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Comparison of Optic Nerve Sheath Diameters Measured by Optic Ultrasonography Before and After Lumbar Puncture in Idiopathic Intracranial Hypertension Patients

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ABSTRACT

Introduction: Idiopathic intracranial hypertension (IIH) symptoms include headache, blurred vision, and papilledema which may lead to permanent vision loss unless diagnosed and treated. Definitive diagnosis of IIH usually requires the measurement of intracranial pressure (ICP) via lumbar puncture (LP) which is an invasive and unwanted technique for patients. In our study, optic nerve sheath diameters (ONSD) were measured before and after lumbar puncture in IIH patients and the relationship of these measurements with ICP changes was evaluated as well as the effect of decreasing cerebrospinal fluid (CSF) pressure after a lumbar puncture on ONSD. Thus, we want to investigate whether optic nerve ultrasonography (USG) is a useful tool instead of the invasive LP for the diagnosis of IIH.

Methods: A total of 25 patients who applied to the neurology clinics of Ankara Numune Training and Research Hospital between May 2014 and December 2015 and were diagnosed with IIH were included in the study. The control group consisted of 22 individuals who applied with complaints other than headaches, visual impairment or tinnitus. Optic nerve sheath diameters were measured from both eyes before and after the LP. After pre-LP measurements were taken, opening and closing CSF pressure was measured. In the control group, ONSD was measured with optic USG.

Results: Mean age of the IIH group and the control group was determined as 34.8±11.5 and 45.8±13.3 years, respectively. In the patient group, mean CSF opening pressure was 33.9±8.0 cm H_2O and mean closing pressure was 18.1±4.7 cm H_2O. Mean ONSD measured pre-LP was 7.1±1.0 mm in the right eye and 6.9±0.7 mm in the left eye, while mean post-LP ONSD was 6.7±0.9 mm in the right eye and 6.4±0.8 mm in the left eye. There was a statistically significant difference between ONSD values before and after the LP (p=0.006 for the right eye, p<0.001 for the left eye). In the control group, mean ONSD was 5.4±0.7 mm in the right eye and 5.5±0.6 mm in the left eye, and a statistically significant difference was found between ONSD values before and after the LP (p<0.001 for the right eye and left eye). A significant positive correlation was determined between left ONSD measurements before the LP and CSF opening pressure (r=0.501, p=0.011).

Conclusions: In the present study, it was found that ONSD measurement by optic USG significantly displays increased ICP, and decreasing pressure via LP is rapidly reflecting ONSD measurement. Based on these findings, it is suggested that ONSD measurements by optic USG, a non-invasive method, can be used in the diagnosis and follow-up of IIH patients.

Keywords: Idiopathic intracranial hypertension, increased intracranial pressure, lumbar puncture, optic nerve sheath diameter measurement

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INTRODUCTION

Idiopathic intracranial hypertension (IIH) is a condition characterized by increased cerebrospinal fluid (CSF) pressure without any structural lesions in the brain or ventricular dilatation (1). The most common symptoms include headaches, blurred vision, temporary vision loss, diplopia, tinnitus, and papilledema. No abnormal symptom is found in the CSF. While the pathophysiology of the IIH is not yet known clearly, it is generally considered to be caused by CSF absorption disorder. Idiopathic intracranial hypertension usually occurs as a chronic disease that could lead to severe visual impairment and permanent vision loss (2–4). The incidence is 1–2/100,000 a year (5). Classically, it is more common in obese women in the fertile period of life (6).

Idiopathic intracranial hypertension is diagnosed by "The Modified Dandy Criteria": Firstly, causes that may lead to increased ICP syndrome are excluded with magnetic resonance imaging (MRI) and MR venography (MRV), then CSF pressure is measured with lumbar puncture (LP) (7). Idiopathic intracranial hypertension is diagnosed if the opening CSF pressure is over 250 mm H_2O in obese individuals and over 200 mm H_2O in normal individuals (8). Treatment is generally carried out by ambulatory follow-up and weight loss diet in patients without vision loss. Previously decreasing CSF pressure by CSF draining with LP was a method used in the treatment while it is not preferred routinely today. For the pharmacological treatment, a carbonic anhydrase inhibitor and a weak inhibitor of the same enzyme can be prescribed to help reducing CSF production together with topiramate as an antiepileptic. In patients whose vision loss is rapidly progressive with a bad course, surgical intervention is recommended (9).

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Highlights

- **Optical USG at the bedside can be easily applied and repeated for follow-up purposes.**
- **Optic nerve sheath diameter measurements with optical USG significantly reflect increased intracranial pressure.**
- **Reducing CSF pressure with LP has an immediate effect on the ONSC measurement.**
- **ONSC measurements may be used for diagnosis and follow-up in IIH patients in the future.**

Recently optic nerve ultrasonography (USG) has come into the field for the diagnosis of ICP. It has been preferred for monitoring due to its ease of application particularly in patients with head trauma in the emergency unit (10). It is known that increased CSF pressure is directly transmitted to the perineural subarachnoid space and the perioptic dural sheath is enlarged. Therefore, it was thought that measurement of optic nerve sheath diameter (ONSD) with optic nerve USG could be used for the diagnosis of increased ICP, and this assumption was supported by other studies.

In the light of these facts, ONSD measurements were evaluated before and after LP in IIH patients in the present study. The relationship between ONSD and ICP changes was examined as well as the effect of decreasing CSF pressure by a LP on these findings. Thus, the present study investigated whether optic nerve USG can be used instead of the invasive LP for the diagnosis of IIH.

METHODS

Patient Selection Criteria

Thirty-three patients who applied to the neurology outpatient clinic of Ankara Numune Training and Research Hospital between May 2014 and December 2015 with the pre-diagnosis of IIH were included in the study. Lumbar puncture could not be administered in 2 patients and their pressure could not be measured. Six patients were found to have normal CSF pressure. Finally, 25 patients were included in the study after they were diagnosed with IIH by measuring their CSF pressures by LP which is not an ideal method to reflect the ICP. In addition, the patients did not receive any medical treatment that could lower the CSF pressure before LP. In order to determine normal ONSD measurement, 22 individuals who applied to the neurosonology unit for complaints other than headaches (dizziness, cerebrovascular accident, transient ischemic stroke, patent foramen ovale examination, etc.), visual impairment or tinnitus were included as the control group and their ONSD was measured. All the patients participating in the study were informed about the method and the aim of the study. All the cases signed the informed consent form. The study was approved by the Ethical Committee of our hospital.

For the patient group, individuals who were diagnosed with IIH according to Modified Dandy criteria aged 17–65 having no contraindications for LP, who accepted the intervention and had no additional neurological or ocular disease were included; and for the control group, individuals who aged 17–65 and applied with other complaints than headaches, visual impairment or tinnitus were included in the present study.

Cranial MRI was obtained from patients in order to eliminate other factors that could cause ICP and to avoid intracranial LP contraindications. Evaluations were made in terms of conditions that could create contraindications for the administration of LP (intracranial mass, general condition disorder, thrombocytopenia or other hemorrhage problems, infection in the LP area, severe skeletal dysplasia). The patients' medical history including age, height, weight, and body mass indices were recorded.

Body Mass Index Evaluation

Body mass indices were calculated using the formula "Body Weight (kg)/Height in meters squared (m^2)". According to this formula, individuals with a body mass indice (BMI) of <20 kg/m^2 are categorized as underweight, 20–25 kg/m^2 as normal weight, 25–30 kg/m^2 as overweight, and >30 kg/m^2 as obese. However, while comparing the data in our study, we evaluated the patients in two groups as BMI <30 kg/m^2 non-obese and BMI >30 kg/m^2 obese. In our study, CSF opening pressure limit value was accepted as 200 mm H_2O in patients with a BMI <30 kg/m^2 and as 250 mm H_2O in those with a BMI >30 kg/m^2, that is, in obese patients. Unfortunately, BMI was not calculated in the control group.

Optic Nerve Ultrasonography

Measurements were taken from all the patients included in the study before and 10–15 minutes after the LP by a neurosonologist experienced in ONSD measurement, who had no prior information about the patients' clinical characteristics and who did not participate in the LP administration or treatment decision of the patients. A high-resolution (Toshiba Xario Model SSA-660A, Japan) ultrasonography device and a 7.5 MHz linear probe were used for the measurements. After making depth and gain adjustments, carotid-vertebral artery ultrasonography was adjusted, and MI (mechanical index) was reduced in accordance with the international rules. The patients were told to look forward with their eyes closed in a supine position and gel was applied to both eyes. As described in the literature, ONSD measurements were taken twice from the border surrounded by the hyperechogenic intraorbital fat tissue of the hypoechogenic nerve sheath surrounding the hyperechogenic area around the optic nerve (ONSDext) of both eyes at 3 mm under the bulb from the sections that give the best images of the area where the optic nerve enters into the globe (Figure 1) by rotating clockwise and the measurements were recorded on the horizontal and vertical planes of the optic nerve.

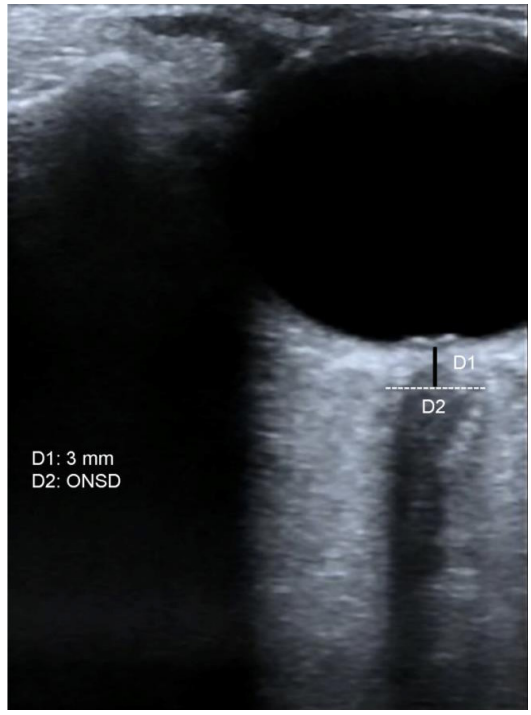

Figure 1. Representative image of an optic nerve sheath diameter (ONSD) measurement by optic ultrasonography. ONSD measured 3 mm behind the globe of an idiopathic intracranial hypertension patient.

Lumbar Puncture Procedure

After measurements were obtained before LP, the patient was placed in the lateral decubitus position. No patient was given sedation for the procedure. All the patients were given 20 mg of subcutaneous prilocaine for local anesthesia. Over the line drawn from the superior iliac spine border, spinous processes were examined, and following the sterilization with povidone-iodine, subarachnoid space was entered using a 18Gx90 mm LP needle from the appropriate distance. Once the CSF was seen to be coming out, CSF opening pressure measurement was taken with an LP manometer. After measuring the opening pressure, approximately 15–20 ml of CSF was taken as a sample for the laboratory examinations; later the CSF closing pressure was measured, and the procedure was concluded by taking the needle out. The patient was rolled back to the supine position. Ultrasonographic measurements were taken again 10–15 minutes after the LP administration.

Similarly, USG and ONSD measurements were obtained from the control group in the supine position without LP.

Statistical Analyses

The data were given as mean±SD and were put into analysis on SPSS (23.0) package program. For all the tests, values under the p-value of 0.05 were accepted as statistically significant. Chi square test, independent sample test, paired sample test, and Pearson correlation analyses were carried out for the evaluation of the data.

Bäuerle et al. (27) found that the mean ONSD at the right and left eyes decreased from 6.4±0.6 mm and 6.4±0.6 mm to 5.8±0.7 mm and 5.9±0.7 mm after LP. The rate of the decrease in ONSD at the right eye after LP was 9.4%. Based on the amount of decrease in the ONSD value of the right eye after LP, the number of patients in the IHH group and the controls were estimated to be five and 13 with a type 1 error of <0.05 (two-sided) and a power of ≥0.8. The overall target size was 23, assuming a 3% dropout rate.

Power analysis was performed using MedCalc Statistical Software Trial version (MedCalc Software bv, Ostend, Belgium; http://www.medcalc.mrg; 2015).

Statistical numeric data were rounded off to have a single-digit after the decimal point.

RESULTS

Idiopathic intracranial hypertension patient group consisted of 4(16%) male, 21(84%) female patients. The mean age of the male patients was 30±13.9 years, that of the female patients was 35.8±11.1 years, and the mean age of all the patients was calculated as 34.8±11.5 years (Table 1). In the control group, 8 male and 14 female voluntary patients applying with complaints other than headache were included in the study. The mean age of these patients was found as 45.8±13.3 years.

In the IIH group, the Chi square test analysis showed a statistically significant difference between the ratios of males and females ($p<0.05$). A statistically significant difference was also observed between the mean ages of the control group and the patient group ($p<0.05$).

In the IIH group, the mean BMI was 34.8±6.5 kg/m^2 in females, 21.2±1.8 kg/m^2 in males, and 32.8±7.8 kg/m^2 for all patients (Table 1).

Cerebrospinal fluid opening and closing pressure were measured in the patient group through a LP. Cerebrospinal fluid values over 25 cm H_2O in obese patients and those over 20 cm H_2O in non-obese patients were accepted as abnormal. The mean CSF opening pressure was found as 33.9±8.0 cm H_2O and, the mean CSF closing pressure was 18.1±4.7 cm H_2O (Table 1). Minimum and maximum values of CSF opening pressure were 22 and 53 cm H_2O, those of closing pressure were 9 and 25 cm H_2O. Due to technical reasons and patient cooperation problems, CSF closing pressure could not be measured in 2 of the patients.

Optic Nerve Sheath Diameters Results

Before the LP, two measurements were taken from the right and left eyes of the patients on the horizontal and vertical planes of the optic nerve. Optic nerve sheath diameter was calculated for both eyes by averaging these horizontal and vertical measurements. The mean ONSD value was found as 7.1±1.00 mm in the right eye and as 6.9±0.7 mm in the left eye of 25 patients.

After the LP, two measurements were taken from the right and left eyes of the patients on the horizontal and vertical planes and, optic nerve sheath diameters were calculated for both eyes by averaging these two measurements.

The mean ONSD value was determined as 6.7±0.9 mm on the right eye and 6.4±0.8 mm on the left eye after the LP.

Like the patient group, two measurements (on the horizontal and vertical planes) were taken from both eyes of the control group. The mean ONSD value was determined as 5.4±0.7 mm on the right eye and 5.5±0.6 mm on the left eye.

There was a highly significant difference between the right and left ONSD measurements taken before the LP with the control group ($p<0.01$, Independent Sample Test) (Table 2).

Right and left ONSD measurements of the patient group obtained before and after the LP was compared using the Paired Sample Test. A statistically significant difference was found between these two groups ($p<0.05$) (Table 2).

Figure 2 represents the correlation of CSF opening pressure (cmH_2O) and average of ONSD (mm) measurements of the right eye.

Pearson Correlation Test was conducted to check the correlation between

Table 1. Patient characteristics, mean CSF opening and closure pressures

Characteristics	IIH group (n=25)	Control group (n=22)
Age (years)	34.8±11.5	45.8±13.3
Sex (female/male; n)	21/4	14/8
BMI (kg/m^2) Female Male	32.8±7.8 34.8±6.5 21.2±1.8	N/A
CSF opening pressure (cm H_2O)	33.9±8.0	N/A
CSF closing pressure (cm H_2O)	18.1±4.7	N/A

BMI: body mass index; CSF: cerebrospinal fluid; IIH: idiopathic intracranial hypertension.

Table 2. Right and left ONSD values and comparison in control and IIH groups

	Right ONSD	Left ONSD
Control group (mm)	5.4±0.7*	5.5±0.6*
IIH group – Pre LP (mm)	7.1±1.0	6.9±0.7
IIH group – Post LP (mm)	6.7±0.9#	6.4±0.8#

IIH: idiopathic intracranial hypertension; LP: lumbar puncture; ONSD: optic nerve sheath diameter.
* p<0.01, comparison of control and IIH group-Pre LP.
# p<0.05, comparison of IIH group-Pre LP and IIH group Post-LP.

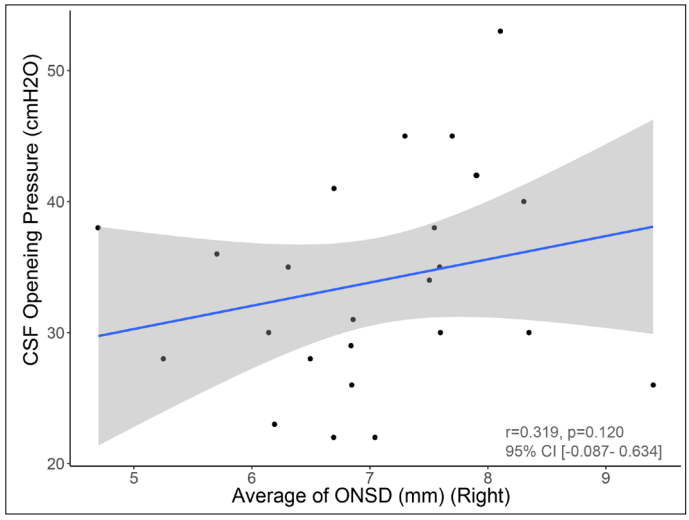

Figure 2. Scatter plot graphs showing the correlation of CSF opening pressure (cm H2O) and average of ONSD (mm) measurements of the right eye.

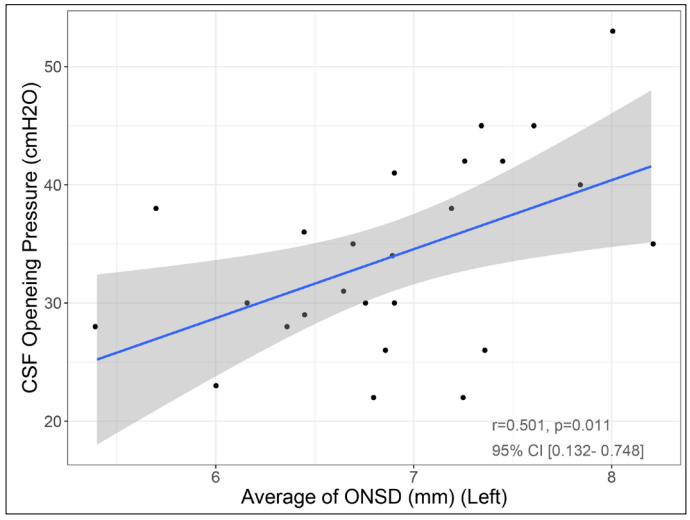

Figure 3. Scatter plot graphs showing the correlation of CSF opening pressure (cm H2O) and average of ONSD (mm) measurements at the left eye.

CSF pressure of values and the right and left ONSD measurements. A significant correlation was found between CSF opening pressure and the left eye ONSD measurements (r=0.501, p=0.011) (Table 3) (Figure 3). There were no significant correlations between other analyses.

DISCUSSION

Idiopathic intracranial hypertension is a disease the etiology of which is not yet understood clearly, and which is considered to develop due to a disorder in CSF absorption (11). In the study we conducted, consistent with the related literature, the incidence ratio in females was seen to be significantly higher than in males. Mean BMI was calculated as 34.8 kg/m^2 in females and 21.2 kg/m^2 in males. This finding is also consistent with the literature; that is, IIH is frequently seen together with obesity in women whereas its relationship with obesity is weak in men (12).

Modified Dandy criteria are used for the diagnosis of IIH and the early diagnosis is considered with patient history, clinical findings, and cranial imaging; however, a definitive diagnosis can be made by measuring ICP with an invasive intervention, LP. Cerebrospinal fluid opening pressure is diagnostic if it is higher than 200 mm H_2O (CSF) in normal weighted patients, and if higher than 250 mm H_2O (CSF) in obese ones. In this respect, we accepted CSF opening values for IIH diagnosis according to these limits. Idiopathic intracranial hypertension diagnosis could be neglected due to low-pressure measures depending on the thickness and length of the needle used in measuring CSF opening pressure with a lumbar puncture. It has been revealed that opening CSF pressure can be as low as 5 mm H_2O (CSF) with an LP needle of 8.9 cm (3.5 inches) or longer (13). In our study, all the LP needles had the same diameter and length so that they would affect CSF opening pressures in the same way in all patients who had a lumbar puncture. The patients were not sedated as it could influence opening CSF pressure.

Idiopathic intracranial hypertension can cause severe vision loss, therefore clinical follow-up and treatment should be managed properly. Clinical and treatment response follow-ups are performed by headache check-ups and fundus oculi, visual acuity, and visual field examinations. In the event of any increase in the patient's symptoms during follow-up, lack of response to treatment, or failure to make the surgical decision, the LP could be repeated to check ICP. Measuring CSF opening pressure via LP is an invasive operation that requires

Table 3. Correlation analysis between CSF opening and closing pressures and ONSD measurements in the study group

Measurements	Features of ONSD	r	95% CI	p-value
CSF opening pressure (cm H_2O)	(PreLP) Right ONSD (mm)	0.319	[-0.087–0.634]	0.120
	(PreLP) Left ONSD (mm)	0.501	[0.132–0.748]	0.011
CSF closing pressure (cm H_2O)	(PostLP) Right ONSD (mm)	0.035	[-0.382–0.441]	0.873
	(PostLP) Left ONSD (mm)	0.101	[-0.325–0.492]	0.648

CI: confidence interval; CSF: cerebrospinal fluid; LP: lumbar puncture; ONSD: optic nerve sheath diameter.

experience, causes discomfort for the patient, and carries the risk of complications. Repetitive emptying LP which was previously preferred for the treatment of IIH is no longer recommended. This has brought about the need for non-invasive and easily applicable methods that could be used for the diagnosis and follow-up of IIH.

Observing papilledema during fundus oculi examination can be informative about increased ICP. Increased CSF pressure affects the optic nerve sheath in the orbita through the optic canal and nerve axons are constricted at the lamina cribrosa. Increased constriction disrupts the axoplasmic transport and oedema develops in the nerve (14). Acute and subacute optic nerve ischemia and occlusion of the retinal artery branches are likely to develop as a result of the suppression by the swollen axons on the veins at the papilla. Most patients have acute papilledema, some have the chronic and atrophic disc (14). Papilledema is bilateral in 93% of the cases and unilateral in 5%. However, papilledema-free cases have also been reported (15). Although it is commonly used for the diagnosis and follow-up of IIH, other methods are still needed since papilledema and atrophic disc are also seen in conditions other than increased ICP, its absence does not exclude IIH diagnosis and is not informative about the degree of increased ICP.

The relationship between ICP and ONSD was first revealed by Hayreh and et al. (16). Optic nerve sheath diameter, which can be measured with cranial MRI and optic ultrasonography, was considered applicable for detecting increased ICP (17,18). In addition, similar sensitivity and specificity values were found in studies comparing computed tomography (CT) and optic USG for ONSD measurement (19,20). The extracranial section of the optic nerve is approximately 20–30 mm in length and is surrounded by a subarachnoid space. The optic nerve is covered only by fat tissue and a dural sheath 3 mm below the ocular globe. There is an enlargement in this space and an increase in optic nerve sheath diameter in case of increased ICP. Therefore, ONSD measurement can provide us information about ICP.

Optic ultrasonography is a non-invasive method that could easily be implemented at the bedside and does not require a long time to learn. Thus, ONSD measurement with optic USG has been used to detect increased ICP due to brain damage after head traumas in emergency departments and to detect brain oedema due to hypertensive encephalopathy, ischemic or haemorrhagic stroke in the intensive care services of neurology and neurosurgery units. In the study conducted by Tayal et al., it was stated that observing 10 normal and 3 pathologic ONSDs would be sufficient to administer optic nerve USG (21). However, Stevans et al. showed that there are different ONSD measurements in studies due to differences in methodology in measurement by USG (22).

In the study conducted by Soldatos et al., the sensitivity and specificity of the predictability of increased ICP with ONSD over 5.7 mm were 71% and 100% respectively (23). In the study of Geeraerts, the best threshold point value to show the level of ICP was found as 5.86 with a sensitivity of 95% and specificity of 79% (24). In another study, the sensitivity and specificity of the ONSD over 5 mm detecting increased ICP were calculated as 88% and 93% respectively (25). Again, in other studies, ICP was found to be associated with ONSD measured by optic USG (26–28). In our study, correlations were determined between CSF opening pressure and pre-LP ONSD values on the left eyes (p=0.011), but no correlation was found in the right eyes (p=0.120). We could not clearly explain the different results in the left and right eyes. Although the complaints and findings of the patients are not more common in the left eye, they may have ONSD asymmetries. It has been shown that the subarachnoid space of the optic nerve can be divided by arachnoid trabeculae and septa, and this may affect the dynamics of the CSF and cause asymmetry (29,30). Asymmetric papilledema can also be seen in IIH patients (31). Since we did not include the ophthalmological examination data in our study, it was difficult for us to explain the correlation difference. In the study by Şahin et al., there was a negative correlation between right ONSD values and Glasgow Coma Scale scores. They suggested that this one-eye correlation might be due to the small sample size (32). It may be useful to evaluate the correlation with a larger sample size. In addition, no significant correlation was found between CSF closing pressure and post-LP ONSD values in right and left eyes. This may be explained by the need for more volume of emptied CSF than we discharged during the LP or the possibility that the time (10–15 min) we allowed after LP was not sufficient for ONSD change compatible with CSF pressure.

Bäuerle et al. examined the relationship between ONSD and ICP in 10 patients diagnosed with IIH and 25 healthy volunteers. Patients' ICP was measured with LP, 30–50 ml CSF was emptied, and ONSD was measured again after the intervention. In this study, the mean ONSD of the IIH patients was found as 6.4±0.6 mm and as 5.4±0.5 mm in the control group, which led to a statistically significant difference (p<0.001). The best threshold value of ONSD to detect ICP increase was found as 5.8 mm with a sensitivity of 90% and specificity of 84% (33). Moreover, it was seen that ONSD decreased after LP in both eyes in IIH patients (right ONSD 5.8±0.7 mm p<0.004, left ONSD 5.9±0.7 mm p<0.043) (33). Similar to this study, a significant difference was found between right and left eye ONSD examined before and after LP in our study.

Dubourg et al. conducted a meta-analysis of 6 studies that were previously published. Intracranial pressure was measured with intracranial catheters through an invasive method in a total of 231 patients in the studies included in the meta-analysis. As a result of this meta-analysis, the sensitivity and specificity of the ONSD in revealing ICP increase were found as 90% and 85% respectively. The diagnostic odds ratio was found as 51, which meant that ONSD would be detected 51 times higher in patients with increased ICP, and it was concluded to have good accuracy in diagnosing ICP increase (34). Similarly, in another study comparing the invasive method and optic USG, the pooled sensitivity was 0.9 (95% CI: 0.85–0.94), specificity was 0.85 (95% CI: 0.8–0.89). Intracranial pressure and ONSD had a correlation coefficient of 0.7 (95% CI: 0.63–0.76, p<0.05) (35).

Although relationships have been found between ONSD and increased ICP, this method is not yet used for the diagnosis of IIH. There is a need for more comprehensive and multicentre studies with larger samples for the method to be used for this purpose. With the validation of ONSD measurements, optic USG can be used instead of the invasive LP method for the diagnosis of IIH in the future. Although it is not used for the diagnosis currently, it is a method that can be used for detecting intracranial hypotension occurring as an LP complication, recurrence, or treatment response in IIH patients or for the long-term follow-up of patients.

In our study, a statistically significant difference was found in the IIH-ONSD measurement group before and after LP and in the comparison of these groups with the control group, but the study has some limitations. First of all, our sample size is relatively small. Therefore, there is a need for multicentre studies to be conducted with a larger sample size to obtain more significant results in the future. The second limitation could be the comparison of our sample group with a non-LP control group. However, since we primarily compared pre and post-LP ONSD measurements and found significant differences in our study, this finding can strengthen any future studies in which the same result is obtained in patients who are found to have normal pressure after lumbar puncture administration. Third, not calculating BMI in the control group is a limitation. Since the ONSD may be related to BMI, the inability to compare the two groups is seen as the weakness of the study. It is also a limitation that CSF pressure

measured by a LP cannot directly and accurately estimate ICP. The gold-standard measurement of ICP is with intraventricular or intraparenchymal invasive devices (36). However, it can be applied in limited patient groups due to being very invasive and having the risk of infection. Another limitation is that a significant difference was found between the patient group and control group in terms of mean age, but this fact was thought to have no impact on the significance of the difference found because there is no study revealing ONSD change along with age in adults. There are also limitations regarding the B-scan USG technique that we used. With this technique, the measurement of structures may not be sensitive when the eyelids are closed (37). B-scan artefacts including blooming effect, poor repeatability of measurements, inability to distinguish other causes that may increase optic nerve diameter (optic neuritis, optic nerve glioma, etc.) can also affect results (38,39). The other limitation is that we did not use ophthalmological parameters. All patients were referred for a detailed ophthalmologic examination, but these data were not included in the study, as our primary goal was to show the difference in ONSD before and after LP in IIH patients.

Optic nerve sheath diameter differences between healthy individuals and those with increased ICP have been revealed by many studies. Thus, the focus of our study is not to show this difference, but to compare ONSD values measured in a short time before and after LP.

CONCLUSION

Optic ultrasonography has recently come into use to diagnose and follow-up of increased ICP in emergency departments, intensive care units, and neurology services as it is less expensive, does not contain radiation, can be easily used at the bedside, and can be repeated for follow-up. In the present study, it was seen that ONSD measurement with optic USG reflected increased ICP significantly and that reducing the pressure through LP had an instant effect on this measurement. Based on these findings, it can be suggested that ONSD measurements obtained from IIH patients with the non-invasive optic USG method can be used for the diagnosis and follow-up of IIH patients.

Ethics Committe Approval: The study was approved by the Ethical Committee of Ankara Numune Training and Research Hospital (Date: 16.04.2014, Number: e14-240).

İnformed Consent: All the patients participating in the study were informed about the method and the aim of the study. All the cases signed the informed consent form.

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