Roma
25 Maggio 2018

XI congresso nazionale
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L'Ecografia del nervo ottico nel monitoraggio della PIC nel traumatizzato cranico

behind the cotton wool of papilledema

Dott. Elena Casiello

Scuola di Specializzazione in Anestesia Rianimazione Terapia Intensiva e del Dolore
Università degli Studi di Foggia, Prof.ssa Gilda Cinnella

Dott. V. Procacci

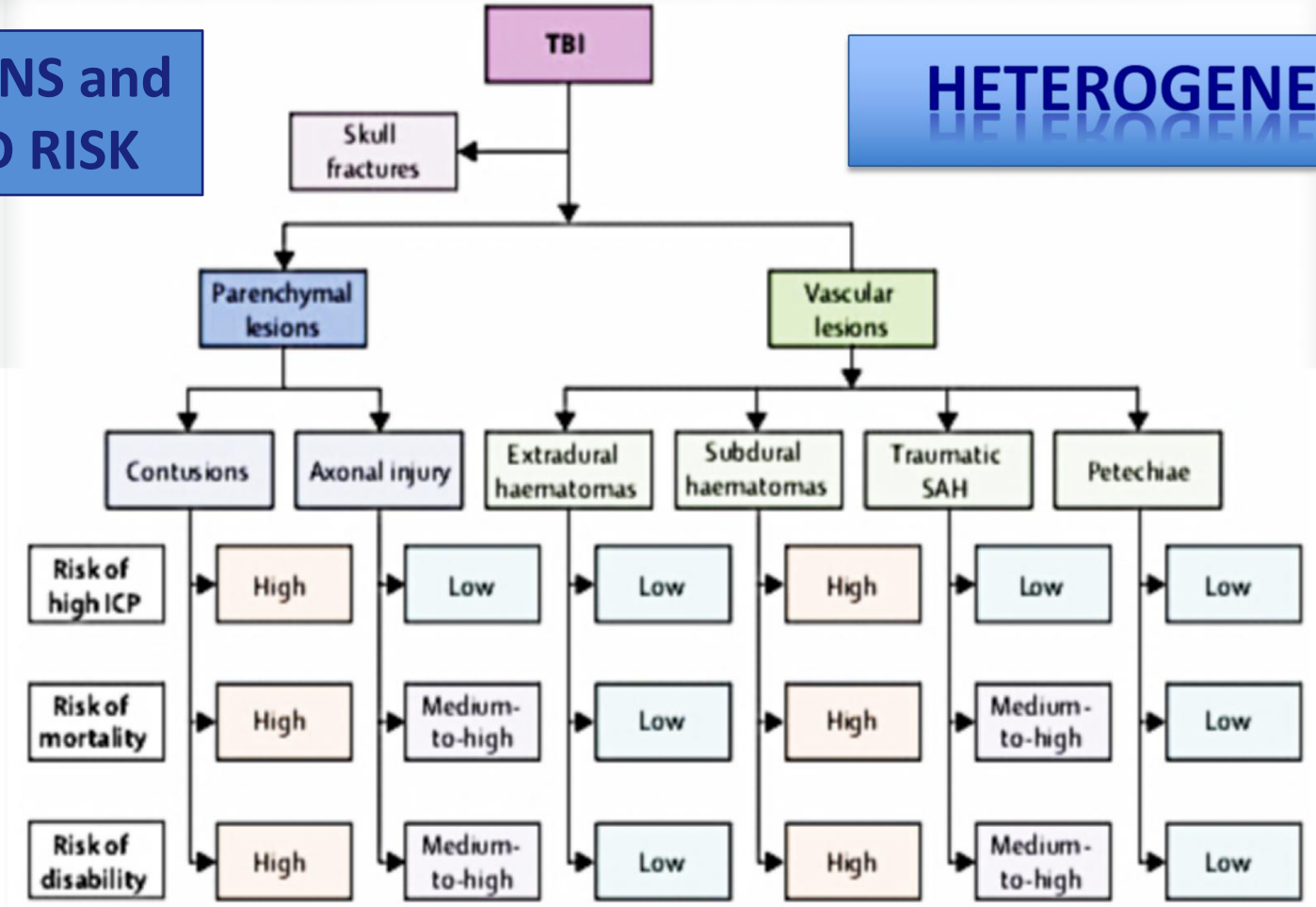
Traumatic brain injury 1

Severe traumatic brain injury: targeted management in the intensive care unit

Nino Stocchetti, Marco Carbonara, Giuseppe Citerio, Ari Ercole, Markus B Skrifvars, Peter Smielewski, Tommaso Zoerle, David K Menon

TBI LESIONS and RELATED RISK

HETEROGENEITY



Lancet Neurol 2017; 16: 452–64

IMAGING

	Variable monitored	Information derived	Spatial resolution
CT	Structural integrity	Space-occupying lesions, CSF space modifications, skull fractures, brain swelling	Medium
CT angiography	Cerebral vessel patency and integrity	Thrombosis and dissection in main intracranial vessels	Medium
Perfusion CT	Cerebral perfusion	Hypoperfusion or hyperperfusion	Low
MRI	Structural, functional, and biochemical integrity, cerebral vessel patency	Space-occupying lesions, CSF space modifications, brain swelling, thrombosis and dissection in main intracranial vessels, hypoperfusion or hyperperfusion, traumatic axonal injury, functional and chemical information	High

NEUROMONITORING

	Variable monitored	Variable derived	Focal or global measure	Time resolution	Risk of brain damage
Intracranial pressure monitoring with intraparenchymal monitor or ventricular catheter	Intracranial pressure	Intracranial volumes, cerebral perfusion pressure, pressure-reactivity index, intracranial compliance	Global	Continuous	Yes
Brain tissue oxygen measurement with parenchymal probe	Brain tissue partial tension of oxygen	Oxygen diffusion and balance between oxygen supply and demand	Focal	Continuous	Yes
Cerebral microdialysis	Brain metabolites and biomarkers	Aerobic or anaerobic metabolism, brain injury severity and inflammation	Focal	Intermittent	Yes
Temperature monitoring via intraparenchymal probe	Brain temperature	Gradient between core and brain temperature	Focal	Continuous	Yes
Intraparenchymal thermal diffusion flowmetry	Cerebral blood flow	Hypoperfusion or hyperperfusion	Focal	Continuous	Yes
Electrocorticography	Cortical and depth electrical activity	Seizure activity, spreading depolarisation	Focal	Continuous	Yes
Jugular bulb oximetry	Oxygen saturation of venous jugular haemoglobin	Cerebral arterojugular difference in oxygen content	Global	Intermittent (continuous with fibreoptic catheters)	No
EEG	Cortical electrical activity	Seizure activity, abnormal patterns	Global	Continuous	No
Transcranial doppler	Cerebral blood velocity	Critical closing pressure, cerebral arterial impedance	Global	Intermittent	No
Optic-nerve sheath ultrasonography	Optic nerve-sheath diameter	Intracranial pressure	Global	Intermittent	No
Near-infrared spectroscopy	Cerebrovascular oxygen saturation and relative blood volume	Cerebral blood flow, cerebral autoregulation	Focal	Continuous	No

TARGETED THERAPIES

Over

ONE-SIZE FITS-ALL STRATEGY

Marked reduction in mortality in patients with severe traumatic brain injury

Clinical article

J Neurosurg 119:1583–1590, 2013

Linda M. Gerber, Ph.D.,[1] Ya-Lin Chiu, M.S.,[1] Nancy Carney, Ph.D.,[2] Roger Härtl, M.D.,[3] and Jamshid Ghajar, M.D., Ph.D.[4,5]

Increased mortality in patients with severe traumatic brain injury treated without intracranial pressure monitoring

Clinical article

J Neurosurg 117:729–734, 2012

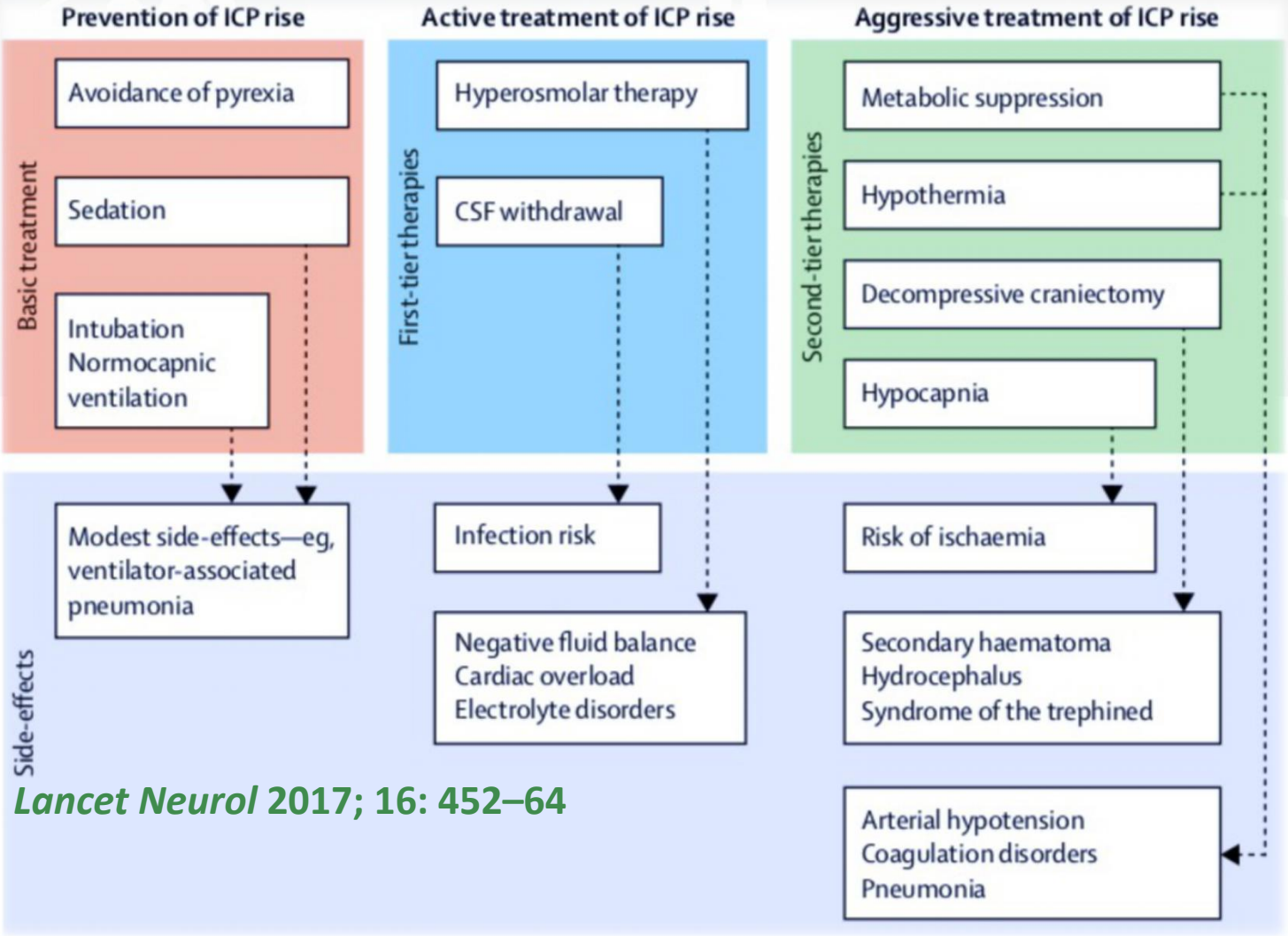
Arash Farahvar, M.D., Ph.D.,[1] Linda M. Gerber, Ph.D.,[2] Ya-Lin Chiu, M.S.,[2] Nancy Carney, Ph.D.,[3] Roger Härtl, M.D.,[4] and Jamshid Ghajar, M.D., Ph.D.[4,5]

[1]*Department of Neurosurgery, University of Rochester Medical Center, Rochester; Departments of* [2]*Public*

MONITORING per se DOESN'T AFFECT OUTCOME

MULTIPLE-MONITORNIG approach to DIRECT TREATMENT

CURRENT MANAGMENT OF INTRACRANIAL HYPERTENSION



Lancet Neurol 2017; 16: 452–64

Brain Trauma FOUNDATION

Guidelines for the Management of Severe Traumatic Brain Injury
4th Edition

IMPORTANCE OF ICP-monitoring in SEVERE TBI

- **ICP monitoring-guided managment of severe TBI** is **RECOMMENDED (LEV. IIB)** to reduce in-hospital and 2-week mortality
- Threshold suggested: 22mmHg
- **CONSIDER inter-individual variability** in critical ICP thresholds

Recomendations from the Prior 3° edition are reported even if not supported by latest evidence

- Intracranial pressure (ICP) should be monitored in all salvageable patients with a severe traumatic brain injury (TBI) (GCS 3-8 after resuscitation) and an abnormal computed tomography (CT) scan. An abnormal CT scan of the head is one that reveals hematomas, contusions, swelling, herniation, or compressed basal cisterns.
- ICP monitoring is indicated in patients with severe TBI with a normal CT scan if two or more of the following features are noted at admission: age over 40 years, unilateral or bilateral motor posturing, or systolic blood pressure (BP) <90 mm Hg.

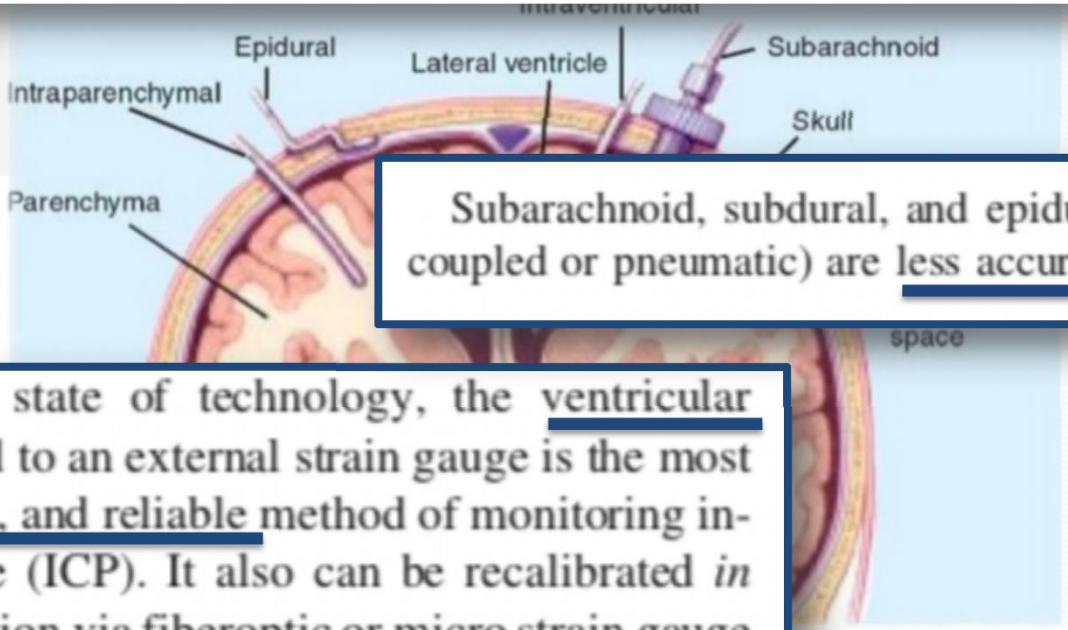
Intracranial Hypertension and invasive ICP-monitoring

INTRAPARENCHIMAL MONITORING

SUBARACHNOID, SUBDURAL, EPIDURAL

INTRAVENTRICULAR CATHETER
allows CSF drainage

VII. Intracranial Pressure Monitoring Technology



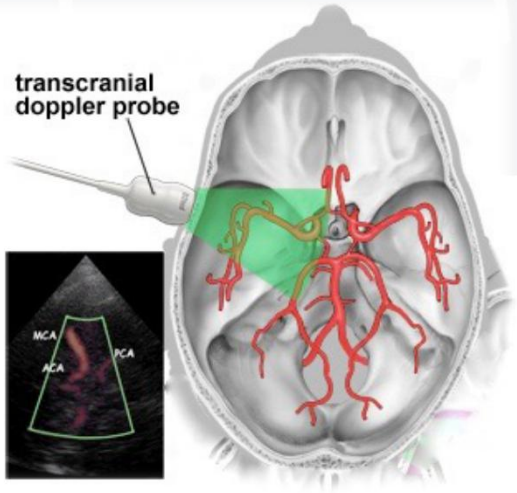
Subarachnoid, subdural, and epidural monitors (fluid coupled or pneumatic) are less accurate.

In the current state of technology, the ventricular catheter connected to an external strain gauge is the most accurate, low-cost, and reliable method of monitoring intracranial pressure (ICP). It also can be recalibrated *in situ*. ICP transduction via fiberoptic or micro strain gauge devices placed in ventricular catheters provide similar benefits, but at a higher cost.

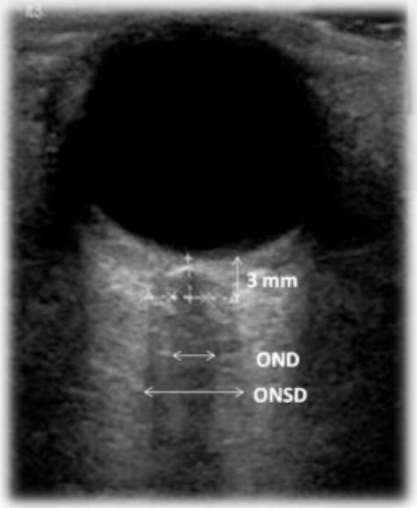
JOURNAL OF NEUROTRAUMA
Volume 24, Supplement 1, 2007

Intracranial Hypertension and non invasive Neuromonitoring

TANSCRANIAL DOPPLER ULTRASONOGRAFY



ULTRASONIC OPTIC NERVE SHEATH DIAMETER



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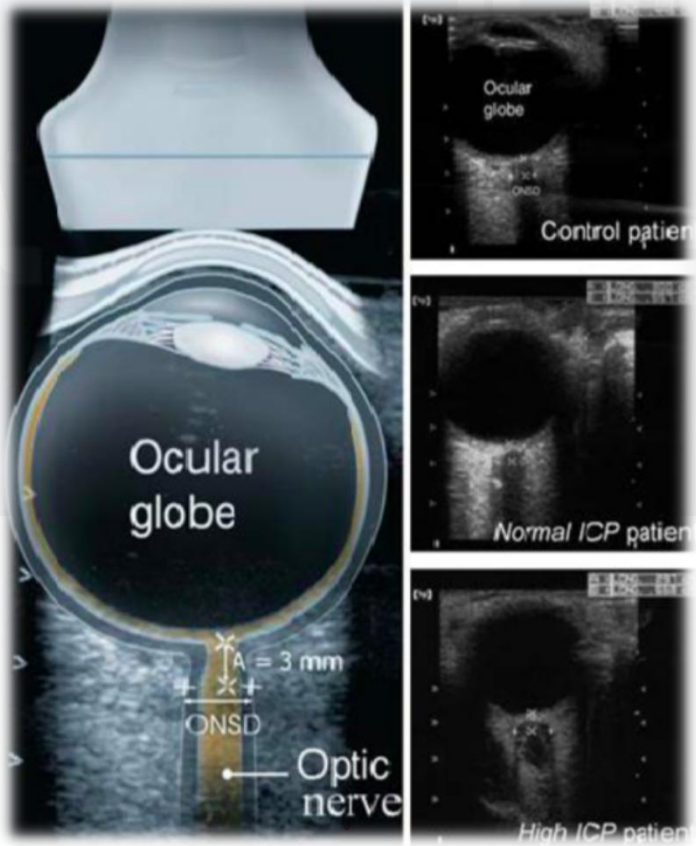
HOW TO ASSESS SONOGRAFIC ONSD

- High fraquency linear probe (7,5 mHz)
- Temporal side-superior eyelid
- 2 measurements:
  - sagittal
  - transverse plan
- Measure ONSD 3mm behind globe



- ***Vaiman et al.:***

1. the most stable results 10mm from the globe

1. **ONSD\EYEBALL DIAMETER-RATIO** indicates ICP: n.v.: 0,19

2. **EYEBALL: moving object**

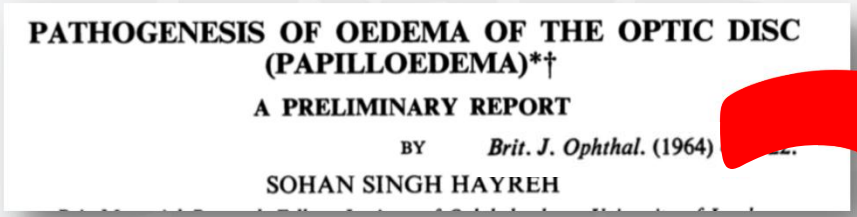
3. **Moving eyeball** might **change the ONSD close to the globe**

Quantitative relations between the eyeball, the optic nerve, and the optic canal important for intracranial pressure monitoring

Michael Vaiman[1,3*], Paul Gottlieb[2] and Inessa Bekerman[2]

Vaiman *et al. Head & Face Medicine* 2014, **10**:32

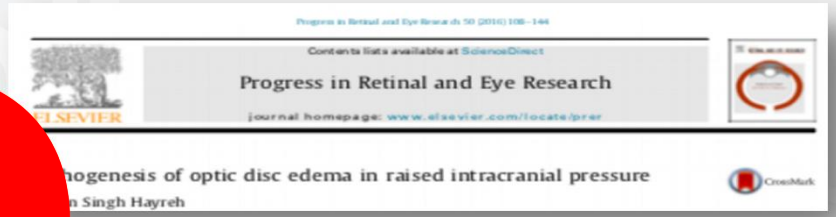
PATHOGENETIC PATHWAYS:
Increased ICP - Papilledema - ONS


PATHOGENESIS OF OEDEMA OF THE OPTIC DISC (PAPILLOEDEMA)*†

A PRELIMINARY REPORT

BY SOHAN SINGH HAYREH

Brit. J. Ophthal. (1964)


Progress in Retinal and Eye Research

journal homepage: www.elsevier.com/locate/prer

ogenesis of optic disc edema in raised intracranial pressure

n Singh Hayreh

- Effects of opening the ons on the edema of the optic disc

- Role of LATERALITY in fundus changes

ONSD VARIABILITY

OPTIC DISC EDEMA<mechanical phenomenon: CSFP RISES IN ONS

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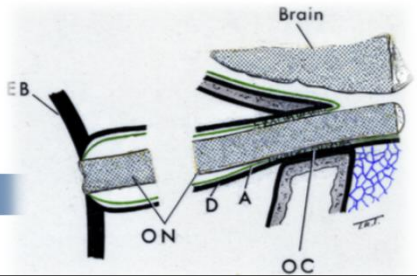
- **Optic canal region**: narrow area
- **ONS BEHIND THE EYEBALL**: BULBOUS APPEARANCE
- **DURAL LAYER OF THE ONS: NOT AN ELASTIC TISSUE BUT A THICK FIBROUS ONE**



INVESTIGATING the RELATIONSHIP BETWEEN ICP and ONSD

Validation of the optic nerve sheath response to changing cerebrospinal fluid pressure: ultrasound findings during intrathecal infusion tests

J Neurosurg 87:34–40, 1997

HANS-CHRISTIAN HANSEN, M.D., AND KNUT HELMKE, M.D.

Neuro-intensive Care Unit, Departments of Neurology and Pediatric Radiology, University Hospital Eppendorf, Hamburg, Germany

The human ONS has sufficient elasticity to ALLOW A DETECTABLE DILATION in response to INTRACRANIAL HYPERTENSION

Relationship between intracranial pressure as measured by an epidural intracranial pressure monitoring system and optic nerve sheath diameter in healthy dogs

Laura A. Ilie DVM

AJVR •Vol 76 • No.8 •August 2015

Use of A-scan Ultrasound and Optical Coherence Tomography to Differentiate Papilledema From Pseudopapilledema

Roberto Saenz, OD, MS,[1] Han Cheng, OD, PhD,[1*] Thomas C. Prager, PhD,[2] Laura J. Frishman, PhD,[1] and Rosa A. Tang, MD[1]

ONSD differentiates papilledema from pseudopapilledema

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ONSD truly resembles ICP VARIATIONS

Optom Vis Sci 2017; Vol 94(12)

RELIABILITY of ONSD MEASUREMENTS

- US: OPERATOR DEPENDENT TECHNIQUE

Observer variation in the sonographic measurement of optic nerve sheath diameter in normal adults

S.A. Ballantyne *, G. O'Neill, R. Hamilton, A.S. Hollman

Department of Radiology and Clinical Physics, Royal Hospital for Sick Children, Glasgow G46 7PD, UK

3 DIFFERENT OPERATORS

→ ONSD: READILY LEARNED REPRODUCIBLE TECHNIQUE → LOW INTRA\INTER-OBSERVER VARIATION

- OPERATOR EXPERIENCE may affect RELIABILITY OF MEASUREMENTS

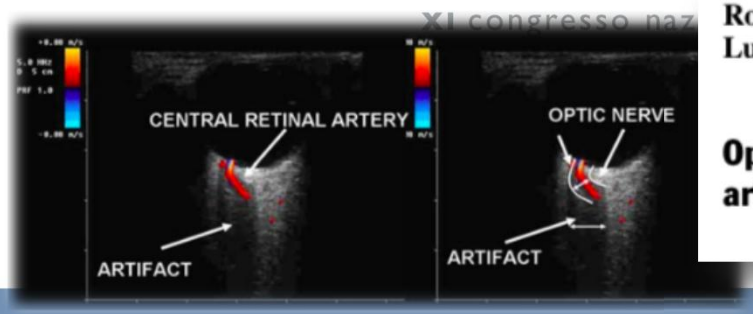
Inter-rater Reliability of Sonographic Optic Nerve Sheath Diameter Measurements by Emergency Medicine Physicians

Stephanie Oberfoell, MD, David Murphy, MD, Andrew French, MD, Stacy Trent, MD, David Richards, MD

→ ULTRASOUND FELLOWSHIP TRAINED
VS
RESIDENT EMERGENCY MEDICINE PHYSYCIANS → NO DIFFERENCE OF STATISTICAL IMPORTANCE

- ARTIFACTS vs REAL IMAGES:

artifacual us-image : lamina cribrosa's acoustic shadow



Roberto Copetti
Luigi Cattarossi

Optic nerve ultrasound: artifacts and real images

Literature discordance in defining NORMAL CUT-OFF VALUES

Ultrasonographic measurement of the optic nerve sheath diameter and its association with eyeball transverse diameter in 585 healthy volunteers

Dong Hwan Kim[1], Jin-Sun Jun[2] & Ryul Kim[3]

- ONSD in healthy volunteers: 4.11mm
- ONSD\ETD: more reliable than ONSD itself

Elevated Intracranial Pressure Detected by Bedside Emergency Ultrasonography of the Optic Nerve Sheath

Michael Blaivas, MD, RDMS, Daniel Theodoro, MD, RDMS, Paul R. Sierzenski, MD, RDMS

CUT-OF

Research

Open Access

Optic nerve sonography in the diagnostic evaluation of adult brain injury

Theodoros Soldatos[1], Dimitrios Karakitsos[2], Katerina Chatzimichail[1], Matilda Papathanasiou[1], Athanasios Gouliamos[1] and Andreas Karabinis[2]

ONSD among healthy: A REVIEW:

- WIDE RANGE: **2,2->5,9mm**
- Different ethnicities
- Errors
- Quality of device used

❖ **Furthermore**: *Thotakura et al. (2017) Suggest measuring the ONSD values in each institute* ***TO DEFINE THE NORMAL RANGE as it is variable from one study to another***

literature and ONSD serial monitoring

Research Article

Optic Nerve Sheath Diameter Ultrasound Evaluation in Intensive Care Unit: Possible Role and Clinical Aspects in Neurological Critical Patients' Daily Monitoring

M. Toscano,[1] G. Spadetta,[2] P. Pulitano,[1] M. Rocco,[3] V. Di Piero,[1] O. Mecarelli,[1] and E. Vicenzini[1]

ONSD daily monitoring:

MAY help in ICU when invasive ICP is not available

- ONSD monitoring : to early identify malignant intracranial hypertension
- 21 patients who developed Brain death
- ONSD measure were performed daily pre- and post-BD

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BioMed Research International,2017

literature and ONSD serial monitoring

Role of serial ultrasonic optic nerve sheath diameter monitoring in head injury

A.K. Thotakura[a,*], N.R. Marabathina[a], A.R. Danaboyina[b], R.R. Mareddy[a]

[a] Department of Neurosurgery, NRI Medical College and General Hospital, Chinakakani, Mangalagiri, Guntur, 522503 Andhra Pradesh, India
[b] Department of Radiology, NRI Medical College and General Hospital, Chinakakani, Mangalagiri, Guntur, 522503 Andhra Pradesh, India

ONSD:
useful when invasive ICP monitoring is not available

SERIAL RECORDINGS:
provides
Valuable information for decision making

- significance of serial ONSD monitoring in 40 TBI PATIENTS
- ON ADMISSION
  GCS Rotterdam and Marshall
  ONSD performed
- ONSD every 24 h to 48 h

Neurochirurgie 63 (2017) 444–448

STUDY PROTOCOL

OBSERVATIONAL STUDY

ONSD-7-DAYS
serial monitoring
in patients with a positive brain CT-scan.

Patients with ischemic lesions are also included

OBJECTIVES

compare ONSD measurements with:

- GCS and GOS
- clinical findings suggesting ICH
- P peak PEEP (PCV)
- Rotterdam and Marsall
- invasive ICP and sedation monitoring if available
- osmotic therapies and sedation

STUDY PROTOCOL

METHODS

EXCLUSION CRITERIA

- **age < 18 y**
- **glaucoma**
- **inflammatory, traumatic, tumoral pathology of the optic nerve**
- **cerebral neoplasia**

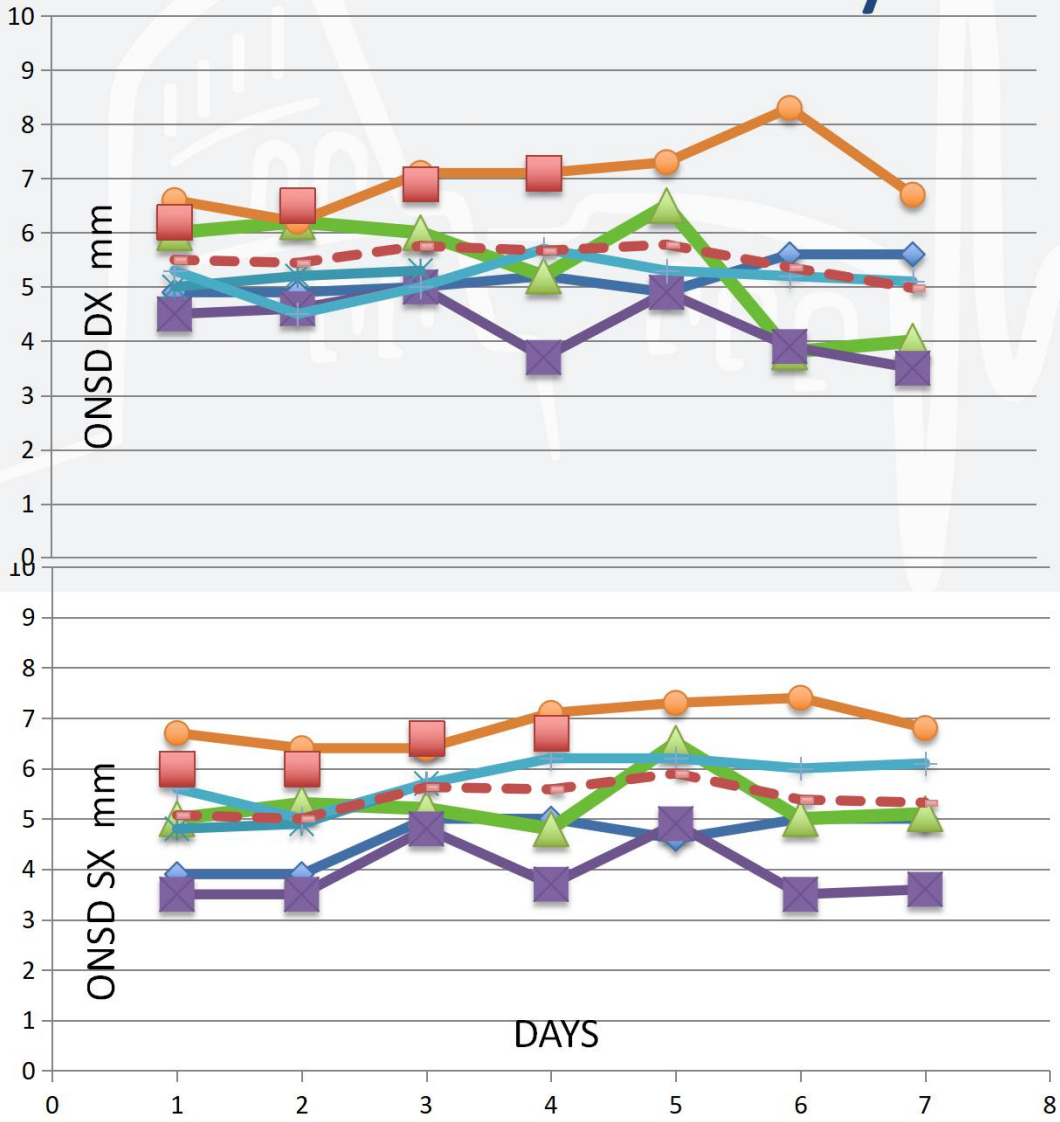
ONSD daily monitoring :

2:00 pm

- linear probe 7,5 Hz
- sagittal and transverse plan
- dx VS sx ONSD acquired

All patients undegoing sedation and Pressure Controlled Ventilation during the 7 days-serial measurement

ONSD-7days-TREND



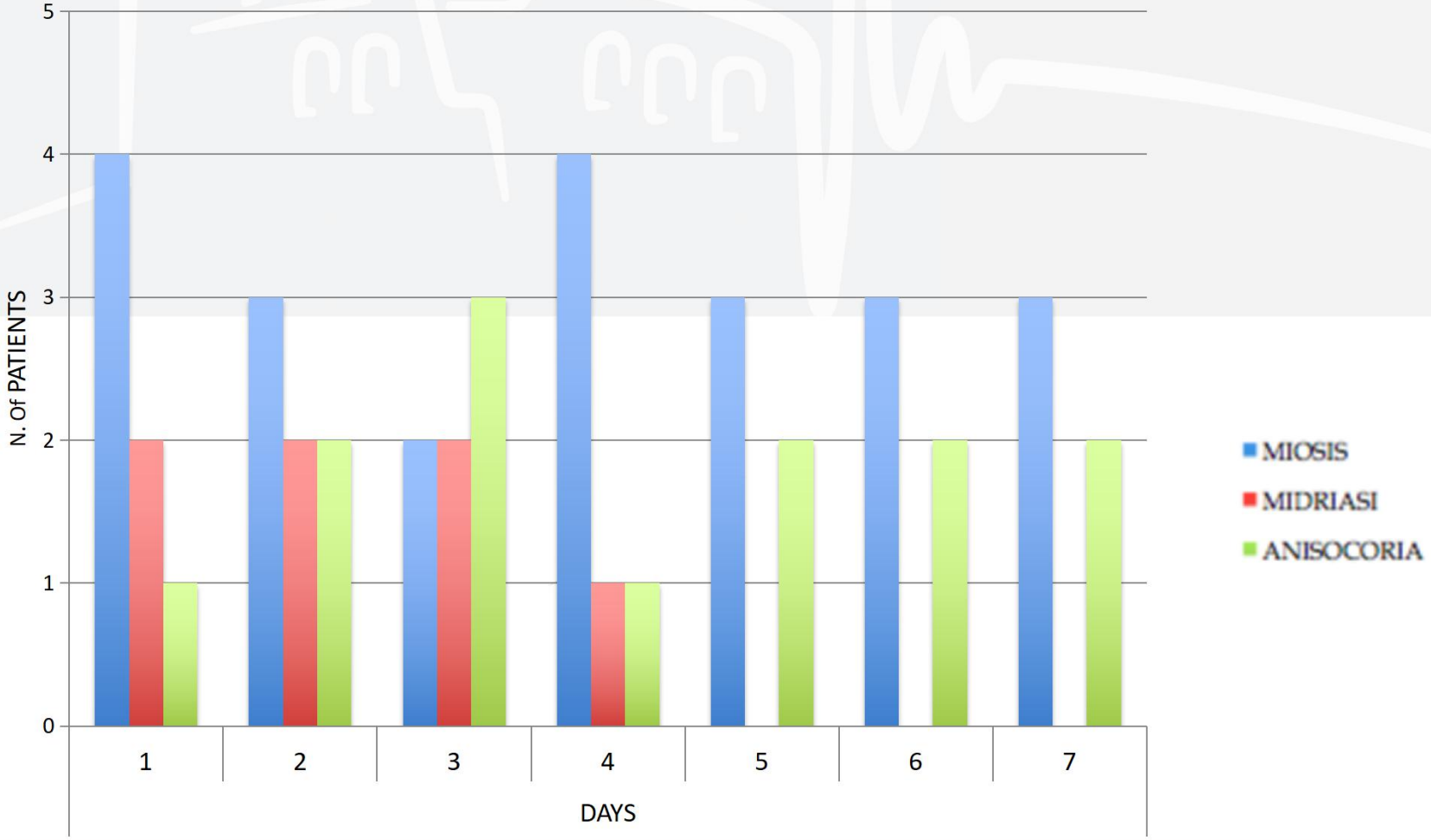
ONSD DX

- MAX 8,3 mm
- MIN 5 mm
- MEDIA [4,98;5,78] mm

ONSD SX

- MIN 3,5 mm
- MAX 7,4 mm
- MEDIA [5;5,9] mm

Pupillar diameter variation



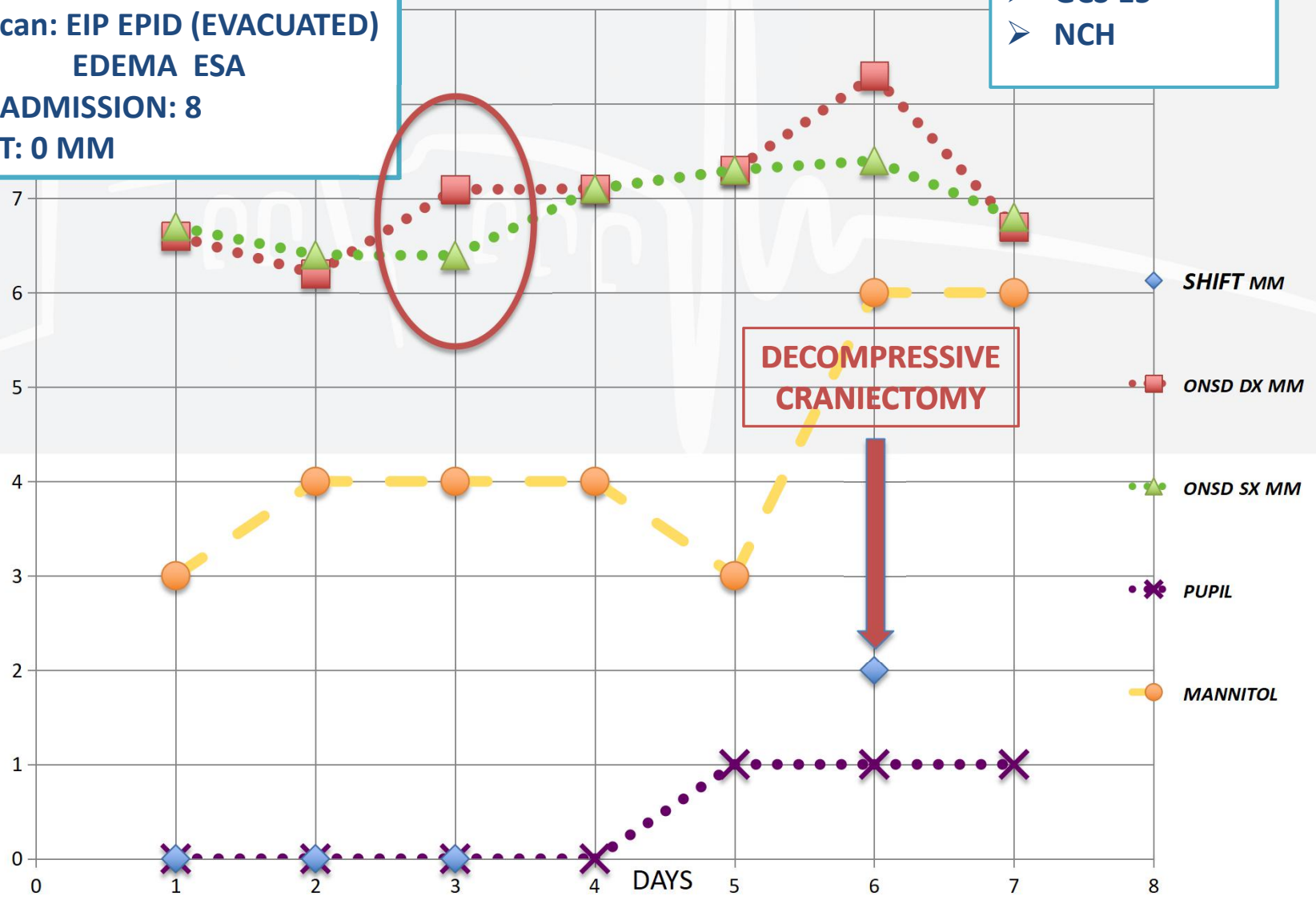
Case patient 6: TBI

ADMISSION

- ✧MALE 21Y
- ✧CT-scan: EIP EPID (EVACUATED) EDEMA ESA
- ✧GCS ADMISSION: 8
- ✧SHIFT: 0 MM

DISCHARGE

- ➢ GCS 15
- ➢ NCH



Conclusions

- ONSD: AS POCT can be helpful in severe TBI management and decision making in icu
- measure ONSD values among icu non-TBI population in order to define the normal threshold
- Readly learned reproducible technique: training is necessary to avoid artifacts and errors in measurements

Grazie per la cortese attenzione

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