

BEDSIDE DIFFUSE OPTICAL TOMOGRAPHY OF RESTING-STATE FUNCTIONAL CONNECTIVITY IN NEONATES

Silvina L. Ferradal¹, Steve M. Liao², Adam T. Eggebrecht³, Terrie E. Inder², and Joseph P. Culver³

¹Biomedical Engineering, Washington University in St. Louis, Saint Louis, MO, United States, ²Pediatrics, Washington University in St. Louis, Saint Louis, United States, ³Radiology, Washington University in St. Louis, Saint Louis, United States

Introduction

The high incidence of adverse neurodevelopmental outcomes in preterm infants remains a major clinical problem. Defining both anatomical and functional brain lesions may lead to a better understanding of the neural mechanism of adverse outcomes. Recent advances with resting-state functional connectivity MRI (fcMRI) provide an approach to defining functional lesions and have been used to investigate the maturation of the functional network architecture in neonates [1, 2]. Although fcMRI is an attractive tool because it does not require the subject to perform tasks, it has significant limitations for use in preterm infants due to challenges involved in the transportation to the scanner. Advances in high-density diffuse optical tomography (HD-DOT) techniques [3] provide a portable and wearable alternative for evaluating the same hemodynamic physiology as BOLD-MRI. In previous work, we demonstrated the feasibility of resting-state functional connectivity DOT (fcDOT) in adults [4]. Recently we extended fcDOT to the occipital cortex of hospitalized neonates [5]. Herein we demonstrate the feasibility of an expanded field-of-view system. Multiple functional connectivity networks are mapped over the occipital, parietal and temporal lobes of neonates. These results illustrate the potential of fcDOT as a valuable imaging tool for reporting brain function in neonates at the bedside.

Methods

Infants were recruited from the neonatal intensive care unit at St. Louis Children's Hospitals. Resting-state data was collected from six premature infants at term-equivalent age. The imaging cap consisted of a high-density array of 32 sources and 34 detectors (Fig. 1a). Our data processing has been previously described in [5]. Briefly, an MRI-based neonatal atlas was used for creating a light propagation model of the infant head (Fig. 1a). Based on this model, optical measurements were converted into volumetric reconstructions of both HbO₂ and HbR. Eleven pairs of seeds were chosen in the left and right cortices based on the imaging pad's location relative to the infant head. The time courses from these seed regions were correlated with all other voxels in our field-of-view to generate functional connectivity maps. An average surface-based atlas of the neonatal cortex was used to display the functional connectivity maps.

Results

Fig. 1 shows correlation patterns obtained for a single subject using three pairs of seeds (Fig. 1b). The extended field-of-view allowed us to spatially map three distinguishable functional connectivity networks (Fig. 1c-e). Interhemispheric bilateral correlation coefficients obtained for the six infants using eleven pairs of seeds (Fig. 2a) show robust fcDOT in the occipital, parietal and temporal regions (Fig. 2b).

Conclusions

Our overall goal is to establish fcDOT as a bedside tool to monitor infant brain function. We have previously shown the feasibility of detecting ischemia in an infant with an occipital stroke [5]. In order to move forward with clinical applications of the technique, we first need to establish normal patterns of fcDOT maps in healthy infants and validate these results with those obtained with fcMRI. These preliminary results represent a promising first step towards establishing a normative data set and serve as a foundation upon which to build studies of infants at greater risk for adverse outcome.

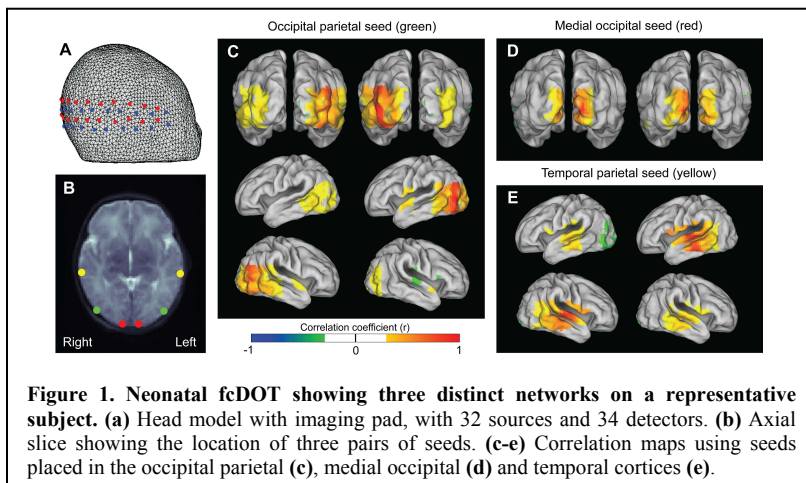


Figure 1. Neonatal fcDOT showing three distinct networks on a representative subject. (a) Head model with imaging pad, with 32 sources and 34 detectors. **(b)** Axial slice showing the location of three pairs of seeds. **(c-e)** Correlation maps using seeds placed in the occipital parietal **(c)**, medial occipital **(d)** and temporal cortices **(e)**.

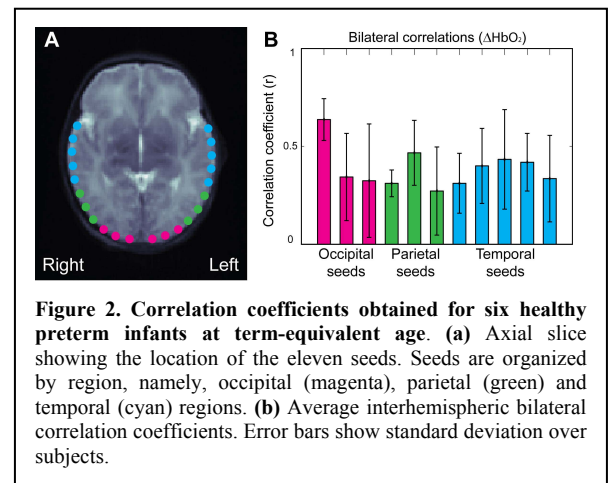


Figure 2. Correlation coefficients obtained for six healthy preterm infants at term-equivalent age. (a) Axial slice showing the location of the eleven seeds. Seeds are organized by region, namely, occipital (magenta), parietal (green) and temporal (cyan) regions. **(b)** Average interhemispheric bilateral correlation coefficients. Error bars show standard deviation over subjects.

References

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