DCS publications on PubMed: Apr 1, 2021 - June 30, 2021

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Methodology. Searches were made in PubMed constraining the search period between Apr 1, 2021 and June 30, 2021. These were later processed for readability but no records were otherwise added or removed. In the preparation of this file, the following searches have been executed:

- diffuse correlation spectroscopy

Cortese L(1)(2), Lo Presti G(1)(2), Zanoletti M(3), Aranda G(4), Buttafava M(5), Contini D(3), Dalla Mora A(3), Dehghani H(6), Di Sieno L(3), de Fraguier S(7), Hanzu FA(4)(8)(9), Mora Porta M(4)(8)(9), Nguyen-Dinh A(10), Renna M(5)(11), Rosinski B(10), Squarcia M(4)(12), Tosi A(5), Weigel UM(13), Wojtkiewicz S(6), Durduran T(1)(14).

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The LUCA device: a multi-modal platform combining diffuse optics and ultrasound imaging for thyroid cancer screening.

Recipes for diffuse correlation spectroscopy instrument design using commonly utilized hardware based on targets for signal-to-noise ratio and precision.

Cortese L, Lo Presti G, Pagliazzi M, Contini D, Dalla Mora A, Dehghani H, Ferri F, Fischer JB, Giovannella M, Martelli F, Weigel UM, Wojtkiewicz S, Zanoletti M, Durduran T.

Biomed Opt Express. May 11;12(6):3265-
doi: 10.1364/BOE. eCollection Jun 1.

Over the recent years, a typical implementation of diffuse correlation spectroscopy (DCS) instrumentation has been adapted widely. However, there are no detailed and accepted recipes for designing such instrumentation to meet pre-defined signal-to-noise ratio (SNR) and precision targets. These require specific attention due to the subtleties of the DCS signals. Here, DCS experiments have been performed using liquid tissue simulating phantoms to study the effect of the detected photon count-rate, the number of

parallel detection channels and the measurement duration on the precision and SNR to suggest scaling relations to be utilized for device design.

Optical characterization of 3D printed PLA and ABS filaments for diffuse optics applications.

Amendola C, Lacerenza M, Pirovano I, Contini D, Spinelli L, Cubeddu R, Torricelli A, Re R.

PLoS One. Jun 16;16(6):e

doi: 10.1371/journal.pone. eCollection 2021.

The interest for Fused Deposition Modelling (FDM) in the field of Diffuse Optics (DO) is rapidly increasing. The most widespread FDM materials are polylactic acid (PLA) and acrylonitrile butadiene styrene (ABS), thanks to their low cost and easiness-to-print. This is why, in this study, 3D printed samples of PLA and ABS materials were optically characterized in the range from the UV up to the IR wavelengths, in order to test their possible employment for probe construction in DO applications. To this purpose, measurements with Near Infrared Spectroscopy and Diffuse Correlation Spectroscopy techniques were considered. The results obtained show how the material employed for probe construction can negatively affect the quality of DO measurements.

Pilot Study on Dose-Dependent Effects of Transcranial Photobiomodulation on Brain Electrical Oscillations: A Potential Therapeutic Target in Alzheimer's Disease.

Spera V, Sitnikova T, Ward MJ, Farzam P, Hughes J, Gazecki S, Bui E, Maiello M, De Taboada L, Hamblin MR, Franceschini MA, Cassano P.

J Alzheimers Dis. Jun

doi: 10.3233/JAD-Online ahead of print.

BACKGROUND: Transcranial photobiomodulation (tPBM) has recently emerged as a potential cognitive enhancement technique and clinical treatment for various neuropsychiatric and neurodegenerative disorders by delivering invisible near-infrared light to the scalp and increasing energy metabolism in the brain. OBJECTIVE: We assessed whether transcranial photobiomodulation with near-infrared light modulates cerebral electrical activity through electroencephalogram (EEG) and cerebral blood flow (CBF). METHODS: We conducted a single-blind, sham-controlled pilot study to test the effect of continuous (c-tPBM), pulse (p-tPBM), and sham (s-tPBM) transcranial photobiomodulation on EEG oscillations and CBF using diffuse correlation spectroscopy (DCS) in a sample of ten healthy subjects [6F/4 M; mean age 28.612.9 years]. c-tPBM near-infrared radiation (NIR) (830 nm; 54.8 mW/cm2; 65.8 J/cm2; 2.3 kJ) and p-tPBM (830 nm; 10 Hz; 54.8 mW/cm2; 33%; 21.7 J/cm2; 0.8 kJ) were delivered concurrently to the frontal areas by four LED clusters. EEG and DCS recordings were performed weekly before, during, and after each tPBM session. RESULTS: c-tPBM significantly boosted gamma ($t = 3.02$, $df = 7$, $p < 0.02$) and beta ($t = 2.91$, $df = 7$, $p < 0.03$) EEG spectral powers in eyes-open recordings and gamma power ($t = 3.61$, $df = 6$, $p < 0.015$) in eyes-closed recordings, with a widespread increase over frontal-central scalp regions. There was no significant effect of tPBM on CBF compared to sham. CONCLUSION: Our data suggest a dose-dependent effect of tPBM with NIR on cerebral gamma and beta neuronal activity. Altogether, our findings support the neuromodulatory effect of transcranial NIR.

Optical Detection of Intracranial Pressure and Perfusion Changes in Neonates With Hydrocephalus.

Flanders TM, Lang SS, Ko TS, Andersen KN, Jahnavi J, Flibotte JJ, Licht DJ, Tasian GE, Sotardi ST, Yodh AG, Lynch JM, Kennedy BC, Storm PB, White BR, Heuer GG, Baker WB.

J Pediatr. May 15:S0022-3476(21)00447-
doi: 10.1016/j.jpeds.2021.05. Online ahead of print.

OBJECTIVE: To demonstrate that a novel noninvasive index of intracranial pressure (ICP) derived from diffuse optics-based techniques is associated with intracranial hypertension. STUDY DESIGN: We compared noninvasive and invasive ICP measurements in infants with hydrocephalus. Infants born term and preterm were eligible for inclusion if clinically determined to require cerebrospinal fluid (CSF) diversion. Ventricular size was assessed preoperatively via ultrasound measurement of the fronto-occipital (FOR) and frontotemporal (FTHR) horn ratios. Invasive ICP was obtained at the time of surgical intervention with a manometer. Intracranial hypertension was defined as invasive ICP =15mmHg. Diffuse optical measurements of cerebral perfusion, oxygen extraction, and noninvasive ICP were performed preoperatively, intraoperatively, and postoperatively. Optical and ultrasound measures were compared with invasive ICP measurements, and their change in values after CSF diversion were obtained. RESULTS: We included 39 infants, 23 with intracranial hypertension. No group difference in ventricular size was found by FOR (P=.93) or FTHR (P=.76). Infants with intracranial hypertension had significantly higher noninvasive ICP (P=.02) and oxygen extraction fraction (OEF) (P=.01) compared with infants without intracranial hypertension. Increased cerebral blood flow (P=.005) and improved OEF (P<.001) after CSF diversion were observed only in infants with intracranial hypertension. CONCLUSIONS: Noninvasive diffuse optical measures (including a noninvasive ICP index) were associated withintracranial hypertension. The findings suggest that impaired perfusion from intracranial hypertension was independentof ventricular size. Hemodynamic evidence of the benefits of CSF diversion was seen in infants with intracranial hypertension. Noninvasive optical techniques hold promise for aiding the assessment of CSF diversion timing.

Towards rapid intraoperative axial localization of spinal cord ischemia with epidural diffuse correlation monitoring.

Busch DR, Lin W, Goh CC, Gao F, Larson N, Wahl J, Bilfinger TV, Yodh AG, Floyd TF.

PLoS One. May 10;16(5):e
doi: 10.1371/journal.pone. eCollection 2021.

Spinal cord ischemia leads to iatrogenic injury in multiple surgical fields, and the ability to immediately identify onset and anatomic origin of ischemia is critical to its management. Current clinical monitoring, however, does not directly measure spinal cord blood flow, resulting in poor sensitivity/specificity, delayed alerts, and delayed intervention. We have developed an epidural device employing diffuse correlation spectroscopy (DCS) to monitor spinal cord ischemia continuously at multiple positions. We investigate the ability of this device to localize spinal cord ischemia in a porcine model and validate DCS versus Laser Doppler Flowmetry (LDF). Specifically, we demonstrate continuous (>0.1Hz) spatially resolved (3 locations) monitoring of spinal cord blood flow in a purely ischemic model with an epidural DCS probe. Changes in blood flow measured by DCS and LDF were highly correlated (r = 0.83). Spinal cord blood flow measured by DCS caudal to aortic occlusion decreased 62%. This monitor demonstrated a sensitivity of 0.87 and specificity of 0.91 for detection of a 25% decrease in flow. This technology may enable early identification and critically important localization of spinal cord ischemia.

Dissecting the microvascular contributions to diffuse correlation spectroscopy measurements of cerebral hemodynamics using optical coherence tomography angiography.

Jang JH, Solarana K, Hammer DX, Fisher JAN.

Neurophotonics. Apr;8(2):
doi: 10.1117/1.NPh.8.2.Epub Apr 25.

Significance: Diffuse correlation spectroscopy (DCS) is an emerging noninvasive, diffuse optical modality that purportedly enables direct measurements of microvasculature blood flow. Functional optical co-

herence tomography angiography (OCT-A) can resolve blood flow in vessels as fine as capillaries and thus has the capability to validate key attributes of the DCS signal. Aim: To characterize activity in cortical vasculature within the spatial volume that is probed by DCS and to identify populations of blood vessels that are most representative of the DCS signals. Approach: We performed simultaneous measurements of somatosensory-evoked cerebral blood flow in mice in vivo using both DCS and OCT-A. Results: We resolved sensory-evoked blood flow in the somatosensory cortex with both modalities. Vessels with diameters smaller than 10 m featured higher peak flow rates during the initial poststimulus positive increase in flow, whereas larger vessels exhibited considerably larger magnitude of the subsequent undershoot. The simultaneously recorded DCS waveforms correlated most highly with flow in the smallest vessels, yet featured a more prominent undershoot. Conclusions: Our direct, multiscale, multimodal cross-validation measurements of functional blood flow support the assertion that the DCS signal preferentially represents flow in microvasculature. The significantly greater undershoot in DCS, however, suggests a more spatially complex relationship to flow in cortical vasculature during functional activation.

Role of Optical Neuromonitoring in Neonatal Encephalopathy-Current State and Recent Advances.

Harvey-Jones K, Lange F, Tachtsidis I, Robertson NJ, Mitra S.

Front Pediatr. Apr 9;9:

doi: 10.3389/fped.2021.eCollection 2021.

Neonatal encephalopathy (NE) in term and near-term infants is a significant global health problem; the worldwide burden of disease remains high despite the introduction of therapeutic hypothermia. Assessment of injury severity and effective management in the neonatal intensive care unit (NICU) relies on multiple monitoring modalities from systemic to brain-specific. Current neuromonitoring tools provide information utilized for seizure management, injury stratification, and prognostication, whilst systemic monitoring ensures multi-organ dysfunction is recognized early and supported wherever needed. The neuromonitoring technologies currently used in NE however, have limitations in either their availability during the active treatment window or their reliability to prognosticate and stratify injury confidently in the early period following insult. There is therefore a real need for a neuromonitoring tool that provides cot side, early and continuous monitoring of brain health which can reliably stratify injury severity, monitor response to current and emerging treatments, and prognosticate outcome. The clinical use of near-infrared spectroscopy (NIRS) technology has increased in recent years. Research studies within this population have also increased, alongside the development of both instrumentation and signal processing techniques. Increasing use of commercially available cerebral oximeters in the NICU, and the introduction of advanced optical measurements using broadband NIRS (BNIRS), frequency domain NIRS (FDNIRS), and diffuse correlation spectroscopy (DCS) have widened the scope by allowing the direct monitoring of oxygen metabolism and cerebral blood flow, both key to understanding pathophysiological changes and predicting outcome in NE. This review discusses the role of optical neuromonitoring in NE and why this modality may provide the next significant piece of the puzzle toward understanding the real time state of the injured newborn brain.

Blood flow response to orthostatic challenge identifies signatures of the failure of static cerebral autoregulation in patients with cerebrovascular disease.

Gregori-Pla C, Mesquita RC, Favilla CG, Busch DR, Blanco I, Zirak P, Frisk LK, Avtzi S, Maruccia F, Giacalone G, Cotta G, Camps-Renom P, Mullen MT, Mart-Fbregas J, Prats-Snchez L, Martnez-Domeo A, Kasner SE, Greenberg JH, Zhou C, Edlow BL, Putt ME, Detre JA, Yodh AG, Durduran T, Delgado-Mederos R.

BMC Neurol. Apr 9;21(1):

doi: 10.1186/s12883-021-02179-8.

BACKGROUND: The cortical microvascular cerebral blood flow response (CBF) to different changes in head-of-bed (HOB) position has been shown to be altered in acute ischemic stroke (AIS) by diffuse correlation spectroscopy (DCS) technique. However, the relationship between these relative ?CBF changes and associated systemic blood pressure changes has not been studied, even though blood pressure is a major driver of cerebral blood flow. METHODS: Transcranial DCS data from four studies measuring bilateral frontal microvascular cerebral blood flow in healthy controls (n = 15), patients with asymptomatic severe internal carotid artery stenosis (ICA, n = 27), and patients with acute ischemic stroke (AIS, n = 72) were aggregated. DCS-measured CBF was measured in response to a short head-of-bed (HOB) position manipulation protocol (supine/elevated/supine, 5 min at each position). In a sub-group (AIS, n = 26; ICA, n = 14; control, n = 15), mean arterial pressure (MAP) was measured dynamically during the protocol. RESULTS: After elevated positioning, DCS CBF returned to baseline supine values in controls ($p = 0.890$) but not in patients with AIS (9.6% [6.0,13.3], mean 95% CI, $p < 0.001$) or ICA stenosis (8.6% [3.1,14.0], $p = 0.003$)). MAP in AIS patients did not return to baseline values (2.6 mmHg [0.5, 4.7], $p = 0.018$), but in ICA stenosis patients and controls did. Instead ipsilesional but not contralesional CBF was correlated with MAP (AIS 6.0%/mmHg [- 2.4,14.3], $p = 0.038$; ICA stenosis 11.0%/mmHg [2.4,19.5], $p < 0.001$). CONCLUSIONS: The observed associations between ipsilateral CBF and MAP suggest that short HOB position changes may elicit deficits in cerebral autoregulation in cerebrovascular disorders. Additional research is required to further characterize this phenomenon.

Impact of changes in tissue optical properties on near-infrared diffuse correlation spectroscopy measures of skeletal muscle blood flow.

Bartlett MF, Jordan SM, Hueber DM, Nelson MD.

J Appl Physiol (1985). Apr 1;130(4):1183-
doi: 10.1152/japplphysiol.00857.Epub Feb 11.

Near-infrared diffuse correlation spectroscopy (DCS) is increasingly used to study relative changes in skeletal muscle blood flow. However, most diffuse correlation spectrometers assume that tissue optical properties-such as absorption (a) and reduced scattering ('s) coefficients-remain constant during physiological provocations, which is untrue for skeletal muscle. Here, we interrogate how changes in tissue a and 's affect DCS calculations of blood flow index (BFI). We recalculated BFI using raw autocorrelation curves and a/'s values recorded during a reactive hyperemia protocol in 16 healthy young individuals. First, we show that incorrectly assuming baseline a and 's substantially affects peak BFI and BFI slope when expressed in absolute terms (cm2/s, $P < 0.01$), but these differences are abolished when expressed in relative terms (% baseline). Next, to evaluate the impact of physiologic changes in a and 's, we compared peak BFI and BFI slope when a and 's were held constant throughout the reactive hyperemia protocol versus integrated from a 3-s rolling average. Regardless of approach, group means for peak BFI and BFI slope did not differ. Group means for peak BFI and BFI slope were also similar following ad absurdum analyses, where we simulated supraphysiologic changes in a/'s. In both cases, however, we identified individual cases where peak BFI and BFI slope were indeed affected, with this result being driven by relative changes in a over 's. Overall, these results provide support for past reports in which a/'s were held constant but also advocate for real-time incorporation of a and 's moving forward.NEW & NOTEWORTHY We investigated how changes in tissue optical properties affect near-infrared diffuse correlation spectroscopy (NIR-DCS)-derived indices of skeletal muscle blood flow (BFI) during physiological provocation. Although accounting for changes in tissue optical properties has little impact on BFI on a group level, individual BFI calculations are indeed impacted by changes in tissue optical properties. NIR-DCS calculations of BFI should therefore account for real-time, physiologically induced changes in tissue optical properties whenever possible.

Speckle contrast diffuse correlation tomography of cerebral blood flow in perinatal disease model of neonatal piglets.

Huang C, Mazdeyasna S, Mohtasebi M, Saatman KE, Cheng Q, Yu G, Chen L.

J Biophotonics. Apr;14(4):e

doi: 10.1002/jbio.Epub Jan 3.

We adapted and tested an innovative noncontact speckle contrast diffuse correlation tomography (scDCT) system for 3D imaging of cerebral blood flow (CBF) variations in perinatal disease models utilizing neonatal piglets, which closely resemble human neonates. CBF variations were concurrently measured by the scDCT and an established diffuse correlation spectroscopy (DCS) during global ischemia, intraventricular hemorrhage, and asphyxia; significant correlations were observed. Moreover, CBF variations associated reasonably with vital pathophysiological changes. In contrast to DCS measurements of mixed signals from local scalp, skull and brain, scDCT generates 3D images of CBF distributions at prescribed depths within the head, thus enabling specific determination of regional cerebral ischemia. With further optimization and validation in animals and human neonates, scDCT has the potential to be a noninvasive imaging tool for both basic neuroscience research in laboratories and clinical applications in neonatal intensive care units.