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● *Original Contribution*

EFFECT OF CERVICAL SYMPATHETIC BLOCK ON OPTIC NERVE SHEATH DIAMETER MEASURED BY ULTRASONOGRAPHY

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Abstract—Optic nerve sheath diameter (ONSD) measurement using ocular ultrasonography was introduced as a non-invasive technique to assess intracranial pressure. We investigated changes in ONSD after cervical sympathetic block (CSB). Ultrasound-guided CSB was performed with a lateral approach at the C6 level in 35 patients. ONSD was measured before CSB and after checking for Horner's syndrome 15 minutes after CSB. The mean ONSD was significantly higher after CSB than before (5.15 ± 0.38 mm vs. 4.75 ± 0.32 mm, $p < 0.001$). A comparison of ONSDs between the blocked and non-blocked sides revealed that these values did not differ significantly between sides at baseline and after CSB. On the basis of these preliminary data, CSB caused an increase in ONSD in patients without intracranial pathology or neurologic disorders. Further larger and controlled studies of the effect of CSB on intracranial pressure in humans are needed to confirm our findings. (E-mail: breadfans@yuhs.ac) © **2015 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Intracranial pressure, Nerve block, Optic nerve sheath diameter, Sympathetic ganglia.**

INTRODUCTION

Cervical sympathetic block (CSB), a type of sympathetic block, is a procedure performed to treat patients with a variety of conditions ranging from pain syndromes of the face, neck and upper extremities to vascular insufficiency (Elias 2000; Kang et al. 2010). All sympathetic nerves distributed to the head and neck and the majority of those in the upper extremities traverse the stellate ganglion. CSB results in sympathetic denervation of the head, neck and upper extremities and, as a result, decreased peripheral vascular resistance and increased blood flow to areas innervated by the stellate ganglion (Elias 2000).

Previous studies have reported increased cerebral blood flow (CBF) after CSB (Gupta et al. 2005; Ohinata et al. 1997; Umeyama et al. 1995). From a neurophysiologic perspective, increased CBF may change the intravascular pressure at the capillary level, augment cerebrospinal fluid production, and increase intracranial pressure (ICP). Also, increased cerebral blood volume (CBV) caused by increased CBF may elevate ICP (Schaller and Graf 2005). However, the effect of CSB on ICP in humans has not been determined. In a previous study that used CSB to treat complex regional pain syndrome, 61.9% of patients complained of headache and 23.8% experienced nausea and vomiting after CSB (van Eijs et al. 2012). The cause of these symptoms was not determined. However, the possibility of an increased ICP after CSB could be not completely excluded, as increased ICP also causes symptoms such as headache, nausea and vomiting.

Intracranial pressure is generally measured with invasive techniques. However, increased ICP has been associated with optic nerve sheath diameter (ONSD) measured non-invasively by ultrasonography (Hansen and Helmke 1997). Studies that target adults with brain injury reported that ONSD measurements can be a sensitive screening tool to assess increases in ICP (Blaivas et al. 2003; Geeraerts et al. 2007; Soldatos et al. 2008; Tayal et al. 2007). Furthermore, meta-analyses have reported that ONSD is valuable for evaluating increased ICP in a non-invasive manner (Dubourg et al. 2011; Moretti and Pizzi 2011). A recent study using ocular ultrasonography evaluated the changes in ONSD before and after lumbar epidural blood patch in patients with

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post-dural puncture headache, which is known to be related to cerebrospinal fluid hypotension (Dubost et al. 2011). Another study described the effect of delivery on ONSD values in pre-eclampsia (Dubost et al. 2012).

In the present study, our aim was to determine the effect of CSB on ONSD by comparing ONSDs measured by ultrasonography, a non-invasive screening tool, before and after CSB in patients without intracranial pathology or neurologic disorders.

METHODS

After acquiring approval from the institutional review board of Severance Hospital, Yonsei University Health system (Reference No. 4-2013-0078), we registered this study on ClinicalTrials.gov (Reference No. NCT01840995). Participants were enrolled for this study from our outpatient department for pain management between April and December 2013. Before enrollment, written informed consent was obtained from all participants. Patients between 20 and 70 years of age who were scheduled to undergo CSB at our outpatient department for pain management were recruited. Patients were excluded if they had a coagulation disorder, neurologic symptoms such as headache and dizziness, stroke, peripheral neuropathy, history of intracranial surgery, carotid artery disease, ophthalmic disease or history of ocular surgery, severe cardiorespiratory dysfunction or extreme obesity (body mass index $\geq$35 kg/m^2). Patients who had a psychiatric disorder and who could not understand the objectives and methods of the present clinical study were also excluded.

Patients were placed in a supine position and were monitored with pulse oximetry and a non-invasive blood pressure monitor. Blood pressure, heart rate and oxygen saturation (SpO_2) were obtained at 5-min intervals before CSB and for 20 min after CSB. We instructed patients not to cough, swallow or talk during the procedure and to raise a hand if they felt something unusual.

For CSB, we used the ultrasound-guided lateral approach described previously (Bhatia et al. 2012; Gofeld et al. 2009). CSB was performed at the C6 level by a skilled anesthesiologist using a 7.5-MHz linear probe (SonoSite S-Nerve Ultrasound System, Sonosite, Bothell, WA, USA), and 5 mL of 1% lidocaine was injected. Successful CSB was defined on the basis of the appearance of Horner's syndrome (miosis, ptosis and hemifacial anhydrosis of the ipsilateral side) 15 min after CSB.

Optic nerve sheath diameter was measured before CSB and after determining that Horner's syndrome developed 15 min after CSB. Methods described in the previous study were employed to measure ONSD by one investigator trained in ocular ultrasonography (D.H.K.) (Moretti and Pizzi 2011; Tayal et al. 2007). A 7.5-MHz linear probe (SonoSite S-Nerve Ultrasound System) was used with all patients in the supine position. The probe was placed on the upper eyelid with the patient's eyes closed (the investigator's hand was steadied against the patient's forehead to prevent too much pressure from being exerted on the patient's eyes with the probe). In 2-D mode, we adjusted the probe to get a clear view of the optic nerve and measured ONSD 3 mm from rear end of the globe with electronic calipers. For each optic nerve, two measurements were made: one in the transverse plane and one in the sagittal plane. The four values from both eyes were averaged to calculate the ONSD for each patient. ONSDs of the ipsilateral and contralateral eyes were calculated as averages of the two values for each eye (Fig. 1).

We collected complaints of blurred vision, headache, nausea, vomiting, dysphagia and hoarseness. The study protocol was terminated if any complications other than the expected symptoms arose or if the block was unsuccessful.

In a previous study, the mean ONSD for normal adults was 3.6 $\pm$ 0.6 mm (Soldatos et al. 2008). We calculated that we needed 32 patients to detect differences in ONSD of 0.3 mm before and after CSB given a 5% two-tailed significance level (α = 0.05) and power of 80% (β = 0.20). To allow for possible dropouts, 35 patients were recruited.

Statistical analysis

We used SPSS Version 18.0 (IBM, Armonk, NY, USA) for all statistical analyses, and all data were

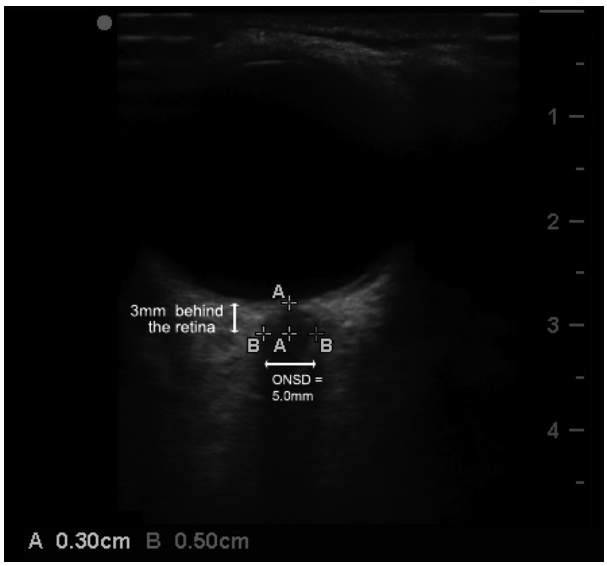

Fig. 1. Ultrasonographic assessment of optic nerve sheath diameter (ONSD).