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Evaluation of optic nerve sheath complex by magnetic resonance imaging in patients with idiopathic normal pressure hydrocephalus

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Abstract

Background: We aimed to evaluate the optic nerve and optic nerve sheath diameter of patients with idiopathic normal pressure hydrocephalus with magnetic resonance imaging and to compare with the normal population. *Methods:* Magnetic resonance images and clinical records of the patients were retrospectively evaluated between 01.01.2015 and 01.01.2020. Twenty one patients in the normal pressure hydrocephalus group and 47 patients in the control group were included. Measurements were performed from the images obtained by creating multiplanar reconstructions from thin-slice Fast Spin Echo T2-weighted images. Measurements were made of optic nerve from the 3 mm posterior to the optic globe, on the plane which is oriented perpendicular to the nerve. *Results:* There was no difference between the two groups in terms of optic nerve diameters. Optic nerve sheath diameters are significantly higher in the normal pressure hydrocephalus group ($p<0.0001$).
Conclusion: Morphological analysis of the optic nerve sheath complex which contains cerebrospinal fluid will contribute to the diagnosis and understanding chronic effects of normal pressure hydrocephalus, a disease in which changes in brain compliance and cerebrospinal fluid absorption are suspected in its etiology.

Keywords: Idiopathic normal pressure hydrocephalus, optic nerve sheath, optic nerve, magnetic resonance imaging, disproportionately enlarged subarachnoid space of hydrocephalus.

INTRODUCTION

The optic nerve sheath complex is a structure in which the outer part is formed by the dura mater and contains the cerebrospinal fluid (CSF) and the optic nerve. Previous studies have identified a change in the diameter of the optic nerve sheath when intracranial pressure increases.[1]

Idiopathic normal pressure hydrocephalus (iNPH) disease can be described as an enlargement of the brain ventricular system without an increase in intracranial pressure.[2] Gait disturbance, urinary incontinence, and impaired cognitive functions are among the most prominent clinical features.

Although the exact etiology of idiopathic normal pressure hydrocephalus is not known, some assumptions such as CSF malabsorption and periventricular ischemia are emphasized.[3] The disproportionately enlarged subarachnoid space of hydrocephalus (DESH) finding, which is among the diagnostic criteria of the disease, is a finding characterized by narrowed CSF distance in the vertex and disproportionately increased CSF distance in the sylvian fissure and temporal lobes.[4-6] Although this disproportionality in the CSF distance suggests that the disease is based on local absorption disorder, the DESH finding is not pathognomonic for iNPH disease.

In our study, we aimed to analyze morphologically the structure containing CSF, such as the optic nerve sheath complex, in patients with normal pressure hydrocephalus.

METHODS

Following the ethical approval of local ethics committee, magnetic resonance images and clinical records of the patients were retrospectively evaluated between 01.01.2015 and 01.01.2020.

According to the revised Guidelines for INPH,

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patients were divided into three groups as possible, probable and distinct.[7] Patients were defined as possible INPH provide presence of more than one symptom from the classic INPH triad (gait disturbance, urinary incontinence, and cognitive impairment), onset of the symptoms at the age 60 or older, Evan's index value is more than 0.3, no presence of underlying diseases or congenital hydrocephalus. Patients with CSF pressure less than 200 mmH_2O and the tap test or drainage test response or presence DESH sign with the gait disturbance in addition to possible iNPH criteria were defined as probable INPH and shunt responders with probable iNPH criteria were defined as distinct INPH.

Twenty-one patients fulfilled the iNPH criteria and were included in the NPH group.

Patients who underwent the orbital MRI examination with nonspecific complaints and not found any pathology were included in the control group. Patients under 60 years of age, with brain ventriculomegaly or an intra-orbital pathology were excluded from the study.

İmaging technique

Brain MRI examinations of the patients were performed in the supine position using a standard head coil on a 1.5 Tesla Philips (Philips MRI Systems, Achieva Release 3.2 Level 2013-10-21, Philips Medical Systems Nederland B.V.) device.

Measurements Multiplanar reconstructions were created from volumetric FSE T2 (TR ms / TE; 7290/74 ms, FOV; 220 × 175 mm and Slice thickness; 3 mm) weighted images routinely taken in brain MRI and orbital MRI.

The measurements of optic nerve sheath complex was performed from images obtained coronal section to the optic nerve from the 3 mm posterior to the optic globe (Figure 1). One neuroradiologist with at least 5 years of experience in the field performed the measurements.

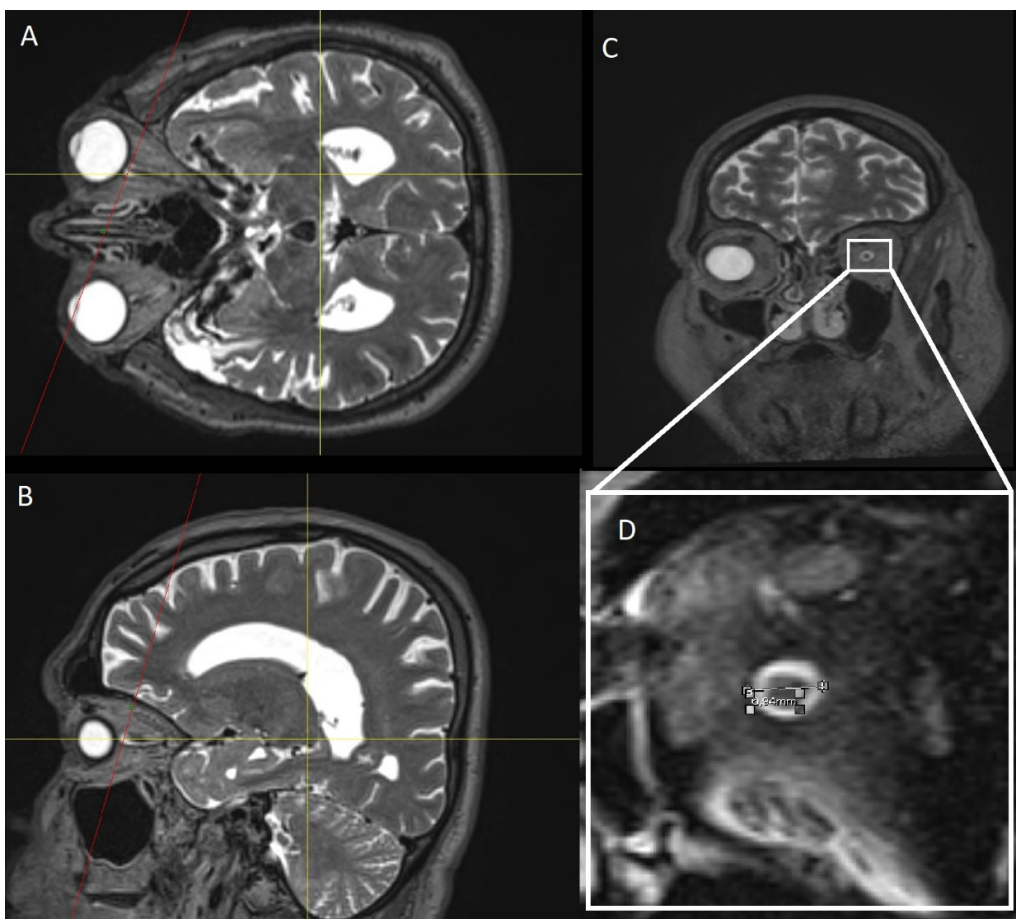

Figure 1. Evaluation of the optic nerve sheath complex reformatted in axial and sagittal T2 weighted images **(A and B).** T2-weighted image perpendicular to the left optic nerve sheath complex **(C).** Left optic nerve sheath complex measurement from the magnified image **(D).**

Statistical analysis

The diameters of the optic nerve sheath complex and optic nerve, the difference between their diameters and the ratio of diameters were calculated in both groups. Statistical evaluations among the mean values were calculated using the Mann Whitney-u test and the t-test through the SPSS program ver. 24 (IBM Corp., Armonk, NY, USA).

RESULTS

Twenty-one patients (11 DESH negative, 10 DESH positive) in the NPH patient group and 47 patients in the control group were included in the study. The age, gender distributions and radiological findings of the patients are summarized in Table 1. Optic nerve sheath diameter is higher in the normal pressure hydrocephalus patient group compared to the control group ($p < 0.0001$). The ratio of optic nerve sheath diameter and optic nerve diameter was found to be significantly higher in the normal pressure hydrocephalus patient group compared to the control group ($p < 0.0001$).

DISCUSSION

Normal pressure hydrocephalus is a disease of unknown etiology with impaired cognitive functions. A disease-specific atrophy pattern is described and local function loss in CSF absorption is blamed for the formation of the pattern.[3] The optic nerve sheath is a structure that surrounds the optic nerve with the dura and contains CSF fluid. It is known that the morphological characteristics of the optic nerve sheath change with the increase in intracranial pressure.[8] Although intracranial pressure does not change in normal pressure hydrocephalus disease, its course with ventriculomegaly and its unique atrophy pattern suggests that a disruption in the CSF circulation may cause these morphological changes, and therefore the optic nerve sheath complex may also be affected.[9] In our study, although the optic nerve diameter did not change in the normal pressure hydrocephalus patient group compared to the control group, an increase in the optic nerve sheath complex diameter was detected. Parallel to this, the distance between optic nerve sheath complex and optic nerve increased compared to the control group. This may indicate that the focal increase in CSF distance in the temporal lobe and sylvian fissures also occurs in the optic nerve sheath complex.

There are publications supporting that ventriculomegaly develops in patients with normal pressure hydrocephalus due to the decrease in ventricular compliance secondary to periventricular infarction.[10,11] Recently, studies on optic nerve sheath complex have been carried out in this patient group because it may reflect CSF flow pattern and brain parenchymal compliance. In a study by Ertl *et al*., optic nerve sheath diameter was measured in supine and standing positions in patients with normal pressure hydrocephalus, and a correlation was found between this difference and the spinal tap test.[12] In the study, the idea was advocated that the change between supine and standing measurement may reflect brain compliance. However, the major disadvantage of this study is the evaluation of the optic nerve with a non-cross-sectional imaging method and practitioner-dependent visualization of ultrasonography evaluation.[13] In addition, the mean age of the control group is significantly different from the average age of the study group. However, some physiological and morphological features in the normally aging brain may change depending on age, thus this suggests that the mean ages of the study and control groups should be similar.[14] In our study, it was evaluated with the magnetic resonance imaging method, which is a cross-sectional imaging method of optic nerve sheath complex, and it revealed the average

Table 1: Distribution and radiological findings of the patients according to the groups

	iNPH Group	Control Group	P value
Age	69± 5.20	67.51± 5.35	0.741[t]
Gender (F/M)	9/12	24/23	0.605[f]
ONSD	6.90± 0,66	6.15± 0,92	0.0001[m]
OND	2.80±0,44	2.98± 0,47	0.156[t]
ONSD-OND	4.10± 0,69	3.17± 0,59	0.0001[t]
ONSD/OND	2.50± 0,53	2.06± 0,18	0.0001[a]

ONSD: Optic nerve sheath diameter**; OND:** Optic nerve diameter; i**NPH:** idiopathic normal pressure hydrocephalus **[t]:** T test; **[m]**: Mann-Whitney u test **[a]:** Anova test; **[f]:** Fisher exact test.

optic nerve and optic nerve sheath diameters of the patients were compared with asymptomatic cases in similar age range.

In their study conducted with a 3 Tesla MRI device, Liu *et al*. found that the calibration increase in the optic nerve sheath complex in the event of an increase in intracranial pressure was best determined by measurements made from 3 and 9 mm distances to the optic globe.[15] Therefore, in our study, nerve sheath measurements were performed at a distance of 3 mm from the optic globe.

There was no significant difference between the DESH positive and negative groups in terms of optic nerve sheath complex and optic nerve diameters. This situation may be due to the low number of patients in sub-groups or may be due to the absence of a link between the changes in the optic nerve sheath complex and DESH. Studies with larger patient populations should be conducted on this subject.

Limitations include the retrospective design of the study, the small number of patients, and the lack of knowledge of the subgroups of iNPH patients due to lack of data.

In conclusion, the increase in optic nerve sheath diameter detected in our study compared to the normal population may reflect the chronic effect of this disease on the optic nerve sheath complex. In addition, although it could not be detected in our study, it may be a candidate finding to be a component of the DESH finding. Studies with a larger patient group are needed.

DISCLOSURE

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Conflict of interest: None

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