Echographie cérébrale en réanimation

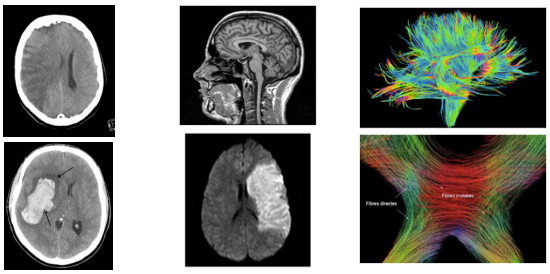
Pr Thomas GEERAERTS
Anesthésie – Réanimation - Médecine Péri-opératoire
CHU de Toulouse

UNIVERSITE TOULOUSE III PAUL SABATIER
FACULTÉ DE SANTÉ

Hôpitaux de Toulouse

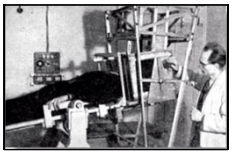
POP ART Anesthésie Réanimation Toulouse

Les références

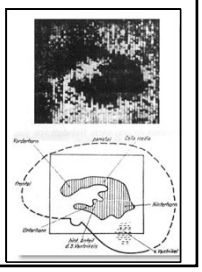


Echographie cérébrale

Karl Dussik
1908-1968



http://www.ob-ultrasound.net/dussikbio.html



Wise J, *BMJ*, 2008

Brain ultrasonography: methodology, basic and advanced principles and clinical applications. A narrative review

Chiara Robba[1], Alberto Goffi[2], Thomas Geeraerts[3], Danilo Cardim[4], Gabriele Via[5], Marek Czosnyka[6], Soojin Park[7], Aarti Sarwal[8], Llewellyn Padayachy[9], Frank Rasulo[10] and Giuseppe Citerio[11]

Brain ultrasonography enables assessment of the main structures of the brain, including the parenchyma and major cerebral vessels.

Intensive Care Med
https://doi.org/10.1007/s00134-019-05610-4

Brain ultrasonography: methodology, basic and advanced principles and clinical applications. A narrative review

Chiara Robba[1*], Alberto Goffi[2], Thomas Geeraerts[3], Danilo Cardim[4], Gabriele Via[5], Marek Czosnyka[6], Soojin Park[7], Aarti Sarwal[8], Llewellyn Padayachy[9], Frank Rasulo[10] and Giuseppe Citerio[11]

Brain ultrasonography can be used for rapid bedside assessment of pathological changes in neurocritically ill patients, allowing, for example, evaluation of intracerebral haematomas, estimation of raised intracranial pressure, and detection of midline shift and intracranial masses.

Intensive Care Med
https://doi.org/10.1007/s00134-019-05610-4

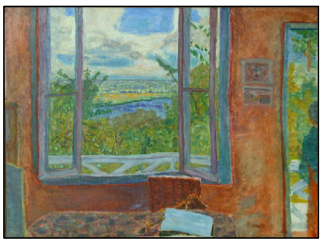
Brain ultrasonography: methodology, basic and advanced principles and clinical applications. A narrative review

Chiara Robba[1*], Alberto Goffi[2], Thomas Geeraerts[3], Danilo Cardim[4], Gabriele Via[5], Marek Czosnyka[6], Soojin Park[7], Aarti Sarwal[8], Llewellyn Padayachy[9], Frank Rasulo[10] and Giuseppe Citerio[11]

Brain ultrasonography is not used exclusively in neurocritical care; clinical applications have been described in different settings, including general intensive care and the emergency department.

Intensive Care Med
https://doi.org/10.1007/s00134-019-05610-4

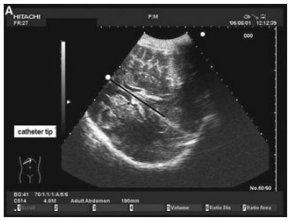
Parfois la fenêtre est ouverte



Pierre Bonnard, Fenêtre ouverte sur la Seine, 1911

Usefulness of transcranial echography in patients with decompressive craniectomy: A comparison with computed tomography scan*

Anselmo Caricato, MD; Vittorio Mignani, MD; Maria Grazia Bocci; Mariano Alberto Pennisi, MD; Claudio Sandroni, MD; Alessandra Tersali, MD; Alessandra Antonaci, MD; Chiara de Waure, MD; Massimo Antonelli, MD



Crit Care Med 2012; 40:1745–1752

Usefulness of transcranial echography in patients with decompressive craniectomy: A comparison with computed tomography scan*

Anselmo Caricato, MD; Vittorio Mignani, MD; Maria Grazia Bocci; Mariano Alberto Pennisi, MD; Claudio Sandroni, MD; Alessandra Tersali, MD; Alessandra Antonaci, MD; Chiara de Waure, MD; Massimo Antonelli, MD

Table 2. Diameters of mass lesions

	Mean Difference (95% confidence interval)	Intraclass Correlation Coefficient (95% confidence interval)
Hyperdense lesions		
Axial diameter	−1.30 (3.18−0.58)	0.954 (0.967−0.992)*
Sagittal diameter	−0.13 (−1.77 to 1.51)	0.979 (0.957−0.990)*
Coronal diameter	−1.10 (−2.58 to 0.38)	0.982 (0.961−0.991)*
Hypodense lesions		
Axial diameter	−12.55 (−21.05 to −4.05)	0.490 (−0.897 to 0.863)
Sagittal diameter	−11.82 (−21.00 to −2.63)	0.161 (−2.117 to 0.774)
Coronal diameter	−8.00 (−13.81 to −2.19)	0.134 (−2.219 to 0.767)

*Statistically significant correlation.

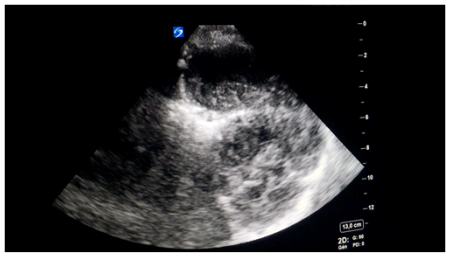
Crit Care Med 2012; 40:1745–1752

Usefulness of transcranial echography in patients with decompressive craniectomy: A comparison with computed tomography scan*

Anselmo Caricato, MD; Vittorio Mignani, MD; Maria Grazia Bocci; Mariano Alberto Pennisi, MD; Claudio Sandroni, MD; Alessandra Tersali, MD; Alessandra Antonaci, MD; Chiara de Waure, MD; Massimo Antonelli, MD

Crit Care Med 2012; 40:1745–1752

Ventricules



Dérivation ventriculaire

Usefulness of transcranial echography in patients with decompressive craniectomy: A comparison with computed tomography scan*

Anselmo Caricato, MD; Vittorio Mignani, MD; Maria Grazia Bocci; Mariano Alberto Pennisi, MD; Claudio Sandroni, MD; Alessandra Tersali, MD; Alessandra Antonaci, MD; Chiara de Waure, MD; Massimo Antonelli, MD

Echographie cérébrale utile pour

- Volume des hématomes
- Taille des ventricules

Echographie cérébrale PAS utile pour

- Volume ischémique

Crit Care Med 2012; 40:1745–1752

Parfois la fenêtre est fermée

- Jusqu'à 18% dans les études d'AVC

- Femme
- Age
- Ethnie « non-blanche »

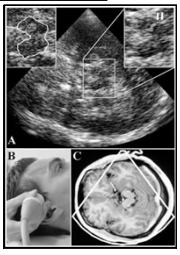
Grolimund P. Transmission of ultrasound through the temporal bone. In: Aaslid R, ed. Transcranial Doppler sonography. Wien/New York: Springer Verlag, 1985:10–18.

Transcranial sonography of the cerebral parenchyma: Update on clinically relevant applications

Uwe Walter*

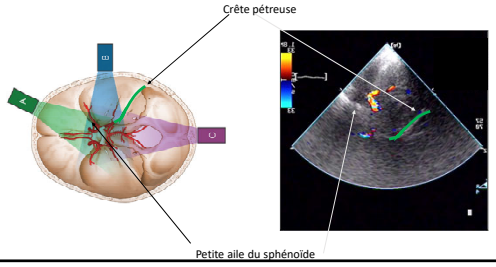
Table 1 Ultrasound system settings for transcranial sonography.

Parameter	Settings
Ultrasound system	
Penetration depth	Start with 14–16 cm, reduce if needed
Dynamic range	45–55 dB
Postprocessing function	Moderate suppression of low echo signals
Time gain compensation	Adjust manually as needed, or use the 'tissue optimization' function if available
Image brightness	Adjust manually, not too high, or use the 'tissue optimization' function if available
Ultrasound transducer	
Crystal/channel	As high as possible, ideally: 'matrix' probe
Insonation frequency (center frequency)	2.0–3.5 MHz, preferably 2.5 MHz

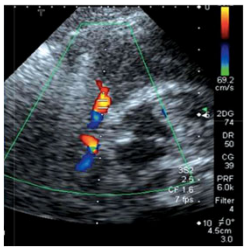


Perspectives in Medicine (2012) 1, 334–343

Repères osseux

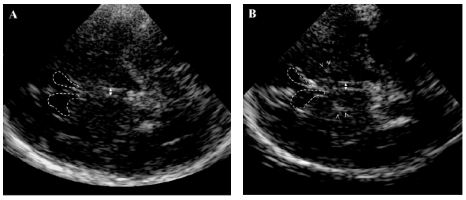


Visualiser le mesencéphale

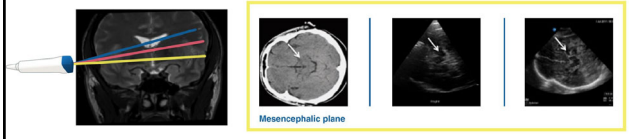


Perspectives of B-Mode Transcranial Ultrasound

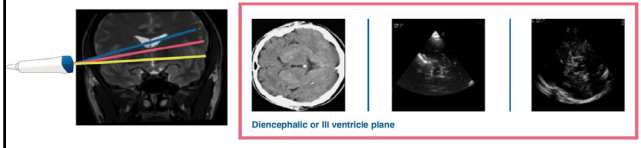
Daniela Berg and Georg Becker*



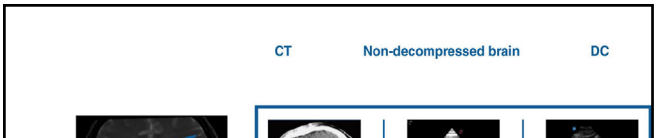
NeuroImage 15, 463–473 (2002)



Intensive Care Med
https://doi.org/10.1007/s00134-019-05610-4



Intensive Care Med
https://doi.org/10.1007/s00134-019-05610-4



Intensive Care Med
https://doi.org/10.1007/s00134-019-05610-4

Comparison of the accuracy of ventricular catheter placement using freehand placement, ultrasonic guidance, and stereotactic neuronavigation

Clinical article

Thomas J. Wilson, M.D., William R. Stetler Jr., M.D., Wajd N. Al-Holou, M.D., and Stephen E. Sullivan, M.D.

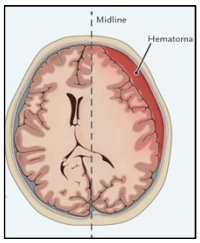
- Etude rétrospective
- N=249

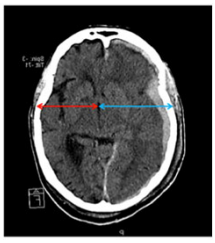
DVE	Sans aide	Guidée par Scanner	Guidée par échographie
Placement correct	55%	88%	89%

- DVE sans aide = facteur de risque de mauvais placement

J Neurosurg 119:66–70, 2013

Déviation de ligne médiane





Assessment of brain midline shift using sonography in neurosurgical ICU patients

Julie Motuel[1], Isaure Biette[2], Mohamed Srairi[1], Ségolène Mrozek[1], Matt M Kurrek[3], Patrick Chaynes[4], Christophe Cognard[2], Olivier Fourcade[1] and Thomas Geeraerts[1*]

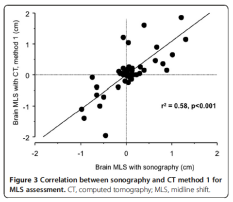


Figure 3 Correlation between sonography and CT method 1 for MLS assessment. CT, computed tomography; MLS, midline shift.

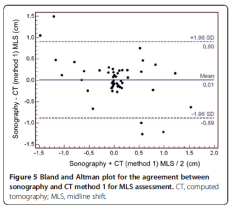
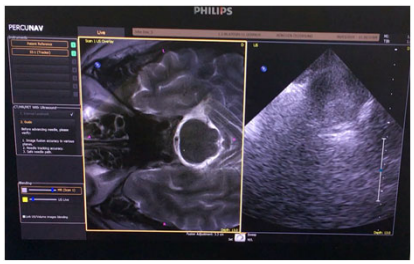


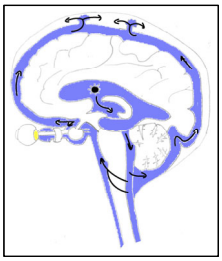
Figure 5 Bland and Altman plot for the agreement between sonography and CT method 1 for MLS assessment. CT, computed tomography; MLS, midline shift.

CRITICAL CARE *Critical Care* (2014) 18:676

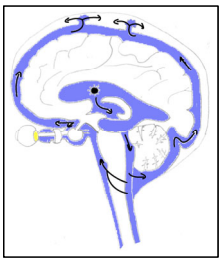
Echographie combinée



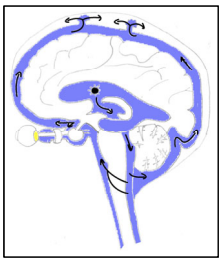
Enveloppes du nerf optique



Enveloppes du nerf optique



Enveloppes du nerf optique

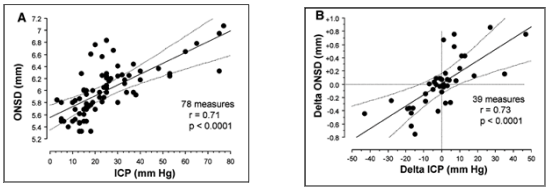


Intensive Care Med
DOI 10.1007/s00134-008-1149-x

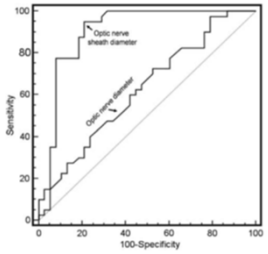
ORIGINAL

Thomas Geeraerts
Sybille Merceron
Dan Benhamou
Bernard Vigué
Jacques Duranteau

Non-invasive assessment of intracranial pressure using ocular sonography in neurocritical care patients



Prédiction PIC > 20 mmHg

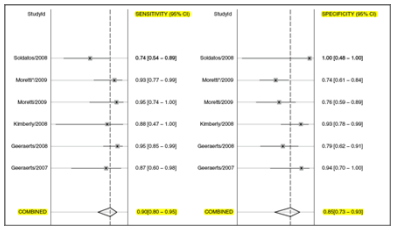


Intensive Care Med
DOI 10.1007/s00134-011-2224-2

REVIEW

Julie Dubourg
Étienne Javouhey
Thomas Geeraerts
Mahmoud Messerer
Behrouz Kassai

Ultrasonography of optic nerve sheath diameter for detection of raised intracranial pressure: a systematic review and meta-analysis



Effect of Osmotherapy on Optic Nerve Sheath Diameter in Patients With Increased Intracranial Pressure

Yoann Launey,[1–3] Nicolas Nesseler,[1–3] Pascale Le Maguet,[1] Yannick Mallédant,[1–3] and Philippe Seguin[1–3]

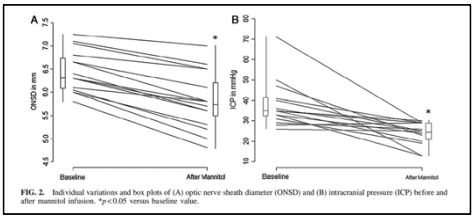


FIG. 2. Individual variations and box plots of (A) optic nerve sheath diameter (ONSD) and (B) intracranial pressure (ICP) before and after mannitol infusion. *$p < 0.05$ versus baseline value.

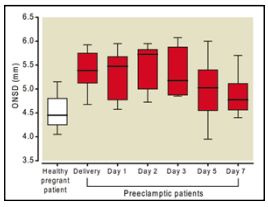
JOURNAL OF NEUROTRAUMA XX:1–5 (Month XX, 2014)

Optic Nerve Sheath Diameter Used as Ultrasonographic Assessment of the Incidence of Raised Intracranial Pressure in Preeclampsia

A Pilot Study

Clément Dubost, M.D.,* Agnès Le Gouez, M.D.,† Viridiana Jouffroy, M.D.,* Sandrine Roger-Christoph, M.D.,† Dan Benhamou, M.D.,‡ Frédéric J. Mercier, M.D., Ph.D.,§ Thomas Geeraerts, M.D., Ph.D.#

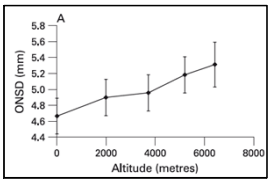
	Preeclamptic Patients (n = 26)	Healthy Pregnant (n = 25)	*P* Value
ONSD (mm)	5.4 (5.2–5.8)	4.5 (4.3–4.8)	<0.0001
Systolic BP (mmHg)	143 (138–153)	111 (102–119)	<0.0001
Diastolic BP (mmHg)	84 (79–88)	70 (66–75)	<0.0001
Mean BP (mmHg)	105 (98–109)	84 (80–92)	<0.0001



Anesthesiology 2012; 116:1066–71

Optic nerve sheath diameter, intracranial pressure and acute mountain sickness on Mount Everest: a longitudinal cohort study

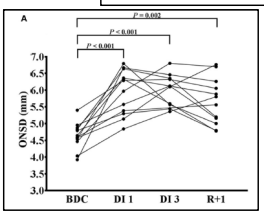
A I Sutherland,[1] D S Morris,[2] C G Owen,[3] A J Bron,[4] R C Roach[5]

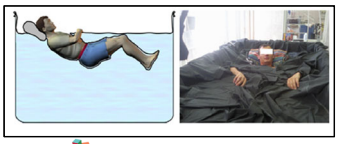


Br J Sports Med 2008;**42**:183–188.

Impacts of Simulated Weightlessness by Dry Immersion on Optic Nerve Sheath Diameter and Cerebral Autoregulation

Marc Kermorgant[1], Florian Leca[2], Nathalie Nasr[1,2], Marc-Antoine Custaud[4], Thomas Geeraerts[2,5], Marek Czosnyka[6,7], Dina N. Arvanitis[1], Jean-Michel Senard[1,3] and Anne Pavy-Le Traon[1,3]

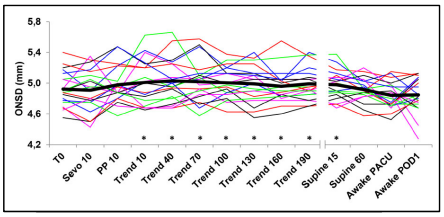




frontiers in Physiology
October 2017 | Volume 8 | Article 780

Optic Nerve Sheath Diameter Remains Constant during Robot Assisted Laparoscopic Radical Prostatectomy

Philip Verdonck[1], Alain F. Kalmar[2]*, Koen Suy[3], Thomas Geeraerts[4], Marcel Vercauteren[1], Alex Mottrie[5,7], Andre M. De Wolf[6], Jan F. A. Hendrickx[3]



PLOS ONE
November 2014 | Volume 9 | Issue 11 | e111916

Quality And Feasibility of Sonographic Measurement of the Optic Nerve Sheath Diameter to Estimate the Risk of Raised Intracranial Pressure After Traumatic Brain Injury in Prehospital Setting

Charles-Henri Houzé-Cerfon, MD, Vincent Bounes, PhD, Johanna Guemon, MD, Thibault Le Gourrierec, MD, Thomas Geeraerts, PhD

- Echographie oculaire
- En pré-hospitalier
- Traumatisme crânien

- 20% non fait, manque de temps

- Si fait, 80% de mesures valides

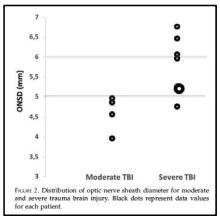
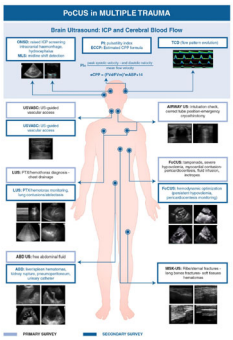


FIGURE 2. Distribution of optic nerve sheath diameter for moderate and severe trauma brain injury. Black dots represent data values for each patient.

PREHOSPITAL EMERGENCY CARE 2018;00:1–7



Intensive Care Med
https://doi.org/10.1007/s00134-019-05610-4

Effets biologiques des ultrasons

- **Effets thermiques** (Thermal Index = TI)
  - 1 à 3° C
  - Dépend du temps d'exposition aux ultrasons
  - Toxique pour le SNC

- **Effets mécaniques** (Mechanical Index = MI)
  - Présence de gaz, cavitations
  - Hémorragie pétéchiale
  - Nécrose / apoptose endothéliale

Potential Adverse Ultrasound-related Biological Effects

A Critical Review

Hariharan Shankar, M.B.B.S.,* Paul S. Pagel, M.D., Ph.D.†

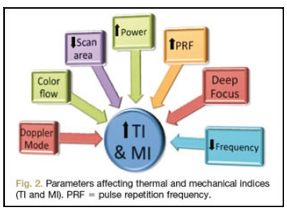


Fig. 2. Parameters affecting thermal and mechanical indices (TI and MI). PRF = pulse repetition frequency.

Anesthesiology 2011; 115:1109–24

The British Medical Ultrasound Society.

Guidelines for the safe use of diagnostic ultrasound equipment

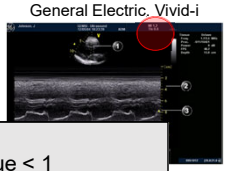
Prepared by the Safety Group of the British Medical Ultrasound Society.

Application	Values to monitor (A)	Thermal Index value		Mechanical Index value	
		0 – 1.0	> 1.0	0 - 0.3	> 0.7
General abdominal Peripheral vascular Unlisted applications	Usually TIB and MI. [use TIC and MI if bone closer than 1 cm; TIS and MI only if bone does not come into the image]	✓	(B) restrict time to 1.0<TIB≤1.5 : 120 min 1.5<TIB≤2.0 : 60 min 2.0<TIB≤2.5 : 15 min 2.5<TIB≤3.0 : 4 min 3.0<TIB≤4.0 : 1 min 4.0<TIB≤5.0 : 15 sec 5.0<TIB≤6.0 : 5 sec TIB>6: not recommended	✓	(C) risk of cavitation with contrast agents
Eye	TIS and MI recommended	✓	Scanning of the eye is not recommended	✓	(C) risk of cavitation with contrast agents
Adult transcranial (imaging and stand-alone) (D)	TIC and MI	✓	(B) restrict time to 0.7<TIC≤1.0 : 60 min 1.0<TIC≤1.5 : 30 min 1.5<TIC≤2.0 : 15 min 2.0<TIC≤2.5 : 4 min 2.5<TIC≤3.0 : 1 min TIC>3: not recommended	✓	(C) risk of cavitation with contrast agents

Web site: http://www.bmus.org/policies-guides/pg-safety03.asp.

Sonosite, Edge

General Electric, Vivid-i



Pour le cerveau
- Index thermique < 1
- Index mécanique < 0,3

Phillips, IU-22

Je vous remercie de votre attention

geeraerts.t@chu-toulouse.fr