

# Sonographic Assessment of Optic Nerve Sheath Diameter for Increased Intracranial Pressure

Surafel Dubale, Yohannes Seife, Robel Beyene

## Introduction:

Optic nerve sheath diameter measurement is a non-invasive, time saving, and efficient way of assessing raised intracranial pressure in a patient with altered consciousness of unknown etiology. The optic nerve sheath demonstrates changes in diameter with intracranial pressure changes, as there is a layer of subarachnoid space between the nerve and its sheath, which expands due to raised intracranial pressure. These changes are appreciated more along the anterior aspect of the nerve and can be detected using a high frequency ultrasound.

Studies have shown that optic nerve sheath diameter measurement has:

- High sensitivity for ruling out raised intracranial pressure in a low-risk group
- High specificity for ruling in raised intracranial pressure in a high-risk group.

A 2011 study done in adult patients with different kinds of brain injury showed an optimal optic nerve sheath diameter for detection of intracranial hypertension (ICP > 20 mmHg) was  $\geq 0.48$  cm with a sensitivity 96% and specificity 94%. Another study done in trauma patients with median Glasgow Coma Scale of 7 showed that the ability to detect intracranial hypertension was high for ONSD with area under the curve of 0.91.

## Steps:

1. Perform a thorough clinical and neurological examination of the patient for increased intracranial pressure.
2. A high frequency linear probe is used.



The linear probe has a frequency of 5-7.5 MHz and is used to see fine detail at depths up to 6cm. See [Introduction to Ultrasonography](#) for more details.

3. Patient is positioned supine; the eye is covered with the eyes shut with an occlusive dressing (such as Tegaderm®) or clean tape. Copious amounts of ultrasound gel are applied over the tape.

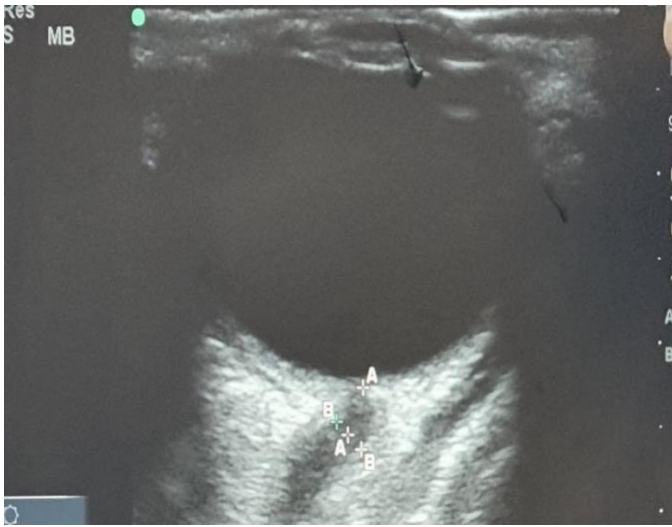


An occlusive dressing is applied over the eye and generous ultrasound gel is then applied.

4. The optic nerve sheath is located 3mm behind the globe. It appears as a bright (hyperechoic) circular or oval structure surrounding the dark (hypoechoic), longitudinal, optic nerve. With a gentle application of transducer on the globe, a characteristic image with the optic nerve and sheath emerging posteriorly should appear as shown below.
5. The papilla is located as shown. A 3mm line is drawn along the long axis of the nerve sheath and marked as a distance Point A - A.
6. A line perpendicular to the A-A is then drawn at the 3mm depth from the medial to the lateral inner walls of the hyperechoic nerve sheath and is marked as Point B -B, which is the Optic Nerve Sheath Diameter.

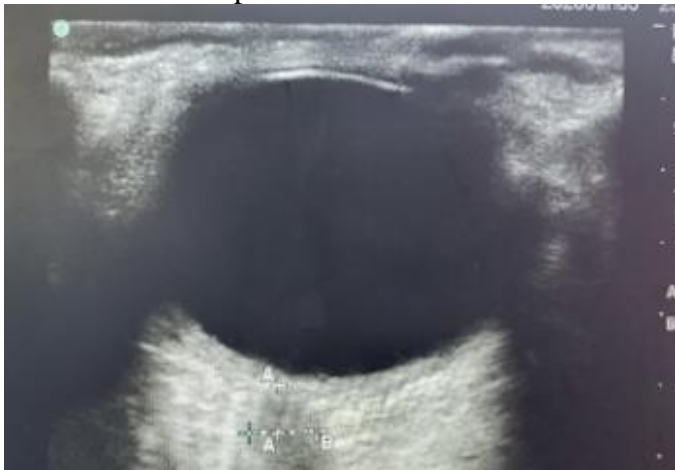
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With the probe held in longitudinal orientation, (sagittal plane) a distance of 3mm from the inner wall of the nerve sheath (A-A') is first measured. Then, at this distance, the width of the nerve sheath (B-B') is measured.

7. Measurement is done in both the longitudinal (sagittal) axis, as shown above, and the transverse (axial) axis, as shown below. The average is taken. The measurement is then repeated on the other eye and the average is taken as the mean Optic Nerve Sheath Diameter.



With the probe oriented transversely (Axial plane) the measurement is repeated as above.

## Interpretation:

Normal values are shown below. Values above these indicate elevations in intracranial pressure above 20mmHg.

Up to 4 mm in infants
Up to 4.5 mm in children
Up to 5 mm in adults

## Pitfalls

The following conditions can cause the optic nerve sheath diameter to be elevated without an increase in intracranial pressure:

- Optic neuritis
- Optic nerve glioma
- Optic nerve meningioma
- Inflammatory infiltration
- Graves' orbitopathy
- Leukemic infiltration
- Orbital congestion with sheath swelling
- Obesity / high body mass index
- Chronic ICP elevation

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Further Reading:

Open Access:

Ohle R, McIsaac SM, Woo MY, Perry JJ. Sonography of the Optic Nerve Sheath Diameter for Detection of Raised Intracranial Pressure Compared to Computed Tomography: A Systematic Review and Meta-analysis. J Ultrasound Med. 2015 Jul;34(7):1285-94. doi: 10.7863/ultra.34.7.1285.

Robba C, Cardim D, Tajsic T, Pietersen J, Bulman M, Donnelly J, Lavinio A, Gupta A, Menon DK, Hutchinson PJA, Czosnyka M. Ultrasound non-invasive measurement of intracranial pressure in neurointensive care: A prospective observational study. PLoS Med. 2017 Jul 25;14(7):e1002356. doi: 10.1371/journal.pmed.1002356.

Not Open Access:

Rajajee, V., Vanaman, M., Fletcher, J.J. et al. Optic Nerve Ultrasound for the Detection of Raised Intracranial Pressure. Neurocrit Care 15, 506–515 (2011).

<https://doi.org/10.1007/s12028-011-9606-8>

