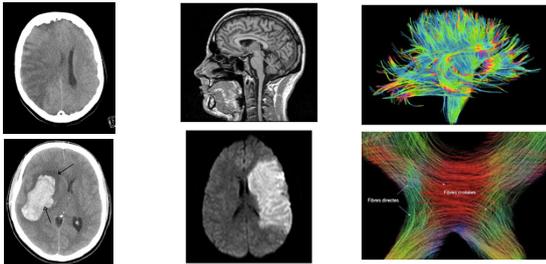


Echographie cérébrale en réanimation

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



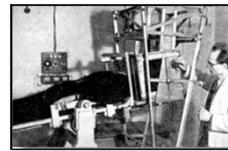
Les références



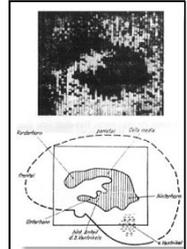
Echographie cérébrale



Karl Dussik
1908-1968



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



Everyone's a radiologist now

Are ultrasound machines truly the stethoscope of the 21st century? Should all doctors keep one in their back pocket? **Jacqui Wise** reports on the battle over ultrasound imaging



Wise J, BMJ, 2008

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

Chiara Robba¹, Alberto Goffi², Thomas Geeraerts³, Danilo Cardim⁴, Gabriele Via⁵, Marek Czosnyka⁶, Soojin Park⁷, Aarti Sarwal⁸, Llewellyn Padayachy⁹, Frank Rasulo¹⁰ and Giuseppe Citerio¹¹

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 Goffi², Thomas Geeraerts³, Danilo Cardim⁴, Gabriele Via⁵, Marek Czosnyka⁶, Soojin Park⁷, Aarti Sarwal⁸, Llewellyn Padayachy⁹, Frank Rasulo¹⁰ and Giuseppe Citerio¹¹

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>

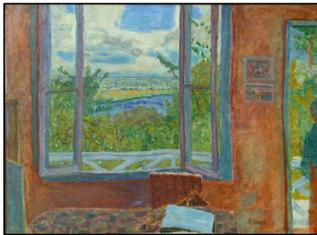
Brain ultrasonography: methodology, basic and advanced principles and clinical applications. A narrative review

Chiara Robba^{1*}, Alberto Goffi², Thomas Geeraerts³, Danilo Cardim⁴, Gabriele Via⁵, Marek Czosnyka⁶, Soojin Park⁷, Aarti Sarwal⁸, Llewellyn Padayachy⁹, Frank Rasulo¹⁰ and Giuseppe Citerio¹¹

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>

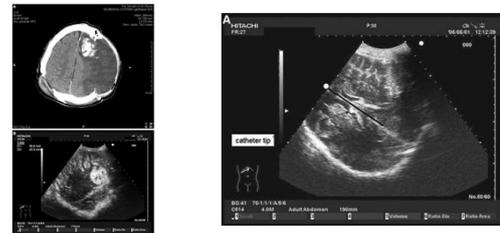
Parfois la fenêtre est ouverte



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*

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Table 2. Diameters of mass lesions

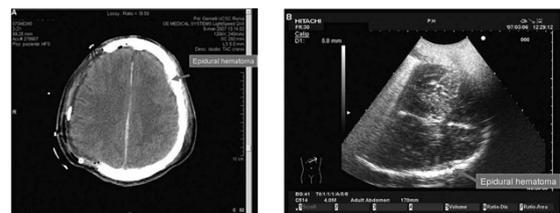
| | Mean Difference (95% confidence interval) | Intraclass Correlation Coefficient (95% confidence interval) |
|---------------------------|--|---|
| Hyperdense lesions | | |
| Axial diameter | -1.30 (3.18-0.58) | 0.934 (0.967-0.992)* |
| Sagittal diameter | -0.13 (-1.77 to 1.51) | 0.970 (0.957-0.990)* |
| 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) | 0.181 (-2.117 to 0.774) |
| Coronal diameter | -8.00 (-15.81 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*

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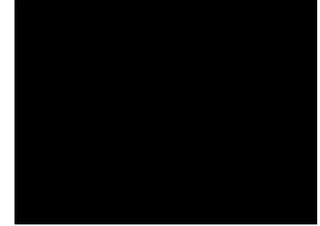


Crit Care Med 2012; 40:1745-1752

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 Tersari, 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 »

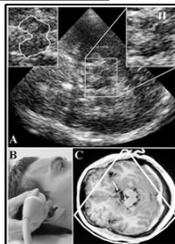


Grolimund P. Transmission of ultrasound through the temporal bone.
In: Aaslid R, ed. Transcranial Doppler sonography. Wien/New York: Springer Verlag, 1985:10-18.

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

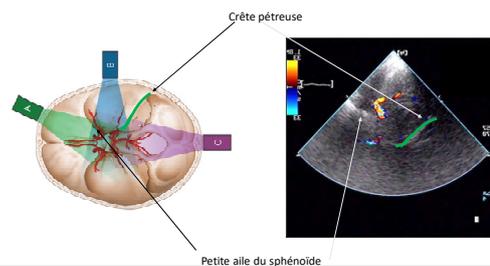
Uwe Walter*

| 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 |



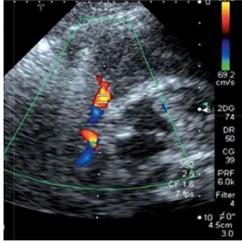
Perspectives in Medicine (2012) 1, 334–343

Repères osseux



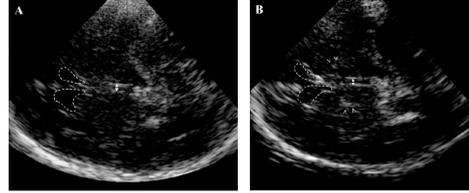
Petite aile du sphénoïde

Visualiser le mesencéphale



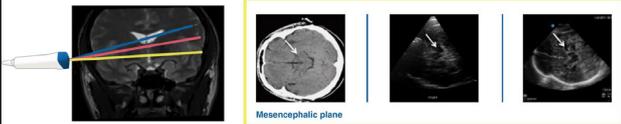
Perspectives of B-Mode Transcranial Ultrasound

Daniela Berg and Georg Becker*



NeuroImage 15, 463-473 (2002)

CT Non-decompressed brain DC



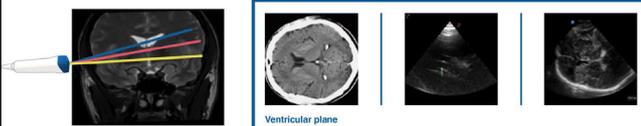
Intensive Care Med
<https://doi.org/10.1007/s00134-019-05610-4>

CT Non-decompressed brain DC



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

CT Non-decompressed brain DC



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., WAJID N. AL-HOLOU, M.D., AND STEPHEN E. SULLIVAN, M.D.

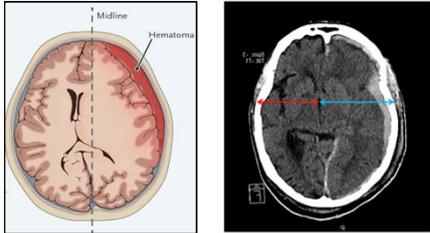
- Etude rétrospective
- N=249

| 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

Déviatión de ligne médiane



Assessment of brain midline shift using sonography in neurosurgical ICU patients

Julie Motuel¹, Isaura Biette², Mohamed Srain¹, Ségólène Mrozek¹, Matt M Kurek³, Patrick Chaynes⁴, Christophe Cognard⁵, Olivier Fourcade⁶ and Thomas Geeraerts^{1*}

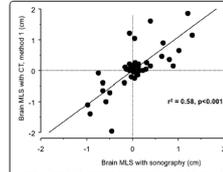


Figure 3 Correlation between sonography and CT method 1 for MLS assessment. CT, computed tomography; MLS, midline shift.

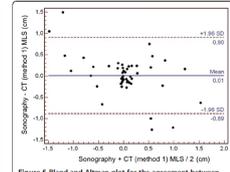
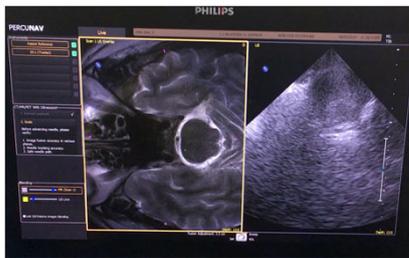


Figure 5 Bland and Altman plot for the agreement between sonography and CT method 1 for MLS assessment. CT, computed tomography; MLS, midline shift.

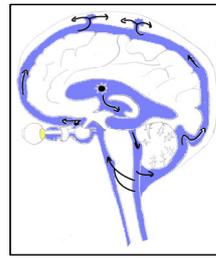


Critical Care (2014) 18:676

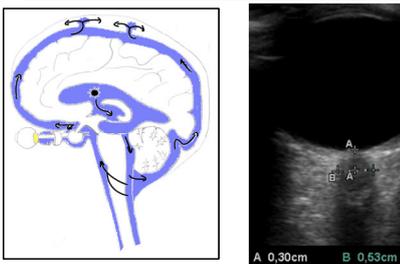
Echographie combinée



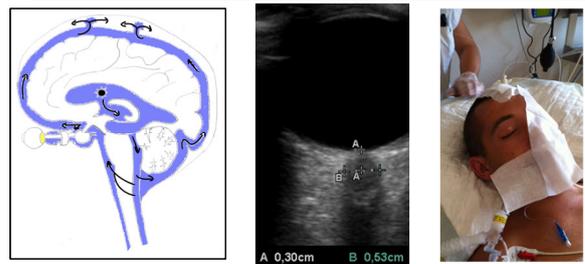
Enveloppes du nerf optique

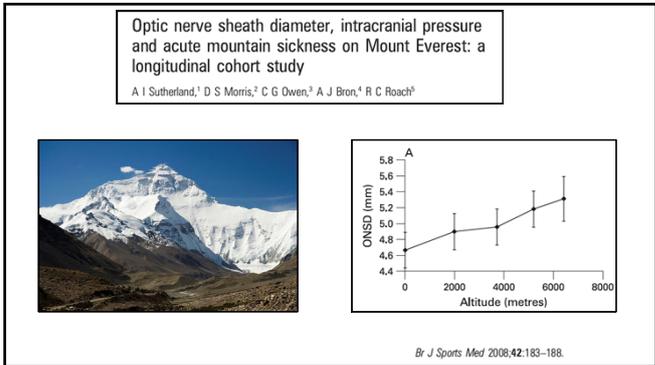
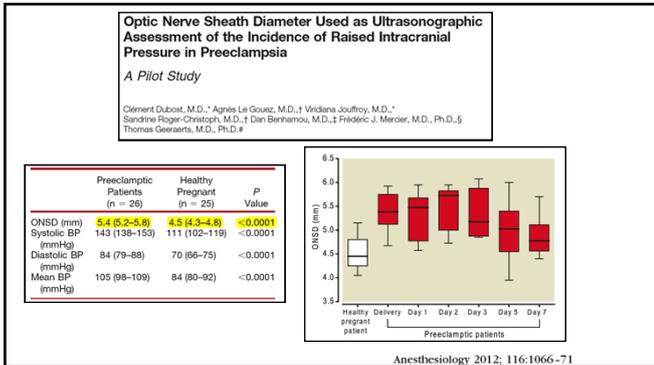
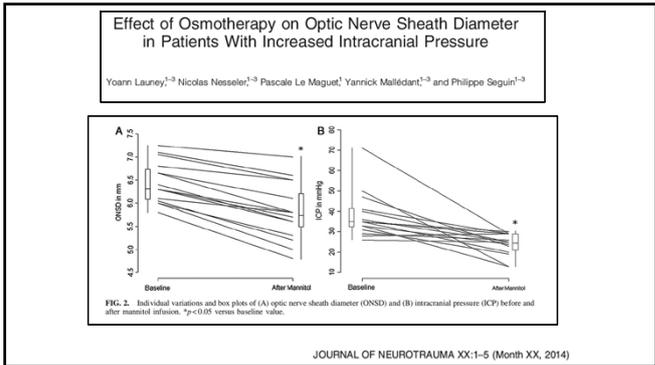
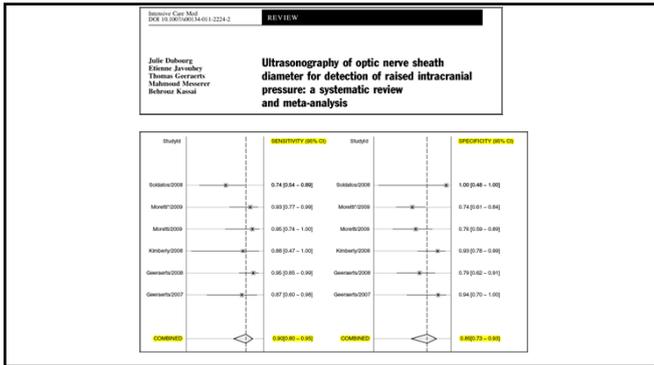
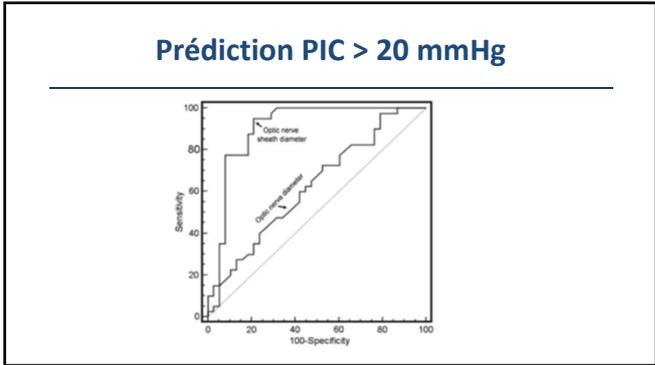
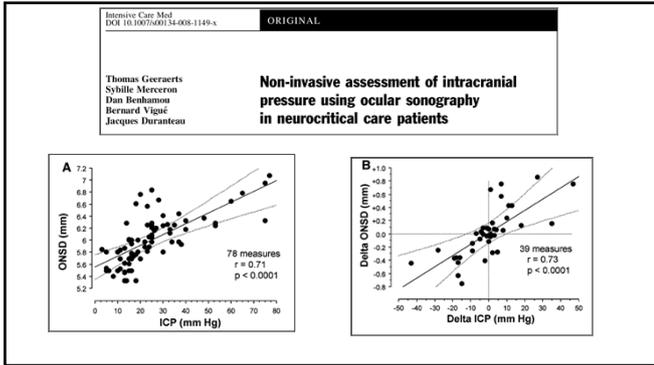


Enveloppes du nerf optique



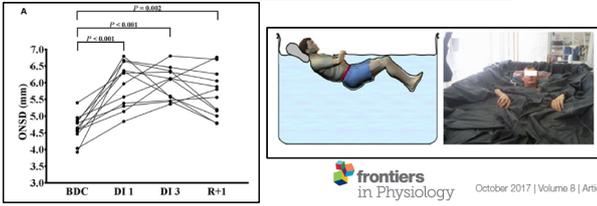
Enveloppes du nerf optique





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

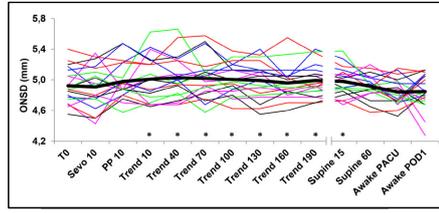
Marc Kormorgant¹, Florian Leca², Nathalie Nasr^{1,2}, Marc-Antoine Custaud⁴, Thomas Geeraerts^{1,2}, Marek Czosnyka^{5,6}, Dina N. Arvanitis¹, Jean-Michel Senard^{1,2} and Anne Pavy-Le Traon^{1,2}



frontiers in Physiology October 2017 | Volume 8 | Article 780

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

Philip Verdonck¹, Alain F. Kalmar^{2*}, Koen Suy³, Thomas Geeraerts⁴, Marcel Vercauteren⁵, Alex Mottrie^{5,7}, Andre M. De Wolf⁶, Jan F. A. Hendricks³

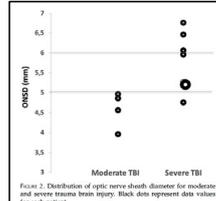


PLOS ONE November 2014 | Volume 9 | Issue 11 | e111916

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

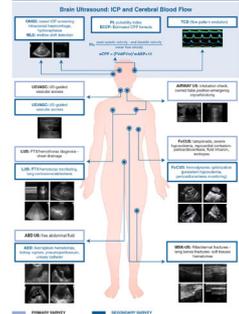
Charles-Henri Houzé-Cerfon, MD, Vincent Bounes, PhD, Johanna Guemon, MD, Thibault Le Gourrierec, MD, Thomas Geeraerts, PhD

- Echographie oculaire
- En pré-hospitalier
- Traumatisme crânien
- 20% non fait, manque de temps
- Si fait, 80% de mesures valides



PREHOSPITAL EMERGENCY CARE 2018;00:1-7

PoCUS in MULTIPLE TRAUMA



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 pétéchiiale
 - Nécrose / apoptose endothéliale

Potential Adverse Ultrasound-related Biological Effects

A Critical Review
Harisharan Shankar, M.B.B.S.,* Paul S. Pagel, M.D., Ph.D.†

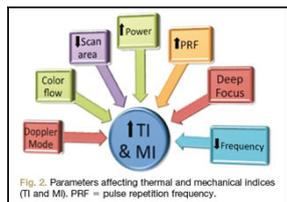


Fig. 2. Parameters affecting thermal and mechanical indices (TI and MI). PRF = pulse repetition frequency.

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 | > 0.3 |
| General abdominal | Usually TIB and MI. | ✓ | (B) restrict time to 1.0-TIBx1.5 : 120 min 1.5-TIBx2.0 : 60 min 2.0-TIBx2.5 : 15 min 2.5-TIBx3.0 : 4 min 3.0-TIBx4.0 : 1 min 4.0-TIBx5.0 : 15 sec 5.0-TIBx6.0 : 5 sec TIB>6: not recommended. | ✓ | (C) risk of cavitation with contrast agents |
| Peripheral vascular | Use TIC and MI if bone closer than 1 cm; TIC and MI only if bone does not come into the image) | ✓ | | ✓ | |
| Unlisted applications | | | | | |
| Eye | TIB and MI recommended | ✓ | Scanning of the eye is not recommended. | ✓ | (C) risk of cavitation with contrast agents |
| Adult transcranial (pregnancy and stroke) (D) | TIC and MI | ✓ | (B) restrict time to 0.7-TICx1.5 : 60 min 1.0-TICx1.5 : 30 min 1.5-TICx2.0 : 15 min 2.0-TICx2.5 : 4 min 2.5-TICx3.0 : 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

