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ORIGINAL ARTICLE **ÖZGÜN ARAŞTIRMA**

PROGNOSTIC VALUE OF OPTIC NERVE SHEATH DIAMETER IN SPONTANEOUS INTRACEREBRAL HEMORRHAGE

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ABSTRACT

INTRODUCTION: Optic nerve sheath diameter (ONSD) is seen to increase in patients with spontaneous intracerebral hemorrhage (ICH) due to increased intracranial pressure. The prognostic value of increased ONSD in ICH patients is uncertain. In this study, we aimed to reveal the predictive power of ONSD about the prognosis of ICH patients.
METHODS: Patients diagnosed with ICH between January 2020 and April 2022 were examined by retrospectively scanning their files. 39 patients with ICH detected on the first cranial computed tomography (CT) scan within 6 hours after the onset of symptoms were included in the study. In the first cranial CT of the patients, bleeding localization, volume, presence of intraventricular hemorrhage (IVH), ONSD, optic nerve sheath area (ONSA) were examined. Final outcome at discharge: The good prognosis group was divided into patients with 0-3 points according to the modified Rankin scale (MRS), and the poor prognosis group was divided into 4-6 points. Student's t-test was used for continuous variables, chi-square test for categorical variables, Pearson correlation coefficient was used to determine the correlation of OCSD measurement with various parameters, and Spearman correlation coefficient was used to determine the correlation with volume.
RESULTS: The ONSD of the poor outcome group was significantly higher than positive outcome group (6.67±0.85 vs. 5.97±0.61 mm, $p<0.001$). A significant positive correlation was found between hematoma volume and ONSD measurements ($r=0.529$, $p<0.001$). The hematoma volumes of the bad group were significantly higher than good group ($p=0.012$). The presence of IVH was significantly higher in bad group ($p=0.026$).
In addition, the cut-off value for ONSD was found to be 6.60 mm, with a specificity of %90.9 and sensitivity of %64.7.
DISCUSSION AND CONCLUSION: Increased ONSD measured on initial CT predicted poor outcome. Therefore, it can be used as a prognostic scale and alert the physician for timely appropriate intervention.
Keywords: Optic nerve sheat diameter, intracerebral hemorrhage, hematoma.

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SPONTAN İNTRASEREBRAL HEMORAJİLERDE OPTİK SİNİR KILIF ÇAPININ PROGNOSTİK DEĞERİ

ÖZ

GİRİŞ ve AMAÇ: Optik sinir kılıf çapı (OSKÇ) spontan intraserebral kanamalı (İSK) hastalarda artan kafa içi basınca bağlı artmış olarak görülür. İSK hastalarında artmış OSKÇ'nin prognostik değeri belirsizdir. Bu çalışmada İSK hastalarının prognozu hakkında OSKÇ'nın öngörü gücünü ortaya koymayı amaçladık.
YÖNTEM ve GEREÇLER: Ocak 2020 ile Nisan 2022 arasında İSK tanısı alan hastalar dosyaları geriye doğru taranarak incelendi Travmatik İSK, serebral enfarktüsün hemorajik dönüşümü, anevrizma veya arteriyovenöz malformasyon kanamaları, tümör kanamaları, orbital kitle lezyonları, orbital cerrahi ve oküler veya retro-orbital yaralanma olan hastalar, OSKÇ ölçümünü kullanılamaz hale getiren hareket artefaktları olan hastalar dışlandı. Semptomların başlangıcından sonraki 6 saat içinde ilk kraniyal bilgisayarlı tomografi (BT) uygulamasında İSK saptanan 39 hasta çalışmaya dahil edildi. Hastaların çekilen ilk kraniyal BT'lerinde kanama lokalizasyonu, hacmini, intraventriküler hemoroji (IVH) varlığı; OSKÇ, optik sinir kılıf alanı (OSKA) incelendi.
Taburculuktaki nihai sonlanım: iyi prognozlu grup modifiye rankin skalasına (MRS) göre 0-3 puan alan hastalar, kötü prognozlu grup 4-6 puan alan olarak ikiye ayrıldı. Sürekli değişkenler için Student's t-testi, kategorik değişkenler için ki-kare testi ve OKSÇ ölçümünün çeşitli parametrelerle korelasyonunu belirlemek için Pearson korelasyon katsayısı, volüm ile olan korelasyonunu belirlemek için Spearman korelasyon katsayısı kullanıldı.
BULGULAR: Kötü sonuç grubunun OSKÇ'si, olumlu sonuç grubununkinden önemli ölçüde daha yüksekti (6,67±0,85'ya karşı 5,97±0,61 mm, p<0,001). Hematom hacmi ile OKSÇ ölçümleri arasında pozitif yönlü anlamlı ilişki saptandı (r=0,529, p<0,001). Kötü grubun hematom hacimleri iyi gruba göre anlamlı düzeyde yüksek görüldü (p=0,012). Kötü grupta IVH varlığı anlamlı düzeyde fazla idi (p=0,026). Ayrıca MRS'ye göre oluşturulan hasta gruplarında OSKÇ'nin (p<0,01, güven aralığı: %95 0,573-0,914) kötü sonuç ile ilişkili olduğunu saptadık. Ayrıca OSKÇ için kesme değeri %90,9 özgüllük ve %64,7 duyarlılık oranı ile 6,60 mm olarak bulundu.
TARTIŞMA ve SONUÇ: İlk BT'de ölçülen artmış OSKÇ kötü sonucu öngördü. Bu nedenle prognostik bir ölçek olarak kullanılabilir ve zamanında uygun müdahale için hekimi uyarabilir.

Anahtar Sözcükler: Optik sinir kılıf çapı, intraserebral hemoroji, hematom.

INTRODUCTION

Increased intracranial pressure (ICP) is a common condition among neurological emergencies. If not recognized and treated promptly, the results of increased ICP may lead to disability or death (1).

Increased ICP may be associated with intracerebral hemorrhage (ICH). Intracerebral hemorrhage has a 40% mortality rate at 1 month, and most survivors develop severe disability. The initial clinical course and final prognosis depend on several factors, including age, hematoma volume, hematoma location, level of consciousness, associated intraventricular hemorrhage (IVH), and anticoagulant use prior to presentation. Management in the acute phase of hemorrhage includes several strategies aimed at reducing the risk of hematoma expansion, minimizing the deleterious local effects of blood products on the brain parenchyma, and resolution of the hematoma (2).

Some measures that can be taken to reduce the risk of hematoma enlargement are blood pressure control and reversal of drug effect in patients with oral anticoagulant use. Iron chelation and anti-inflammatory drug therapies to reduce the local effect of hematoma in the brain parenchyma are discussed. Surgical treatment for intracerebral hemorrhage patients includes craniotomy and a range of minimally invasive surgical techniques. Low hematoma volume before and after treatment is correlated with good prognosis in numerous ICH studies. This can be attributed to the attenuation of the mass effect and limitation of cellular toxicity from released blood products (1,2).

The presence of hydrocephalus is an independent predictor of mortality in patients with intracerebral hemorrhage, and extraventricular drainage (EVD) is recommended to reduce ICP in the presence of hydrocephalus leading to decreased level of consciousness. Hyperosmolar therapies should also be considered to reduce ICP temporarily. Minimally invasive approaches to drainage of supratentorial ICHs and intraventricular hemorrhage show reduced mortality compared with medical therapy alone; however, they do not affect functional outcome (3).

Computed tomography (CT) imaging is widely used in most hospitals, although routine invasive monitoring of ICHs is not available. Demonstrating the relationship between non-invasive CT measurement of optic nerve sheath diameter (ONSD) and increased ICP may be particularly useful when routine CT examinations of the brain are required and invasive IOP monitoring is not available, or when lumbar puncture (LP) is contraindicated. Ultrasonography (USG) and Magnetic Resonance Imaging (MRI) are other indirect measurement options. USG is operator-dependent and requires experience (4).

The mechanism responsible for the distension of the optic nerve sheath complex can be explained by the connection between the subarachnoid space surrounding the optic nerve and the intracranial subarachnoid space. An enlarged dural sheath can be measured with an increase in the size of the optic nerve sheath complex when ICP is increased during imaging. Visible differences in ONSD occur within seconds of a change in ICP, making it possible to detect changes in ICP immediately by measuring ONSD (4,5). Optic nerve sheath diameter may be increased in patients with spontaneous ICH due to increased intracranial pressure. The prognostic value of increased ONSD in ICH patients is unclear. This study aimed to demonstrate the predictive power of ONSD for the prognosis of ICH patients.

If there is a significant correlation between optic nerve sheath diameter and poor prognosis, a quantitative value on CT, which is a highly feasible test that is applied to almost all patients in the early period, can give an idea about the prognosis of the patients and the necessary treatment options can be reviewed in the early period.

METHODS

The patients who were clinically and radiologically diagnosed with ICH and underwent cranial CT within the first 6 hours after symptom onset in our hospital between January 2020 and April 2022 were reviewed. Patients over 18 years of age, whose clinical observation was completed, were included in the study. A total of 62 patient records were reviewed for inclusion in the study.

Patients with traumatic ICH, hemorrhagic transformation of cerebral infarction, aneurysm or arteriovenous malformation hemorrhages, tumor hemorrhages, orbital mass lesions, orbital surgery, and ocular or retro-orbital injury were excluded. Patients in whom measurement of ONSD could not be performed due to motion artifact were not included in the study. Thirty-nine patients were included in the study. This study was approved by the Clinical Research Ethics Committee of Health Sciences University Haydarpasa Numune Training and Research Hospital (Number: 2022-191, Date: 03.10.2022) and was conducted in accordance with the Ethical Standards of the Declaration of Helsinki.

Multiplanar reconstruction (MPR) was used to evaluate the hemorrhage localization and volume, the presence of IVH, and to measure the ONSD and optic nerve sheath area (ONSA) on the cranial CT scans of the patients.

All CT images were obtained with a 64-slice CT scanner (TOSHIBA) and 1 mm single-slice sections were analyzed. All measurements were made using the same window, contrast, and brightness. The window setting was as follows: spine window (WW 60, WL 360). Ensuring that the cantomeatal line was perpendicular to the horizontal plane was challenging in some patients due to unconscious movement. Therefore, we used multiplanar reconstruction (MPR) to adjust the CT image to ensure that the patient's eyeball, lens, and optic nerve were in the same plane. The transverse diameter of the optic nerve sheath complex was measured perpendicular to its trajectory on axial images 3 mm behind the sphere as described by Lee et al. (6) and averaged for left and right (Figure 1).

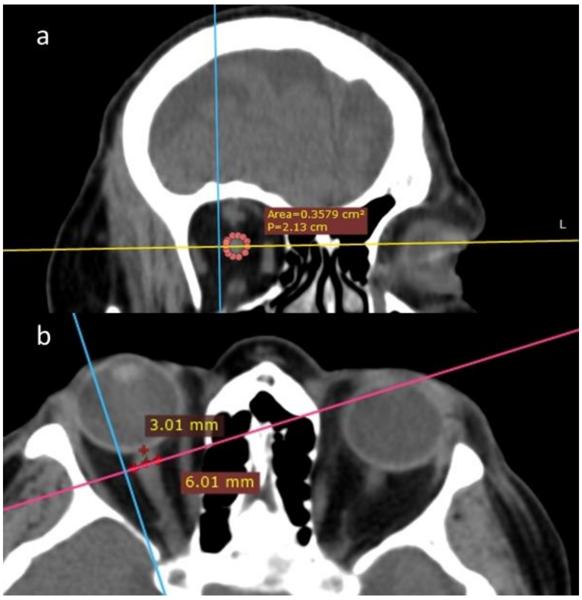

Figure 1. MPR application for the lens, eyeball, and optic nerve to be in the same plane in the axial section. a) ONSA measurement. b) ONSD measurement.

ONSA was measured in the coronal section perpendicular to the horizontal axis where ONSD was measured.

Hematoma volume was calculated using ABC/2 method (7).

Patients were divided into 2 groups according to the Modified Rankin Scale (MRS) at discharge: patients with a discharge MRS of 0-3 were classified as a good prognosis group; patients with a discharge MRS of 4-6 were classified as a poor prognosis group.

Statistical examinations were performed using SPSS 21 software. Categorical data were presented as frequency and percentage. The distribution of numerical data was evaluated with the Kolmogorov-Smirnov test. Normally distributed data were expressed as mean and standard deviation, whereas non-normally distributed data were expressed as median and minimum-maximum. Numerical data were analyzed using Mann-Whitney U and an independent t-test, and categorical data were analyzed using a chi-square test. A p-value of <0.05 was accepted as statistically significant. Spearman correlation coefficient was used to determine the correlation of ONSD measurement with hematoma volume. Furthermore, the cut-off value, sensitivity, and specificity of ONSD in predicting poor outcomes were obtained by receiver operating characteristic analysis. The cut-off value was determined according to the Youden index..

RESULTS

There were 17 patients in the poor prognosis group and 22 patients in the good prognosis group. The mean age of the poor prognosis group was 63.7 years, while the mean age of the good prognosis group was 60.6 years. No significant difference was found in demographic data and serum parameters between the two groups.

The ONSD of the poor prognosis group was significantly higher than that of the good prognosis group (6.67±0.85 vs. 5.97±0.61 mm, p<0.001).

There was a significant positive correlation between hematoma volume and ONSD measurements (r=0.529, p<0.001). Hematoma volumes of the poor prognosis group were significantly higher than those of the good prognosis group (p=0.012). The presence of IVH was significantly higher in the poor prognosis group (p=0.026).

Table. Comparison of good and poor prognosis groups.

	Good Prognosis N=22	Poor Prognosis N=17	p
Age, mean (SD)	60,68(13,90)	63,71(15,89)	0,5
ONSD mm, mean (SD)	5,98(0,61)	6,67(0,85)	**0,005**
ONSA mm^2, mean (SD)	0,40(0,08)	0,42(0,90)	0,55
Hematoma volume mm^3 median (min-max)	17,11(0,1-149,48)	34,61(0,81-88,51)	**0,01**
Presence of IVH	%9,1	%41,2	**0,02**

ONSD: Optic nerve sheath diameter, ONSA: optic nerve sheath area, SD: Standard deviation, min-max: Minimum-maximum, mm: millimeter, mm3: cubic millimeter, IVH: Intraventricular hemorrhage.

We also found that ONSD (p<0.01, confidence interval: 95% 0.573-0.914) was associated with poor outcomes in patient groups formed according to MRS. Furthermore, the cut-off value for ONSD was found to be 6.60 mm with a specificity of 90.9% and a sensitivity of 64.7% (Figure 2).

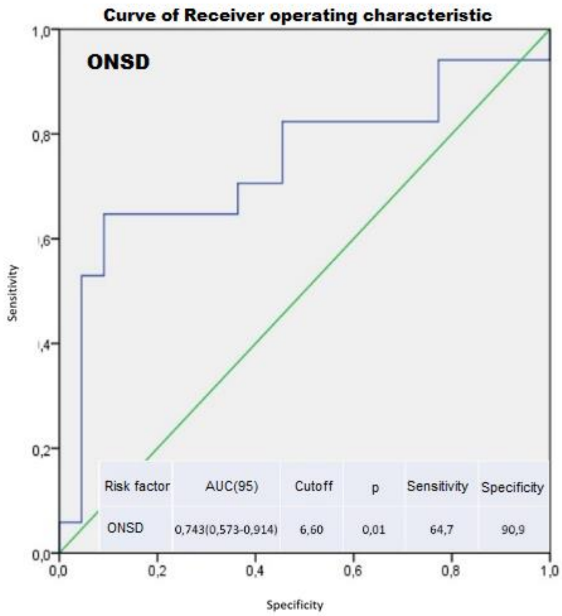

Figure 2. Receiver operating characteristic analysis of ONSD on poor outcome prediction.

DISCUSSION AND CONCLUSION

Measurement standards differ due to the mobile and long course of the optic nerve. The distance from the orbit at which the ONSD should be measured is a matter of debate.

Sekhon et al. used invasive ICP monitoring with an ICP limit of 20 mmHg in patients with traumatic brain injury and divided the patients into 2 groups as high and normal ICP.

Simultaneously, ONSD was measured on CT. The cut-off value of ONSD in determining increased ICP was determined as 6.0 mm with 97% sensitivity and 42% specificity (8). In another study, the cut-off value was reported as 5.0 mm (9). In our study, we found the cut-off value to be 6.60 mm. We suggest that the possible reasons for the difference in ONSD cut-off values in other studies, including ours, could be due to the different imaging methods used to measure ONSD, inter-observer variability, and the distance behind the orbit where the measurements were taken.

In our study, the ONSD of the poor prognosis group was higher than the good prognosis group. In the literature, prognosis studies performed with CT also showed results compatible with our study. (10).

In parallel with previous studies, IVH and hematoma volume were found to be correlated with prognosis in our study (11). Our results were also consistent with previous studies in patients with traumatic brain injury(12) and subarachnoid hemorrhage(13).

Ultrasonography and CT were presented as alternatives to each other in the measurement of ONSD. Kim et al. reported a correlation between USG and CT measurements of ONSD in patients with normal and increased ICP. It was observed that ONSD was significantly higher in the group with increased ICP compared to the normal group. (13).

Current prognosis and severity assessment scales for hemorrhagic stroke patients do not include ICP. We believe that our study can shed light on the prognosis of patients if supported by randomized controlled studies.

The limitations of our study are that it was retrospective, the sample size was small, and a method that has not yet been standardized was employed. However, a standardized measurement method can be determined by prospectively planned studies comparing the measurement techniques of ONSD with invasive methods.

The fact that discharge MRS was calculated on different days in each patient is another limitation of our study. Bias can be reduced by extending patient follow-up and maintaining equal time to calculate the outcome MRS in each patient.

Further studies on the relationship between optic nerve sheath diameter and ICP on CT examinations may provide an idea of the normal value of ONSD and the use of this common and standardized imaging method in many other diseases that may lead to a pathological increase in ICP.

In our study, increased ONSD measured at the first CT predicted poor outcome. ONSD can be used in the improvement of prognostic scales that combine clinical and radiologic markers, such as the Essen ICH Score. (14)

Despite the presence of studies on the measurement of OSCE in various patient groups, a definitive method for measurement has not yet been determined. Studies on the normal population are limited. Further studies conducted in this field in comparison with the normal population would provide us with more insight to understand the prognostic value.

REFERENCES

1. Sheth KN. Spontaneous intracerebral hemorrhage. New England Journal of Medicine 2022; 387(17): 1589-1596.
2. Kase CS, Hanley DF. Intracerebral hemorrhage: Advances in emergency care. Neurologic clinics 2021; 39(2): 405-418.
3. Greenberg SM, Ziai WC, Cordonnier C, et al. 2022 guideline for the management of patients with spontaneous intracerebral hemorrhage: A guideline from the american heart association/american stroke association. Stroke 2022; 53(7): e282-e361.
4. Jenjitranant P, Tunlayadechanont P, Prachanukool T, et al. Correlation between optic nerve sheath diameter measured on imaging with acute pathologies found on computed tomography of trauma patients. European Journal of Radiology 2020; 125: 108875.
5. Hylkema C. Optic nerve sheath diameter ultrasound and the diagnosis of increased intracranial pressure. Critical Care Nursing Clinics 2016; 28(1): 95-99.
6. Lee H-C, Lee W-J, Dho Y-S, et al. Optic nerve sheath diameter based on preoperative brain computed tomography and intracranial pressure are positively correlated in adults with hydrocephalus. Clinical Neurology and Neurosurgery 2018; 167: 31-35.
7. Kothari RU, Brott T, Broderick JP, et al. The abcs of measuring intracerebral hemorrhage volumes. Stroke 1996; 27(8): 1304-1305.
8. Sekhon MS, Griesdale DE, Robba C, et al. Optic nerve sheath diameter on computed tomography is correlated with simultaneously measured intracranial pressure in patients with severe traumatic brain injury. Intensive care medicine 2014; 40: 1267-1274.
9. Luyt D, Joubert G, Hurter D. The relationship between computed tomography measurement of the optic nerve sheath diameter and elevated intracranial pressure in non-trauma patients. SA Journal of Radiology 2016; 20(1): 1-4.
10. Xu H, Li Y, Liu J, et al. Dilated optic nerve sheath diameter predicts poor outcome in acute spontaneous intracerebral hemorrhage. Cerebrovascular Diseases 2022; 51(2): 199-206.
11. Kim DY, Kim SY, Hong DY, et al. Comparison of ultrasonography and computed tomography for measuring optic nerve sheath diameter for the detection of elevated intracranial pressure. Clinical Neurology and Neurosurgery

2021; 204: 106609.
12. Legrand A, Jeanjean P, Delanghe F, et al. Estimation of optic nerve sheath diameter on an initial brain computed tomography scan can contribute prognostic information in traumatic brain injury patients. Critical care 2013; 17(2): 1-7.
13. Lee S, Kim YO, Baek JS, et al. The prognostic value of optic nerve sheath diameter in patients with subarachnoid hemorrhage. Critical care 2019; 23(1): 1-9.
14. Weimar C, Benemann J, Diener H. Development and validation of the essen intracerebral haemorrhage score. Journal of Neurology, Neurosurgery & Psychiatry 2006; 77(5): 601-605.

Ethics

Ethics Committee Approval: The study was approved by Klinical Researches Ethics Committee of Health Sciences University, Haydarpaşa Numune Training and Research Hospital (No: 2022-191, Date: 03.10.2022).

Informed Consent: The authors declared that it was not considered necessary to get consent from the patients because the study was a retrospective data analysis.

Authorship Contributions: Surgical and Medical Practices: HK, ABB, CHM. Concept: HK, ABB, CHM. Design: HK, ABB, CHM. Data Collection or Processing: HK, ABB, CHM. Analysis or Interpretation: HK, ABB, CHM. Literature Search: HK, ABB, CHM. Writing: HK, ABB, CHM.

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