ICP is certainly of great interest to detect patients at risk of raised ICP and to initiate specific treatments aiming at decreasing ICP, and/or to decide to monitor ICP invasively.

In the absence of obstruction in the cerebrospinal fluid (CSF) circulation, the subarachnoid space surrounding the optic nerve is submitted to the same pressure as the intracranial compartment. Owing to the cul-de-sac anatomy of the optic nerve, CSF can accumulate in the retro-orbital part of the optic nerve, and the sheath can inflate in the presence of raised ICP [7]. Several publications have shown than the optic nerve sheath diameter measured using ultrasound [8-10] or MRI [11,12] correlates well with invasive ICP.

In an elegant study, Xie and colleagues have shown that the CSF width surrounding the optic nerve measured using a simple T2-weighted fast-recovery fast-spin echo fat-suppressed sequence correlates well with lumbar CSF pressure in 72 patients with various neurological conditions (CSF hypotension, meningitis, multiple sclerosis, and so forth) [13]. Very similar results showing that the MRI optic nerve sheath, but not the optic nerve itself, correlated well with invasive ICP in comatose traumatic brain injury patients have been published previously in *Critical Care* [11].

Using a stepwise multivariate linear regression analysis, Xie and colleagues have developed a relatively simple formula based on the CSF width surrounding the

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optic nerve, body mass index, and blood pressure to predict ICP noninvasively [13]. In the ICP range from 3 to 26 mmHg, CSF widths 3 mm, 9 mm or 15 mm behind the retina significantly correlated with the lumbar CSF opening pressure ($r^2 = 0.82$ to 0.88) We must, however, note that significant raised ICP (ICP >20 mmHg) was only present in eight of the 72 patients. Moreover, lumbar CSF pressure and MRI were performed with a 24-hour delay. We should also highlight that the relationship between optic nerve sheath enlargement and ICP may not be linear. Hansen and colleagues have clearly shown in an experimental study that a plateau can be reached with a maximum enlargement of the sheath occurring for high ICP values (above 35 to 40 mmHg), and that capability for retraction of the sheath can be altered after exposing the optic nerve trabecula to high pressure and distension [14]. These limitations of the study should be taken into consideration before generalisation of these results in ICU patients with significant raised ICP.

A major interest of the Beijing Intracranial and Intraocular Pressure Study Group is that body mass index has been considered in the prediction model [13]. Anatomy can obviously affect the size of the optic nerve and its sheath. However, normative data of the optic nerve complex, considering the age and the height of the subject, are lacking. Determining these data should be probably be an initial step in the process of studying the possible utilization of the optic nerve CSF width to predict raised ICP.

The T2-weighted fat-suppressed MRI sequence lasts less than 5 minutes and is considered a standard sequence. Moreover, measuring the CSF width takes less than 1 minute. Considering the very interesting results from the Beijing Intracranial and Intraocular Pressure Study Group and the simplicity of optic nerve width measurement, we could wonder whether this parameter should be systematically measured when MRI is performed in comatose patients. This measurement could offer the possibility to detect raised ICP using a simple formula taking into consideration the optic nerve width, the body mass index and mean arterial blood pressure. Early detection of raised ICP based on MRI is certainly of great interest to initiate specific treatments and to refer patients to a specialised critical care unit.

Abbreviations

CSF: Cerebrospinal fluid; ICP: Intracranial pressure; MRI: Magnetic resonance imaging.

Competing interests

The author declares that he has no competing interests.

Published: 20 Sep 2013

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10.1186/cc13012
Cite this article as: Geeraerts: Noninvasive surrogates of intracranial pressure: another piece added with magnetic resonance imaging of the cerebrospinal fluid thickness surrounding the optic nerve. *Critical Care* 2013, 17:187