



# The diagnostic performance of ultrasonographic optic nerve sheath diameter and color Doppler indices of the ophthalmic arteries in detecting elevated intracranial pressure



Mohammad Kazem Tarzamni<sup>a</sup>, Babak Derakhshan<sup>a</sup>, Ali Meshkini<sup>b</sup>, Hamid Merat<sup>c</sup>, Daniel Fadaei Fouladi<sup>d,\*</sup>, Samira Mostafazadeh<sup>a</sup>, Amir Rezakhah<sup>a</sup>

<sup>a</sup> Department of Radiology, Imam Reza Teaching Hospital, Tabriz University of Medical Sciences, Tabriz, Iran

<sup>b</sup> Department of Neurosurgery, Imam Reza Teaching Hospital, Tabriz University of Medical Sciences, Tabriz, Iran

<sup>c</sup> Drug Applied Research Center, Tabriz University of Medical Sciences, Tabriz, Iran

<sup>d</sup> Neurosciences Research Center, Tabriz University of Medical Sciences, Tabriz, Iran

## ARTICLE INFO

### Article history:

Received 8 October 2015

Received in revised form 2 December 2015

Accepted 10 December 2015

Available online 15 December 2015

### Keywords:

Ultrasonography

Color Doppler ultrasound

Optic nerve sheath diameter

Ophthalmic artery

Intracranial pressure

## ABSTRACT

**Objectives:** To assess the diagnostic accuracy of ultrasonographic optic nerve sheath diameter (ONSD) measurement and color Doppler indices of the ophthalmic arteries in detecting elevated intracranial pressure (ICP).

**Patients and methods:** A total 60 patients with (cases,  $n = 30$ ) and without (controls,  $n = 30$ ) acute clinical and computed tomographic findings of elevated ICP due to intracranial mass/hemorrhage were recruited from a teaching hospital. The mean binocular and maximum ultrasonographic ONSDs, as well as the mean binocular Doppler ultrasound waveform indices of the ophthalmic arteries including pulsatility index (PI), resistive index (RI), end-systolic velocity (ESV), peak systolic velocity (PSV) and end-diastolic velocity (EDV) were compared between the two groups.

**Results:** Compared to controls, the case group had significantly higher mean binocular ONSD ( $5.48 \pm 0.52$  mm vs.  $4.09 \pm 0.22$  mm,  $p < 0.001$ ), maximum ONSD ( $5.63 \pm 0.55$  mm vs.  $4.16 \pm 0.23$  mm,  $p < 0.001$ ), mean PI ( $1.53 \pm 0.16$  vs.  $1.45 \pm 0.20$ ,  $p = 0.01$ ), and mean RI ( $0.76 \pm 0.07$  vs.  $0.73 \pm 0.04$ ,  $p = 0.01$ ). The mean EDV, in contrast, was significantly higher in controls ( $8.55 \pm 3.09$  m/s vs.  $7.17 \pm 2.61$  m/s,  $p = 0.01$ ). The two groups were comparable for the mean PSV ( $30.73 \pm 7.93$  m/s in cases vs.  $32.27 \pm 10.39$  m/s in controls,  $p = 0.36$ ). Among the mentioned variables, the mean binocular ONSD was the most accurate parameter in detecting elevated ICP (sensitivity and specificity of 100%, cut-off point = 4.53 mm). The Doppler indices were only moderately accurate (sensitivity: 56.7 – 60%, specificity: 63.3 – 76.7%).

**Conclusion:** While the ultrasonographic mean binocular ONSD ( $>4.53$  mm) was completely accurate in detecting elevated ICP, color Doppler indices of the ophthalmic arteries were of limited value.

© 2015 Elsevier B.V. All rights reserved.

## 1. Introduction

Detecting a clinically significant elevation in the intracranial pressure (ICP) is a pivotal step in triage of patients with neurosurgical conditions [1]. At the moment, computed tomography (CT) is considered as the noninvasive method of choice in this regard, but important disadvantages such as the need for patient transporta-

tion, being time-consuming and excessive radiation hazards have urged researchers to find other alternatives [2].

In the last decade ultrasonographic techniques including determination of the optic nerve sheath diameter (ONSD) [3–5] and transcranial Doppler (TCD) examination [6–9] have been tried to safely detect episodes of increased ICP. Siaudvytyte et al. [8] suggested the ophthalmic arteries as natural ICP sensors and even a TCD-based technique has been devised to use these arteries to estimate intracranial pressure [9]. Technical shortcomings such as inability of ultrasound waves to adequately penetrate the skull [10,11] and anatomical variations in the transcranial portion of the ophthalmic arteries [12,13], however, have rendered TCD inaccurate in revealing intracranial hypertension [8,14,15]. To obviate

\* Corresponding author at: Neurosciences Research Center, Tabriz University of Medical Sciences, Imam Reza Teaching Hospital, Golgasht Street, Tabriz, Iran. Fax: +98 4133340730.

E-mail address: [Fouladi.daniel@yahoo.com](mailto:Fouladi.daniel@yahoo.com) (D.F. Fouladi).

these limitations, we hypothesized that Doppler ultrasound waveform indices of the ophthalmic arteries could be used instead of a TCD approach. So, the present study sought to examine this hypothesis in a group of patients with CT findings suggestive of a clinically significant increase in the ICP and a control group including healthy counterparts. At the same time, the accuracy of ultrasonographic ONSD in detecting intracranial hypertension was tested.

## 2. Patient and methods

### 2.1. Study design and participants

A cohort of 60 subjects including patients with acute clinical and radiological signs of an elevated ICP (cases,  $n = 30$ ) and subjects with normal ICPs (controls,  $n = 30$ ) were prospectively recruited from a teaching hospital between May 2014 and March 2015. Obvious ophthalmic injuries or eye pathologies were the exclusion criteria. Before enrollment, informed written consents were obtained from participants. This work was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) and the ethics committee of a local university approved it.

### 2.2. Definitions and procedures

Increased ICP was suspected clinically (presence of headache, altered consciousness, hypertension, vomiting, bradycardia, pupillary changes, papilledema) and established by CT.

Cranial CT examinations were performed on a 16-slice multidetector-row CT scanner (Somatom Sensation 16, Siemens, Munich, Germany). Three experienced radiologists reached consensus on the presence or absence of increased ICP. Cranial CT findings indicative of increased ICP were midline shift (at least 3 mm), edema, mass effect, collapse of ventricles, compression of mesencephalic cisterns or effacement of sulci [2].

Color Doppler ultrasonographic examinations of the ophthalmic arteries, as well as optic nerve ultrasonography were carried out by two skilled sonologists with over 10 years of academic experience who were unaware of the grouping. To ensure blinding, the sonologists were asked to perform ultrasonographic studies only without further interview or clinical examination.

Using a standard ultrasound machine (Aloka Model Prosound 3500, Tokyo, Japan) equipped with a high-resolution 7.5-MHz linear array transducer probe the ONSD was obtained bilaterally. For this purpose both eyes were scanned in the vertical and horizontal planes with the patient in the supine position. The probe was placed lightly over the upper eyelid and the ONSD was measured 3 mm behind the globe (Fig. 1). The mean ONSD measurements from each eye were averaged to create a binocular ONSD value. The largest ONSD value was also reported as the highest value for the right and left eyes (the maximum reading).

Another experienced sonologist who was also blinded to the grouping and ONSD measurement data performed bilateral color Doppler ultrasonographic assessments of the ophthalmic arteries using the same machine and probe transducer. For this purpose the probe was placed over the closed eyelid transversely and the spectral waveform was obtained (Fig. 2) at the proximal portion of the ophthalmic artery in a degree varying between 0 and 40°. At least 3 repeated measurements were taken for both the right and left ophthalmic arteries and a mean value was reported. Pulsatility index (PI), resistive index (RI), end-systolic velocity (ESV) and end-diastolic velocity (EDV) values were calculated automatically and the measurements from both eyes were averaged to create a binocular value. Patients were hemodynamically stable with blood pressure and pulse rate within normal ranges during ultrasonographic examinations.



Fig. 1. An ultrasonographic image of optic nerve sheath diameter (ONSD) measurement. The distance is the ONSD.

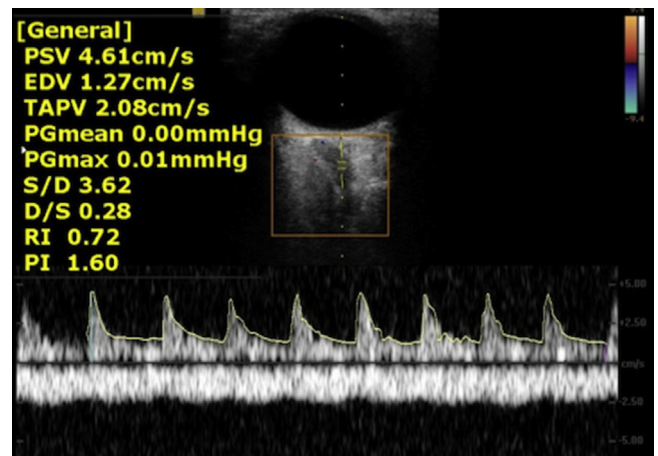


Fig. 2. An example of color Doppler examination of the ophthalmic artery.

### 2.3. Statistical analysis

The SPSS software for Windows V 16.0 (SPSS Inc., IL, USA) was used. Based on the results of the Shapiro–Wilk W test and the quantile–quantile plot (Q–Q plot), the quantitative data followed a Gaussian distribution. Statistical methods included chi-square test, independent samples  $t$  test and Mann–Whitney  $U$ -test (for intra-group comparisons). Correlations were examined using Pearson's  $r$ . Receiver operator characteristic (ROC) curves were plotted for determining area under the curve (AUC) and optimal cut-off points.  $P$ -values  $\leq 0.05$  were considered statistically significant.

## 3. Results

The case group comprised 22 males (73.3%) and 8 females (26.8%) with a mean age of  $48.40 \pm 18.97$  years (range, 22–82). In this group the mean Glasgow Coma Scale (GCS) was  $8.83 \pm 1.53$  at

Download English Version:

<https://daneshyari.com/en/article/3039583>

Download Persian Version:

<https://daneshyari.com/article/3039583>

[Daneshyari.com](https://daneshyari.com)