



EUROPEAN SOCIETY OF NEUROSONOLOGY
AND CEREBRAL HEMODYNAMICS



5th Congress of the European Academy of Neurology

Oslo, Norway, June 29 - July 2, 2019

Hands-on Course 14

**EAN/ESNCH: Neurosonology - contemporary and future
developments (Level 2)**

Optic nerve sonography

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HoC 14 – EAN/ESNCH Neurosonology Contemporary and Future Developments

Convenor & Speaker: Prof. F. Perren

Speakers: Prof. U. Walter, Prof. D. Coraci, Prof. O. Rønning



Conflict of Interest



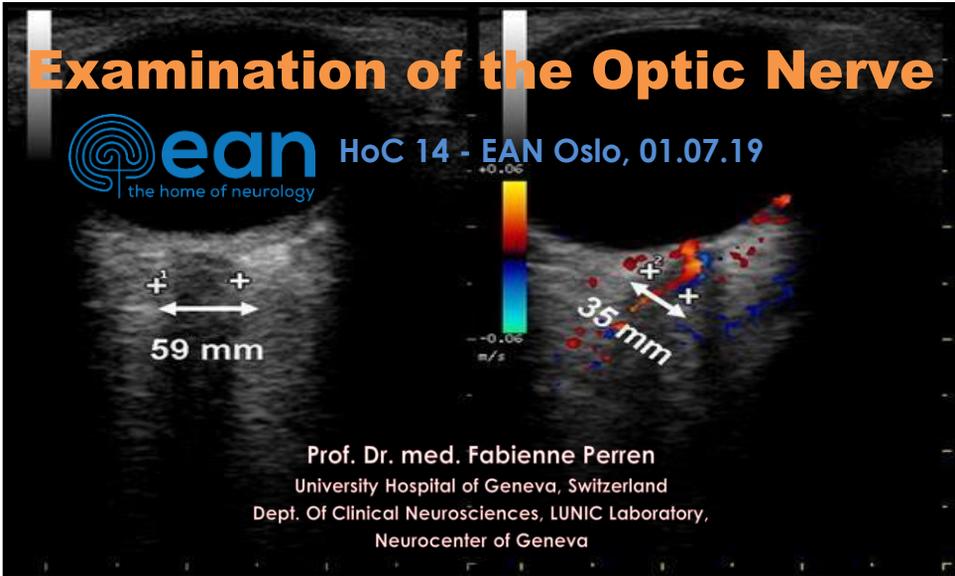
In relation to this presentation and manuscript:

The Author has no conflict of interest in relation to this manuscript.



Examination of the Optic Nerve

ean the home of neurology HoC 14 - EAN Oslo, 01.07.19



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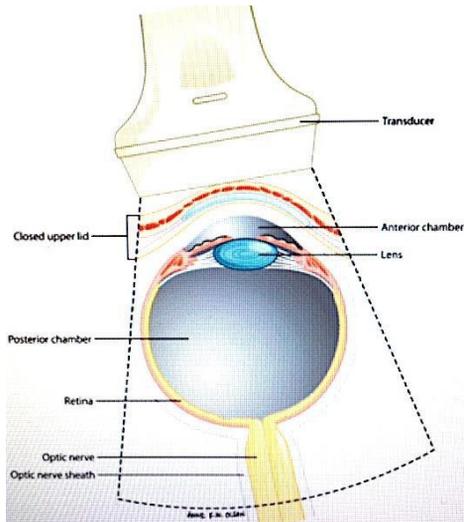
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Laboratory of ultrafast-
Ultrasound Neuroimaging
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L'ESSENTIEL, C'EST VOUS.

 **ESNCH**  **ean** the home of neurology

Neuro-orbital sonography



Transducer

Closed upper lid

Anterior chamber

Lens

Posterior chamber

Retina

Optic nerve

Optic nerve sheath



Introduction

- US examination since the 60's: ophthalmologists (vitreous hemor. & lens opacification)¹
- TCD Insonation through orbita with a 2 MHz PW probe in the early 80's (intracranial ICA)²
- US technique needed long time to adapt power for safety
- In recent years, neurologists interested in clinical information (papilledema, ON structure, intraorbital vessels)³
- Possible thank improved B-mode, lower transmission of energy

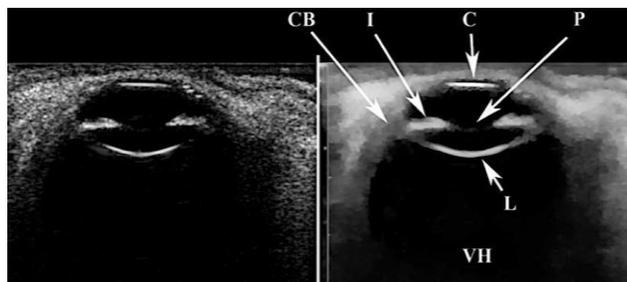
1. AJR 1991;157:1079-86; 2. J Neurosurg 1982; 57: 769-774; 3. Ultraschall Med 2014;35:422-431



Anatomy

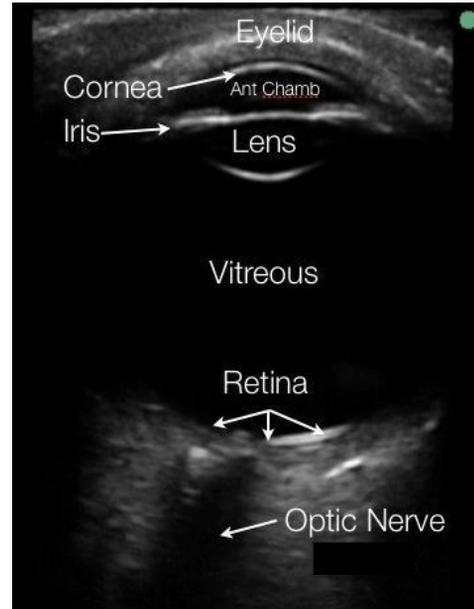
Clinically relevant structures:

- Ocular globe
- ON
- Papilla
- Intraorbital vessels (OA, CRA)



Anatomy

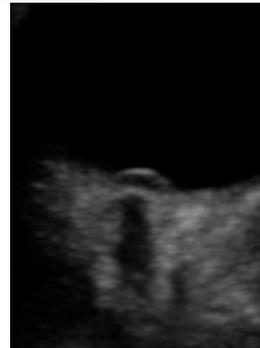
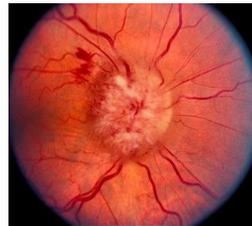
- Eyeball diameter: \pm 24mm
- Optic apparatus: cornea, anterior chamber, pupilla/iris, lens, vitreous body, sclera, retina



Anatomy



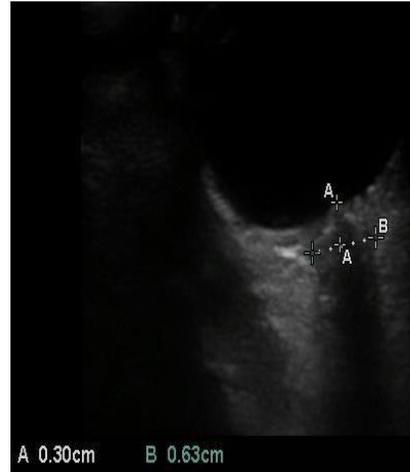
- Papilla (optic nerve disc): origin of the ON, diameter of 1-1.5 mm.
- CRV and CRA pass the papilla.
- ICHT: (high CSF pressure, reduced VF or inflammation) lead to swelling of the papilla (papilledema)



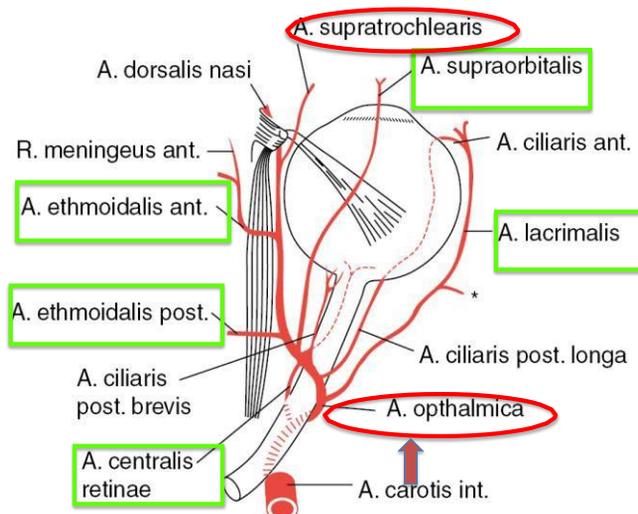


The Optic Nerve (ON):

- is an extracranial part of the brain sheathed by the dura, arachnoidea and pia
- CSF communication to the subarachnoidal space of the brain
- its intraorbital length is ± 2.8 cm (lamina cribrosa – optic canal)
- about 1.2-2cm distal to the globe, the CRA and CRV penetrate the nerve sheath
- diameter of the ON sheath (ONSD) is 5mm (can differ between right and left side)

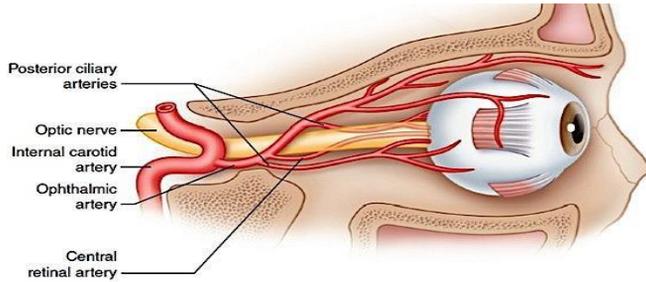
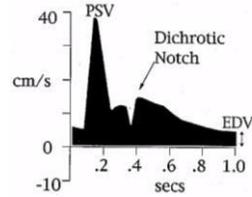


Intraorbital vessels



The ophtalmic artery (OA) :

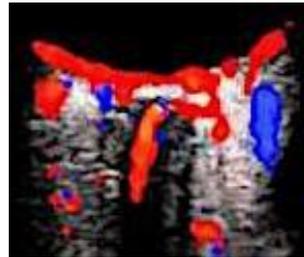
- 1st part located within inferolateral area of the ON in about 90%¹
- External Ø of 1.7mm¹
- crosses the ON: 73% superiorly, 27% inferiorly¹
- 1st branch of the intraorbital part: CRA (26-47%)¹, medial posterior ciliary artery (26%)¹
- The CRA enters the ON 7.52 ± 2mm (5.3-12.5mm) behind the bulb
- The Post. Ciliary Aa. run forward, divide into multiple branches and penetrate the sclera close to the ON medially, laterally or superiorly²



1. Manual of Neurosonology, Cambridge University Press, 2016; Min Invasive Neurosurg 2007;50:202-208

Intraorbital Vessels

- Color-mode imaging
- CRA (branch of the OA)
- CRV running in parallel
- Post Ciliary A. located near the ON
- Alterations of mFV, direction of the flow
- Normal FV



Orbital vessel	Mean (cm/s) [10]	Peak systolic velocity (mean cm/s) [9]
Central retinal artery (CRA)	10.3	11.6
Central retinal vein (CRV)	2.9	-
Ophthalmic artery (OA)	31.4	41.7
Posterior ciliary artery (PCA)	12.4	16.6

Neuro-orbital Examination

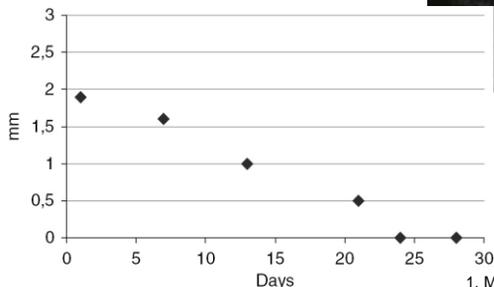
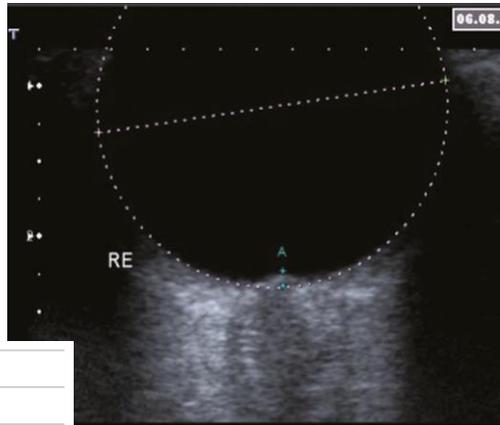
- Probe: linear array 6-12MHz, (up to 15 MHz) or sectorial array 2 MHz
- Supine position, eyes closed during whole examination (remove contact lenses)
- Probe on the lateral upper closed eyelid (avoid uncontrolled pressure!)
- Patients should try not to move and « to look straight »
- Machine Settings: safety aspects: cavitation, T° increase; CI: recent surgery
- During image processing remove probe from the eyelid
- Current guidelines¹: « ALAP » principles
- Acoustic output intensity: <math>< 50\text{mW}/\text{cm}^2</math>
- Mechanical index (MI): <math>< 0.23</math>; T1<math>< 0.2</math>
- Ispta<math>< 17\text{mW}/\text{cm}^2</math>
- Color mode adapted to lower velocities
- Examination time: $\leq 1\text{min}/\text{eye}$



1. www.fda.gov/downloads/MedicalDevices/DeviceRegulationandGuidanceDocuments/ucm070911.pdf

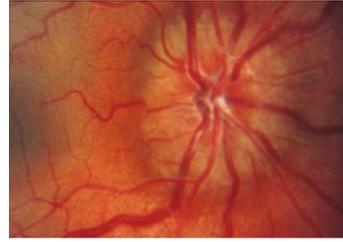
Papilla/Optic disc Examination

- B-mode
- Landmark: origin of the ON
- Plane with maximum disc elevation or excavation selected
- Measure prominence using circle of the optic bulb
- Normal <math>< 0.5\text{mm}</math>
- Optimal to control therapeutical effect on ICP (after LP)

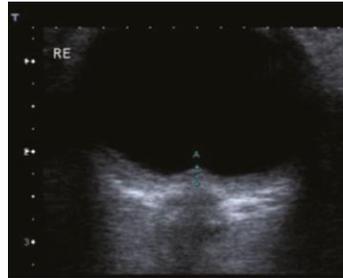


1. Manual of Neurosonology, Cambridge University Press, 2016

Raised ICP/Papilledema



- Cut-off value to predict ICP > 20cm H₂O: 5.7-6mm (sensitivity 87-95%; specificity 79-100%)^{1,2}

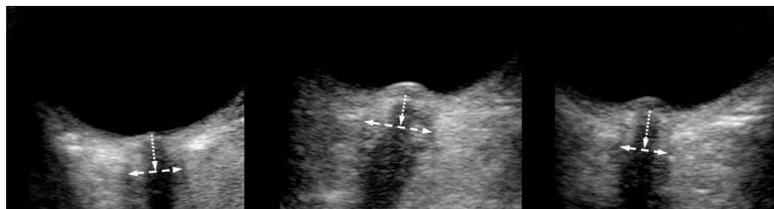


1. Intensive Care Med 2008;34:2062-67; 2. Br J Ophthalmol 2002;86:1109-113

As part of the central nervous system **the optic nerve is** surrounded by CSF and by meninges designated as: optic nerve sheath.

US-Probe is placed on the temporal part of the closed upper eyelid using a thick layer of ultrasound gel.

The retrobulbar part of the ON can be depicted in an axial plane showing the papilla and the optic nerve in its longitudinal course.



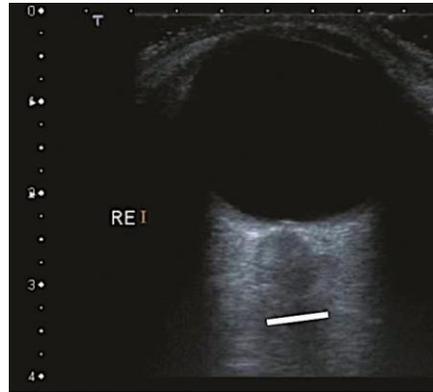
New Trends in Neurosonology and Cerebral Hemodynamics. Perspectives in Medicine 2012

Optic Nerve Sheet Diameter / ONSD

- ON: B-mode: hypoechogenic structure
- ON Ø: behind the papilla: N 4-5mm¹
- ON enlargement with intracranial HT
- Close association between MRI and US ON Ø^{2,3}
- Demyelinating diseases: smaller Ø, increased echogenicity⁴

ONSD NORMAL RANGES:

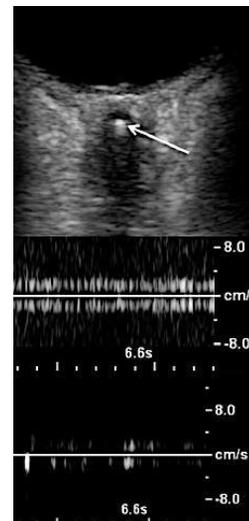
Normal Adults	< 5 mm
Children >1 yr	< 4.5 mm
Infants < 1 yr	< 4 mm



1. Intensive Care Med 2008;34:2062-67; 2. Eur J ultrasound 2002;15:145-9; 3. BMC Neurol 2013;13:187;
4. Br J Ophthalm 2002;86:1109-113

Occlusion of the CRA (CRAO): the retrobulbar « spot sign »

- CRAO occurs mainly in the elderly population
- leads to severe retinal ischemia
- is a common cause of sudden blindness¹⁻³
- Ttt: conservative or invasive: superselective IA or IV thrombolysis
- B-mode US: CRA absence of flow and « spot sign » highly predictive of embolic occlusion⁴⁻⁶ and could differentiate embolic from vasculitic origin^{4,7}
- Retrobulbar spot sign may predict: a-a origin (calcified component) and absence of success of ttt (thrombolysis) and recovery of vision⁷



1. Klinische Monatsblätter für Augenheilkunde 2010;227:712-720. 2. Transact Am Ophthalmologic Soc 1962;60:316-334.
3. Prog Retinal Eye Res 2009;28:34-62 4. Ultraschall Med 2012;33:E263-E267 5. Ophthalmology 2002;109:744-747 6. J Neuroim 2015; 25:251-6; 7. Stroke 2015;

Possible neuro-orbital US applications include:



- Swelling of the papilla (bedside test): in the ICU (high reproducibility, easy documentation)
- OS sheet diameter (intracranial HT)
- Real-time information about intraorbital vascularization and BFV of orbital vessels: OA
- CRAO
- Carotido-cavernous fistula
- Orbital US: fast, mobile and noninvasive tool



ESNCH
BELGRADE 2020

25th Meeting of the European Society of Neurosonology and Cerebral Hemodynamics

Confluence of East and West
Belgrade, Serbia | April 3-5, 2020



Save the Date!

Friday, April 3
Teaching Courses
ESNCH Examination
Lecture of excellence
Opening and Welcome Reception

Saturday, April 4
Scientific Sessions
Young Scientists Projects
Poster Presentations
Gala Dinner

Sunday, April 5
Scientific Sessions
Poster Presentations
Awards
Closing Ceremony

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