□ Transorbital Ocular Ultrasound

Transorbital **ocular ultrasound** is a non-invasive imaging technique performed through the closed eyelid using a high-frequency linear probe. It is increasingly used in **neurocritical care** to assess the **optic nerve sheath diameter** **(ONSD)** as a surrogate marker for **intracranial pressure (ICP)**.

⚙ Equipment and Setup

- **Probe**: High-frequency linear probe (7.5–15 MHz)
- **Position**: Patient in **supine** position, eyes closed
- **Preparation**:
  - Apply generous **sterile gel** on the eyelid
  - Avoid exerting pressure on the globe
- **Planes**: Axial and sagittal (transverse and vertical)

□ Purpose and Clinical Use

- Screening for **elevated intracranial pressure (ICP)**
- Assessment in **trauma**, **encephalopathy**, or **hydrocephalus**
- **Rapid bedside evaluation** when CT/MRI is unavailable
- Follow-up in neuro-ICU settings

□ Measurement of ONSD

- Identify optic nerve as **hypoechoic tube** posterior to the globe
- Locate **3 mm posterior** to the retina
- Measure the **optic nerve sheath diameter** from **outer edge to outer edge**
- Measure **both eyes** and take the average

Population	Normal ONSD	Raised ICP threshold
Adults	< 5.0 mm	> 5.7 mm (suggests ICP > 20 mmHg)
Children	< 4.5 mm	> 4.5–5.0 mm (age-dependent)

⚠ Limitations

- **Operator-dependent**; requires proper training
- May yield **false positives** in:
  - Chronic papilledema
  - Orbital masses
  - Post-surgical or traumatic changes
- Less accurate in **severe periorbital edema**

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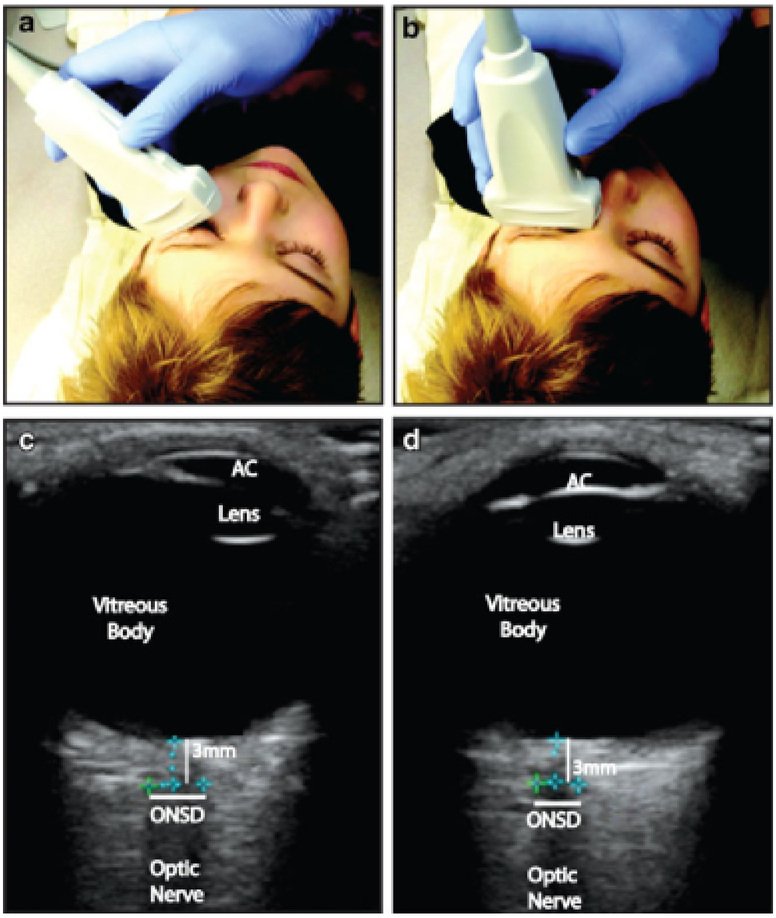

Optic nerve sheath diameter ultrasonography is strongly correlated with invasive ICP measurements and may serve as a sensitive and noninvasive method for detecting elevated ICP in TBI patients after decompressive craniectomy [1)].

Optic nerve sheath diameter measured by transorbital ultrasound imaging is an accurate method for detecting intracranial hypertension that can be applied in a broad range of settings. It has the advantages of being a non-invasive, bedside test, which can be repeated multiple times for re-evaluation [2)].

Evolution of ultrasound technology and the development of high frequency (> 7.5 MHz) linear probes with improved spatial resolution have enabled excellent views of the optic nerve sheath.

The optic nerve sheath diameter (ONSD), measured at a fixed distance behind the retina has been evaluated to diagnose and measure intracranial hypertension in traumatic brain injury and intracranial hemorrhage [3)] [4)].

The optic nerve sheath is fairly easy to visualize by ultrasonography by insonation across the orbit in the axial plane. A-mode ultrasonography was used to view the optic nerve sheath more than four decades ago; B-mode scanning was performed subsequently to assess intraocular lesions [5)].

Shirodkar et al., studied the efficacy of ONSD measurement by ultrasonography to predict intracranial hypertension. The case mix studied included meningoencephalitis, stroke, intracranial hemorrhage and metabolic encephalopathy. Using cut-off values of 4.6 mm for females, and 4.8 mm for males, they found a high level of sensitivity and specificity for the diagnosis of intracranial hypertension as evident on CT or MRI imaging [6)].

There is wide variation reported in the optimal cut-off values, when ONSD was compared with invasive ICP monitoring, ranging from 4.8 to 5.9 mm [7) 8)].

Padayachy et al present a method for assessment of optic nerve sheath ONS pulsatile dynamics using transorbital ultrasound imaging. A significant difference was noted between the patient groups, indicating that deformability of the ONS may be relevant as a noninvasive marker of raised ICP [9)].

Indications

Optic nerve sheath diameter ultrasonography indications.

Prospective observational educational intervention studies

In a Prospective observational educational intervention study Garofalo et al. [10)] evaluate the effectiveness of a brief theoretical-practical training course in enabling different healthcare providers—medical students, ICU nurses, ICU residents, and nursing students—to perform optic nerve sheath diameter (ONSD) ultrasound measurements accurately, compared to an expert tutor.

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1. � **Trivialization of Technical Expertise**

The notion that a **30-minute lecture** plus a handful of supervised measurements enables **reliable ICP-related diagnostics** is dangerously naive. ONSD ultrasound, although conceptually simple, remains **highly operator-dependent** and sensitive to **minor technique deviations**. Reducing it to a “weekend skill” undercuts its clinical seriousness.

2. � **Methodological Laxity**

- **No gold standard comparison**: Measurements were benchmarked against the “expert tutor,” not against **CT, MRI, or invasive ICP monitoring**, rendering the entire exercise **self-referential**.
- **Healthy volunteers only**: This removes all clinical complexity — no pathology, no confounding factors, no real stakes. It's a simulation, not a validation.
- **Sample size per group is unclear** and statistical power for subgroup analysis (especially among nursing students) is not demonstrated.

3. � **Overinterpretation of Bland-Altman**

- A ±0.5 mm margin of agreement might seem small, but considering that the diagnostic threshold for ICP elevation is 5.7 mm, this **range overlaps dangerously with diagnostic cutoffs**.

- The study does not report **intra-rater or inter-rater variability**, nor addresses the **learning curve** over time.

4. □ **Absence of Clinical Translation**

- No patient outcomes.
- No real-world ICU use.
- No stress conditions, no time pressure, no emergency scenario replication.
- No post-training retention testing (1 week later? 1 month?).

5. □ **Academic Rebranding of Mediocrity**

This study reads more like a **marketing brochure for point-of-care ultrasound democratization** than a serious evaluation of neuromonitoring technique deployment. Phrases like "opens the possibility of wider application" are speculative fluff with **no measured impact** or implementation analysis.

6. □ **Potential Harm from Misuse**

Encouraging widespread use of ONSD measurement by insufficiently trained staff **may increase false positives/negatives**, misguide triage decisions, or delay proper neuroimaging. The authors ignore this risk entirely.

□ Final Verdict

This study is a **well-meaning but methodologically hollow exercise** in educational optimism. It offers no robust evidence to support entrusting ONSD-based triage to non-specialists after minimal training. Instead, it trivializes a complex skill, lacks clinical validation, and promotes **technocratic overconfidence**.

If ONSD is to become a neurocritical care tool, let it be wielded by those who understand not just the measurement — but its stakes.

Case series

Optic nerve sheath diameter ultrasonography case series.

References

[1]
Wang J, Li K, Li H, Ji C, Wu Z, Chen H, Chen B. Ultrasonographic optic nerve sheath diameter correlation with ICP and accuracy as a tool for noninvasive surrogate ICP measurement in patients with decompressive craniotomy. J Neurosurg. 2019 Jul 19:1-7. doi: 10.3171/2019.4.JNS183297. [Epub

ahead of print] PubMed PMID: 31323632.

2)
Beare NA, Kampondeni S, Glover SJ, Molyneux E, Taylor TE, Harding SP, Molyneux ME. Detection of raised intracranial pressure by ultrasound measurement of optic nerve sheath diameter in African children. Trop Med Int Health. 2008 Nov;13(11):1400-4. doi: 10.1111/j.1365-3156.2008.02153.x. Epub 2008 Oct 13. PubMed PMID: 18983275; PubMed Central PMCID: PMC3776606.

3)
Geeraerts T, Merceron S, Benhamou D, Vigué B, Duranteau J. Non-invasive assessment of intracranial pressure using ocular sonography in neurocritical care patients. Intensive Care Med. 2008;34:2062–7.

4)
Moretti R, Pizzi B. Optic nerve ultrasound for detection of intracranial hypertension in intracranial hemorrhage patients: Confirmation of previous findings in a different patient population. J Neurosurg Anesthesiol. 2009;21:16–20.

5)
Gangemi M, Cennamo G, Maiuri F, D'Andrea F. Echographic measurement of the optic nerve in patients with intracranial hypertension. Neurochirurgia (Stuttg) 1987;30:53–5.

6)
Shirodkar CG, Rao SM, Mutkule DP, Harde YR, Venkategowda PM, Mahesh MU. Optic nerve sheath diameter as a marker for evaluation and prognostication of intracranial pressure in Indian patients: An observational study. Ind J Crit Care Med. 2014;18:728–734

7)
Rajajee V, Vanaman M, Fletcher JJ, Jacobs TL. Optic nerve ultrasound for the detection of raised intracranial pressure. Neurocrit Care. 2011;15:506–15.

8)
Geeraerts T, Launey Y, Martin L, Pottecher J, Vigué B, Duranteau J, et al. Ultrasonography of the optic nerve sheath may be useful for detecting raised intracranial pressure after severe brain injury. Intensive Care Med. 2007;33:1704–11.

9)
Padayachy L, Brekken R, Fieggen G, Selbekk T. Pulsatile Dynamics of the Optic Nerve Sheath and Intracranial Pressure: An Exploratory In Vivo Investigation. Neurosurgery. 2016 Jul;79(1):100-7. doi: 10.1227/NEU.0000000000001200. PubMed PMID: 26813857; PubMed Central PMCID: PMC4900421.

10)
Garofalo E, Neri G, Bosco V, Zaninni C, Virdò F, Mastrangelo H, Guzzi G, Cammarota G, Robba C, Longhini F, Bruni A; ONSD study group. Efficacy of a theoretical-practical course for the ultrasound measurement of the optic nerve diameter in different healthcare operators. Ultrasound J. 2025 Jun 16;17(1):28. doi: 10.1186/s13089-025-00431-7. PMID: 40522589.