# STUDY OF OPTIC NERVE SHEATH DIAMETER IN NORMAL NEPALESE ADULTS USING ULTRASOUND

*KC B[1*], Thapa A[2]*

**Affiliation**

1. *Lecturer, Department of Neurological Surgery, Kathmandu Medical College*
2. *Associate Professor, Department of Neurological Surgery, Kathmandu Medical College*

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**** Corresponding Author***

*Dr Bidur KC*
*Lecturer*
*Department of Neurological Surgery*
*Kathmandu Medical College, Sinamangal, Kathmandu, Nepal*
*Email: kcbidur@gmail.com*
*https://orcid.org/0000-0003-3691-8764*

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## ABSTRACT

### Introduction

Though invasive intracranial devices are gold standard to calculate intracranial pressure (ICP); these are not without any complications. Non-invasive measurement of ICP by Ultrasonography could be a safe and portable technique.

### Objectives

The objective of the study was to measure and compare values of optic nerve sheath diameter of both eyes in healthy Nepalese adults.

### Methodology

A prospective cross-sectional study of healthy adult Nepalese volunteers was performed using a 7.5 MHz linear Ultrasound probe on the closed eyelids; optic nerve sheath diameter (ONSD) was measured 3 mm behind the globe in each eye.

### Results

Optic nerve sheath diameter (ONSD) of both eyes was measured in 100 healthy volunteers of age ranged from 15 to 75 years with a mean of 30.21 ± 14.05 years. There were 18 (18%) male and 82 (82%) female. ONSD for right eye ranged from 3.20 to 4.90 mm with mean of 4.10 ± 0.50 mm and left eye from 3.20 to 4.80 mm with mean of 4.22 ± 0.49 mm. P value for right and left eye ONSD (P = 0.06) and male and female (*P* = 0.12 and 0.85 for right and left ONSD respectively) were within normal limits. ONSD has no correlation with age (*P* = 0.27 and 0.27 for right and left ONSD respectively).

### Conclusion

Mean of optic nerve sheath diameter (ONSD) is 4.10mm and 4.22 mm for right and left eye respectively. There is no statistical significant difference in mean of ONSD between right and left eye.

## KEY WORDS

*Healthy volunteers, nepalese adult, optic nerve sheath diameter, transorbital sonography*

## INTRODUCTION

The optic nerve, is a second cranial nerve (CNII), derived from embryonic retinal ganglion cell. Also known as the nerve of vision because it carries the electrical impulses from retina to brain. It is myelinated nerve wrapped with three meningeal layers of which subarachnoid space is continuous with that of the brain.[1-3] Hence, change in intracranial pressure (ICP) causes reflective change in intraorbital subarachnoid space pressure at the same time.[1,4,5]

Gold standard for ICP measurement are Invasive intracranial devices.[6,7] However, these devices may invite complications like infection, hemorrhage and dislodgement. Besides, it cannot be performed in cases of bleeding disorders.[8-10] There lies the significance of measuring ICP non-invasively.[11]

Detection of papilloedema to infer Increase in ICP non invasively mandates an experienced examiner and usually occurs late.[12,13] Other noninvasive devices like Computed tomography (CT) and magnetic resonance imaging (MRI) of the head which may not be accessible everywhere, are expensive and may not be portable.[14,15] Bulbar ultrasonography also detects increase in ICP non-invasively before development of papilloedema which is corroborated by In-vitro studies.[16] Optic nerve sheath diameter (ONSD) has been utilized for different conditions to find increase in ICP as a clinical and research tool with high sensitivity and ONSD differs almost simultaneously with ICP.[17-19] It is cheap and easy to train operators. Unlike other ultrasound methods, has low intra and inter-operator variability.[20,21]

There is no consensus of threshold value ONSD pointing increased ICP. It may vary from person to person but doesn't vary among children of different sex.[19, 22] Widely acceptable value for adult is 5 mm, although maximum of 5.9 mm have been quoted.[19] Normal values of ONSD can be used to infer increase in ICP in medical practice.[17,23] ONSD can vary with ethnic origin. Asian countries have found different normal ranges in adults (3.7–4.7 mm in Hong Kong, 2.9–5.3 mm in Korea and 4.25–4.75 mm in Bangladesh).[5,23,24]

Besides, there is a paucity of local data of ONSD in Nepalese adults, so this study aims to evaluate the baseline value of ONSD among healthy Nepalese adults.

## METHODOLOGY

This prospective cross-sectional study was conducted in department of Neurological Surgery at Kathmandu Medical College Hospital (KMCH) in Sinamangal, Kathmandu, Nepal from 5th January 2018 to 15th February 2018. Apparently healthy hospital staffs, medical students and relatives of the patients above 16 years were enrolled after obtaining informed consent. Those with ocular diseases, neurological disorder, features of raised ICP, non Nepalese and aged 16 years or below were excluded from the study. The study was approved by ethical review committee of KMCH.

ONSD was measured using 7.5 MHz linear array transducer of the Mindray Diagnostic Ultrasound System (Model: Z6; Shenzhen Mindray Biomedical Electronics Co., Ltd., Shenzhen- 518057, P.R. China) by a single sonographer. As low as reasonably achievable (ALARA) ultrasonography technique was used for the safety of the volunteers. Volunteers were placed in supine position with closed eyelid. After applying gel at the temporal side of eyelid, transducer was kept horizontally. Transducer was adjusted till appearance of hypoechoic optic nerve behind the globe. ONSD of both eyes were measured at 3 mm behind the globe taking transverse diameter of hypoechoic shadow right angle to the optic nerve by using electronic caliper. Coupling gel was removed with sterile paper from the transducer and clean with normal saline after each use. Data were collected and entered into the excel sheet.

Statistical analysis was performed using IBM SPSS Statistics version 22 (IBM Corporation, New York, USA). Data were analyzed with descriptive and inferential statistics. Paired T test was used to compare the mean ONSD of right and left eye. Mann-Whitney U test was used to determine correlation between the gender and ONSD and Kruskal-Wallis test to evaluate correlation between age and ONSD. P values of $< 0.05$ were considered significant.

## RESULTS

Total of 100 subjects were included. Among them, 18 (18%) were male and 82 (82%) were female. Age ranged from 17 to 75 years, with a mean of 30.21 ± 14.05 years.

ONSD value for right eye ranged from 3.20 mm to 4.90 mm with mean of 4.10 ± 0.50 mm and median of 4.1 mm. ONSD value for left eye ranged from 3.20 mm to 4.80 mm with mean of 4.22 ± 0.49 mm and median of 4.4 mm. There was no statistically significant difference of mean ONSD between right and left eye (P = 0.06). This study showed no statistically significant association of ONSD between male and female ($P$ = 0.12 and 0.85 for right and left ONSD respectively). No statistically significant correlation was found between ONSD and age ($P$ = 0.27 and 0.27 for right and left ONSD respectively).

## DISCUSSION

Most of the neurosurgical patients usually died of raised ICP; head injury is not an exception.[25,26] An increase in ICP impedesthe cerebral blood flow (CBF) leading to ischaemia.[27,28] Secondary brain-injury due to raised ICP is a poor outcome predictor after traumatic brain injury. Treatment algorithms focuses on prevention of these insult.[28]

Neurological intensive care is vital for immediate treatment after picking up subclinical causes of secondary brain injury.[29] ICP monitoring is beneficial in many studies to prevent surgery in the settings of normal initial CT scan.[30] Mortality has been decreased with effective treatment of raised ICP.[26] For effective utilization of ONSD in the situation of raised ICP, normal reference value is required.

Several studies have observed variation of ONSD in normal subjects by using ultrasonography as shown in Table 1. Maude et al found Median ONSD was 4.41 mm with 95% of subjects in the range 4.25–4.75 mm in Bangladesh. Among 100 Pakistani healthy subjects,Ali et al reported ONSD of 4.3–5.7 mm.[23,31] Bauerle et al in German showed normal range of 4.3-7.6 mm among 40 subjects with mean of 5.4 mm.[20] The median ONSD of 4.1 mm with range of 3.1–4.6 mm was observed by Shrestha in 80 healthy Nepalese subjects.[32] Chan et al[5] calculated the normal range from 3.7 mm to 4.7 mm with a mean of 4.05 ± 0.19 mm among 100 normal Hong Kong Chinese adult. Our study revealed the range of 3.20 mm to 4.90 mm with mean of 4.10 ± 0.50 mm for the right eye and 3.20 mm to 4.80 mm with mean of 4.22 ± 0.49 mm for the left eye was similar to the values observed by Maude et al in Bangladesh, Shrestha in Nepal and Chan et al in Hongkong.[5,23,32] However, our values were lower than what has been reported by Ali et al in Pakistan and Bauerle et al in Germany.[20,31]

In concordance with previous studies, our study also concluded no statistically significant association between ONSD and age, gender and side.

## CONCLUSION

Mean of optic nerve sheath diameter (ONSD) in healthy Nepalese adults for the right and left eye is 4.10 ± 0.50 and 4.22 ± 0.49 mm respectively. There is no significant statistical association between ONSD of right and left eyes, ONSD and age and gender and side.

## RECOMMENDATION

Should be used as a bedside screening tool in all patients suspicious of raised ICP. These calculated values of ONSD of healthy Nepalese adults would be used as a baseline for future reference in patients with raised ICP.

**Table 1.** ONSD variation in different countries

| Study | Country of Study | ONSD range in mm | | Mean[a]/Median[b] ONSD in mm | |
|---|---|---|---|---|---|
| Maude et al[23] | Bangladesh | 4.2–4.7 | | 4.4[b] | |
| Ali et al[31] | Pakistan | 4.3–5.7 | | 4.8[b] | |
| Bauerle et al[20] | German | 4.3-7.6 | | 5.4[a] | |
| Shrestha[32] | Nepal | 3.1–4.6 | | 4.1[b] | |
| Chan et al[5] | Hong Kong, China | 3.7-4.7 | | 4.05[a] | |
| This study | Nepal | Right | Left | Right | Left |
| | | 3.2-4.9 | 3.2-4.8 | 4.1[a] | 4.2[a] |

## LIMITATIONS

Study didn't measure ICP directly which would have allowed us to compare and validate how well the ONSD and ICP would have correlated with each other.Study did not include any subjects below 16 years of age.

## CONFLICT OF INTEREST

None

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