Vaso-motor-reactivity

Background:

The cerebrovasculature dilates or constricts in response to acute blood pressure changes to stabilize cerebral blood flow across a range of blood pressures. Transcranial Doppler ultrasound (TCD) can measure cerebral blood flow velocity in the main intracranial vessels non-invasively and with high accuracy.

Combined with the availability of non-invasive devices for continuous measurement of arterial blood pressure, the relatively low cost, ease-of-use, and excellent temporal resolution of TCD have stimulated the development of new techniques to assess cerebral autoregulation in the laboratory or bedside using a dynamic approach, instead of the more classical 'static' method. Cerebral circulation is profoundly affected by changes in PaCO2. CO2 manipulation plays a basic role in the management of intracranial hypertension; CO2 reactivity defines the changes in CBF in response to changes in PaCO2.

The assessment of cerebral autoregulation is a key to the optimization of cerebral perfusion pressure in patients with brain injury.

Literature:

Non-invasive assessment of cerebral autoregulation in real-time mode

Author	*V. B. Semenyutin[1], V. A. Aliev[1], A. A. Ivankov, A. Patzak[2], G. K. Panuntsev[1], B. B. Govorov[1], A. A. Nikiforova[1]* [1] Russian Polenov Neurosurgical Institute, Northwestern Federal Medical Research Center, St.Petersburg, Russian Federation [2] Johannes-Mueller Institute of Physiology University Hospital Charité, Humboldt-University of Berlin, Germany
Content/Summary	It has been already revealed the prognostic value of phase shift between blood flow velocity (BFV) in basal cerebral arteries and systemic blood pressure (BP) using an off-line transfer function analysis for the assessment of cerebral autoregulation (CA). The same role of linear estimation of stochastic relationship between BP and BFV within the range of M-waves (0.08 – 0.12 Hz) in real-time mode is not studied to the present time. **Purpose:** to assess CA by spectral analysis methods using the linear estimation of stochastic relationship between BP and BFV in real-time mode. **Methods:** 10 healthy volunteers (aged 23 to 30 years) were studied. BFV in middle cerebral arteries with MultiDop X DWL (Germany) and BP with CNAP (Austria) were monitored during 30 min. The

	examination was performed in spontaneous respiration, compulsory breathing (6 times per minute) and breath holding. Client-server software has been developed for investigation of non-stationary quasiperiodic stochastic processes within the range of M-waves in real-time mode.
Comment	interesting study for autoregulation
Doppler-device	DWL Multi Dop X
Quantification	

Cerebral autoregulation and shunt flow index in the region of arteriovenous malformation

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Content/Summary	A decrease of cerebral autoregulation (CA) rate in the region of arteriovenous malformation (AVM) may be caused either by the long-term steal of brain in perinidal cerebral area or pathologic shunting. The last may disguise the true state of CA. The influence of both factors on CA could be hardly diagnosed on pre- operative stage. It has recently been established the potentiality of precerebral arteries Duplex scanning for evaluation of shunt flow index (SFI). SFI dynamics after AVM exclusion from circulation may allow to estimate the true state of CA in perinidal area. **Aim of study:** To assess dynamics of SFI and CA in patients with AVM in perioperative period.
Comment	was no direct relationship between the SFI and rate of CA in the region of AVM. Quantitative CA assessment in perinidal zone may be important for the management of surgical treatment of AVM and prognostication of postoperative neurologic complications.
Doppler-device	DWL Multi Dop X
Quantification	

Cerebral autoregulation in operated patients with stenosis of the carotid arteries

Author	*V. B. Semenyutin[1], A. A. Nikiforova[1], G. K. Panuntsev[1], V. A. Aliev[1], A. Patzak[2], G. A. Asaturyan[1], V. B. Iblyaminov[1], I. P. Dudanov[3], K. V. Laptev[3]* [1] Russian Polenov Neurosurgical Institute, St.Petersburg, Russian Federation [2] Johannes-Mueller Institute of Physiology University Hospital Charité, Humboldt-University of Berlin, Germany [3] Municipal Mariinsky Hospital, St.Petersburg, Russian Federation
Content/Summary	It was shown the informative value of preoperative assessment of cerebral autoregulation (CA) to define effective- ness of surgical treatment of patients with carotid artery stenosis. But at the same time perioperative dynamics of CA is not investigated properly. **The aim:** To assess CA dynamics in patients with carotid arteries stenosis in perioperative period **Methods:** 21 patients with atherosclerotic stenosis lesions of carotid arteries were studied. In 16 patients revealed critical stenosis, severe – in 5. Stenting of carotid arteries performed in 5 patients, carotid endarterectomy – in 16.
Comment	The absence of significant preoperative CA impairment in patients with asymptomatic carotid artery stenosis is not a contraindication for surgery. An absence of reliable dynamics of CA indices in patients with asymptomatic stenosis requires further investigation.
Doppler-device	DWL Multi Dop X
Quantification	

Vasomotor reactivity as a predictor for syncope in patients with orthostatism.

Author	(Gur u. a., 2011)
Content/Summary	Mean VMR% values of the MCA and VA in patients with OH with syncope (n=12) were significantly lower as compared with patients with OH without syncope (n=17): 25.2±20.5% and 42.5 ±18.6%; 20.9±15.5% and 40.8±28.5%, respectively (P<0.05)
Comment	Twenty-nine patients with OH underwent transcranial Doppler (TCD) and the Diamox test (1g acetazolamide IV) for assessing VMR during elaboration of their OH syndrome
Doppler-device	Not known
Quantification	Among patients with OH (orthostatic hypotension), we found an association between the presence of syncope and impaired VMR. Assessment of VMR among patients with OH may predict those who are at higher risk to faint and fall and to support more aggressive intervention.

Monitoring cerebral autoregulation after head injury. Which component of transcranial Doppler flow velocity is optimal?

Author	(Budohoski u. a., 2011)
Content/Summary	Systolic flow indices (Sx and Sxa) demonstrated a stronger association with outcome after traumatic brain injury than the mean flow indices (Mx and Mxa), irrespective of whether CPP or ABP was used for calculation
Comment	300 head-injured patients with blood pressure (ABP), intracranial pressure (ICP), cerebral perfusion pressure (CPP), and FV recordings were studied. Autoregulation was calculated as a correlation of slow changes in diastolic, mean and systolic components of FV with CPP (Dx, Mx, Sx, respectively) and ABP (Dxa, Mxa, Sxa, respectively)
Doppler-device	Not known
Quantification	Association with outcome was significant for Mx and Sx. For favorable/unfavorable and death/survival outcomes Sx showed the strongest association.

The effect of blood pressure calibrations and transcranial Doppler signal loss on transfer function estimates of cerebral autoregulation

Author	(Deegan u. a., 2011)
Content/Summary	
Comment	
Doppler-device	Not known
Quantification	Not known

Cerebral autoregulation in stroke: a review of transcranial Doppler studies.

Author	(Aries u. a., 2010)
Content/Summary	General agreement existed on cerebral autoregulation being impaired, even after minor stroke. Impaired cerebral autoregulation as assessed by TCD was related to neurological deterioration, the necessity for decompressive surgery, and poor outcome.
Comment	Review: Twenty-three studies met the inclusion criteria
Doppler-device	Not known
Quantification	TCD in combination with continuous blood pressure measurement offers a method with a high temporal resolution feasible for bedside evaluation of cerebral autoregulation in the stroke unit. TCD studies have shown impairment of cerebral autoregulation in various subtypes of ischemic stroke.

Cerebrovascular regulation during transient hypotension and hypertension in humans.

Author	(Tzeng u. a., 2010)
Content/Summary	As below
Comment	Study to explore, whether such dynamic cerebral autoregulation (dCA) is equally effective in responding to falling versus rising blood pressure.
Doppler-device	DWL Doppler
Quantification	These data indicate that, under our laboratory conditions, dCA (dynamic cerebral autoregulation) appears to be inherently nonlinear with disparate efficacy against rising and falling blood pressure, and dCA gain derived from pharmacologically induced transient hypotension correlates with established nonpharmacological indices of dCA.

A comparison study of cerebral autoregulation assessed with transcranial Doppler and cortical laser Doppler flowmetry.

Author	(Zweifel u. a., 2010)
Content/Summary	When CPP is above 60 mmHg, cortical assessed autoregulation is similar to autoregulation assessed in the MCA.
Comment	Data collected from 29 head injured patients were analysed retrospectively
Doppler-device	Not known
Quantification	After traumatic brain injury, cortical autoregulation (cortical laser Doppler flowmetry) appears to be worse than autoregulation assessed in the MCA (TCD) during rising ICP and falling CPP. When CPP is above 60 mmHg, cortical assessed autoregulation is similar to autoregulation assessed in the MCA.

Practical aspects of bedside cerebral hemodynamics monitoring in pediatric TBI.

Author	(Figaji, 2010)
Content/Summary	This review will focus on key pathophysiological concepts required to understand changes in cerebral hemodynamics after TBI and the principles, potential benefits, and limitations of currently available bedside monitoring techniques, including transcranial Doppler, autoregulation, and local/regional cerebral blood flow.
Comment	Review
Doppler-device	Not known
Quantification	Good summary

Cerebral autoregulation and anesthesia.

Author	(Dagal und Lam, 2009)
Content/Summary	Intraoperative cerebral autoregulation monitoring is an important consideration for the patients with neurologic disease. Transcranial Doppler based static autoregulation measurements appears to be the most robust bedside method for this purpose.
Comment	Review
Doppler-device	Not known
Quantification	TCD is the most robust method to assess cerebral autoregulation

Effects of poor bone window on the assessment of cerebral autoregulation with transcranial Doppler sonography - a source of systematic bias and strategies to avoid it.

Author	(Lorenz u. a., 2009)
Content/Summary	US agents improve signal quality
Comment	46 healthy volunteers. Inserting a thin aluminium foil between TCD probe and skin makes a simple model to artificially worsen a good insonation window. Validation studies are presented.
Doppler-device	DWL MultiDop
Quantification	Poor bone windows can cause considerable bias in TCD autoregulation parameters. This bias might be avoided by the use of ultrasound contrast agents, which may greatly improve the credibility of TCD autoregulation assessment in elderly patients.

Transcranial Doppler for evaluation of cerebral autoregulation

Author	(Panerai, 2009)
Content/Summary	The review concludes with specific recommendations for areas where further validation and research are needed to improve the reliability and usefulness of TCD in clinical practice.
Comment	Review
Doppler-device	Not known
Quantification	Good Review on recommendations

Transcranial Doppler assessment of cerebral autoregulation.

Author	(Bellapart und Fraser, 2009)
Content/Summary	Despite the multiple determinants involved in cerebral autoregulation, it appears feasible to reliably assess cerebral autoregulation through the combination of linear and nonlinear methods.
Comment	Review
Doppler-device	Not known
Quantification	Nonlinear methods appear attractive in the research setting, but the challenge is how to adopt these methods to the clinical setting.

Autoregulation in the vertebrobasilar system using transcranial Doppler and CO2 inhalation.

Author	(Noskin u. a., 2009)
Content/Summary	The average CVC (cerebral vasodilatory capacity) in the posterior circulation (2.50 ±0.90) was not significantly different from that in the anterior circulation (2.69 ±0.98; paired t-test = 0.81, p=0.43).
Comment	Despite a relatively young cohort, the study provides normative data from which to investigate vasoreactivity profiles in diseases affecting the posterior circulation, such as atherosclerosis and the PRES spectrum.
Doppler-device	Not known
Quantification	We demonstrated no significant difference in vasoreactivity profiles of the anterior and posterior circulations in healthy controls, and no variability by age, gender or blood pressure.

Monitoring of cerebrovascular autoregulation: facts, myths, and missing links.

Author	(Marek Czosnyka, Brady, u. a., 2009)
Content/Summary	
Comment	Review
Doppler-device	Not known
Quantification	Very nice and important Overview

Increased cerebral vasomotor reactivity in migraine with aura: an autoregulation disorder? A transcranial Doppler and near-infrared spectroscopy study.

Author	(Vernieri u. a., 2008)
Content/Summary	Cerebral VMR, THC and oxygen% increases were significantly greater on the predominant compared with the non-predominant migraine side, with both sides of patients without side predominance and with controls. These findings suggest altered autoregulation in MA (Migraine with aura) patients, possibly secondary to impaired cerebrovascular autonomic control.
Comment	Twenty-one controls and 16 MA patients (eight with side predominance) underwent simultaneous examination of flow velocity in the middle cerebral arteries by transcranial Doppler (TCD) and of near-infrared spectroscopy (NIRS).
Doppler-device	Not known
Quantification	Simultaneous TCD and NIRS investigation could represent a non-invasive approach to evaluate cerebral haemodynamics at the cortical and subcortical level.

One-minute dynamic cerebral autoregulation in severe head injury patients and its comparison with static autoregulation. A transcranial Doppler study.

Author	(Corina Puppo u. a., 2008)
Content/Summary	
Comment	Trial studied 12 severe TBI patients, age 16-63 years, and median GCS 6
Doppler-device	EME TC2-64b
Quantification	We found that patients with impaired static cerebral autoregulation had a poor outcome, whereas those with preserved static cerebral autoregulation experience favorable outcomes.

Dynamic cerebral autoregulation: should intracranial pressure be taken into account?

Author	(Lewis u. a., 2007)
Content/Summary	
Comment	Intermittent recordings of intracranial pressure (ICP), ABP and middle cerebral artery blood flow velocity (FV) waveforms were made in 151 anaesthetised and ventilated adult head injured patients as part of their required care. (FV and ABP (=Mxa) or FV and CPP (=Mx))
Doppler-device	PCDop 842 Doppler Ultrasound Unit (Scimed, Bristol, UK) or Neuroguard (Medasonics, Fremona, CA).
Quantification	When ICP is monitored, CPP rather than ABP should be included in the calculation of the autoregulatory index.

Noninvasive evaluation of dynamic cerebrovascular autoregulation using Finapres plethysmograph and transcranial Doppler.

Author	(Lavinio u. a., 2007)
Content/Summary	The noninvasive index of autoregulation nMxa correlates with Mx and is sensitive enough to detect autoregulation asymmetry.
Comment	The study included 10 head-injured adults. Mx can be estimated noninvasively (nMxa) with the use of a finger plethysmograph arterial blood pressure measurement instead of an invasive cerebral perfusion pressure measurement. We investigated the agreement between nMxa and the previously validated index Mx.
Doppler-device	DWL-MultiDop, DWL
Quantification	nMxa is proposed as a practical tool to assess cerebral autoregulation in patients who do not require invasive monitoring.

Cerebral autoregulation and vasomotor reactivity.

Author	(Aaslid, 2006)
Content/Summary	Various aspects of the cerebral blood-flow regulation can be assessed by transcranial Doppler (TCD). This chapter describes and discusses the approaches that have been reported in the literature. In this chapter, the various CO2 and acetazolamide approaches that determine vasomotor reactivity are described and discussed.
Comment	
Doppler-device	Not known
Quantification	Introduction into the topic

Summary:

Experts:

Aaslid, Lewis

Literature

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