The Effect of Hyperbaric Oxygen Treatment on Resting State Networks

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Background

Hyperbaric oxygen (HBO) treatment is an established method to improve wound healing in the extremities by stimulating angiogenesis. A similar effect in the brain has not been well established. Resting-state functional magnetic resonance imaging (rsfMRI) has been used to reliably identify and study resting state networks (RSN) in the brain.

The purpose of this project was to evaluate if HBO treatment can help patients with chronic cerebral small vessel disease (CSVD) by measuring changes in connectivity of RSN.

Materials and Methods

- 25 patients >50 years of age with chronic cerebrovascular disease were recruited from the community.
- Each patient presented with two or more symptoms
  - gait disturbance,
  - disequilibrium,
  - decline in cognitive function,
  - upper motor neuron deficit,
  - dysmetria,
  - hyperreflexia, or
  - unilateral increase in muscle tone
- 20 patients completed full course of HBO therapy
- Patients were scanned using rsfMRI before and approximately 4 weeks after treatment with hyperbaric oxygen therapy.
- Subjects were treated in Sechrist Monoplace Hyperbaric Chambers at a pressure of 2 atmospheres absolute for 45 minutes using 100% oxygen.
- Subjects were given 10 treatments over a span of 2 weeks (5 treatments per week).
- 20 age-matched controls and 17 young adult healthy controls were selected from other ongoing studies at our institute.
- rsfMRI pre-processing was performed using standard methods.
- The same analysis was performed on all four groups

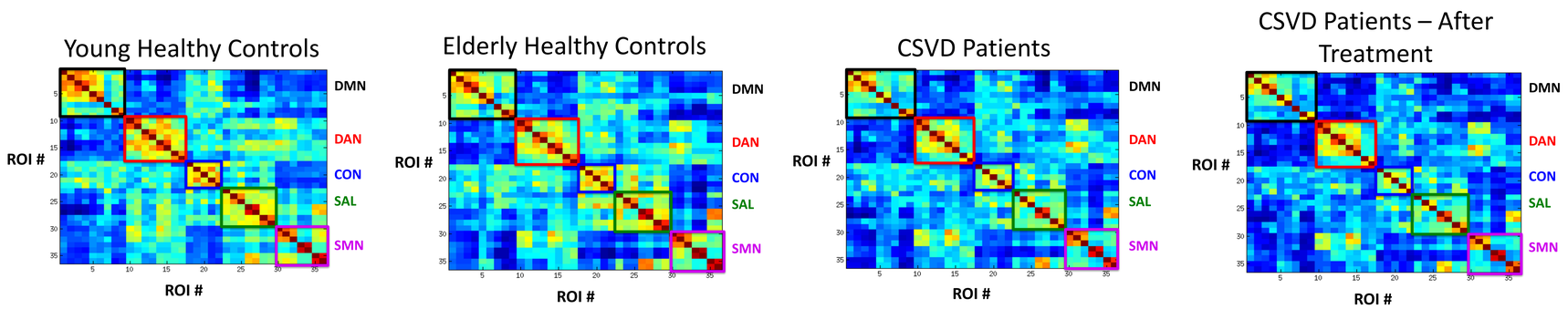

Figure 1 The group average of the resulting correlation map of the 36 Regions of Interest for each of the four groups of subjects. The 36 seeds were a priori identified as located within known networks and each set is highlighted with a black box.

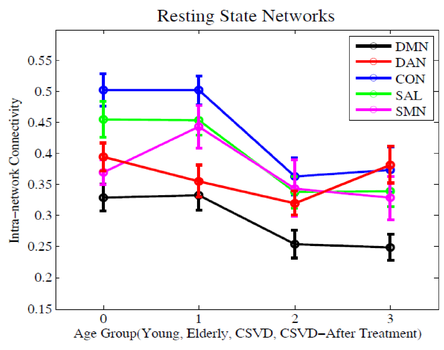

Figure 2 The intra-network composite correlation values for each group of subjects. In general, the the connectivity is significantly reduced in patients with CSVD. However, an improvement in the DAN is was measured with a p value of 0.0878

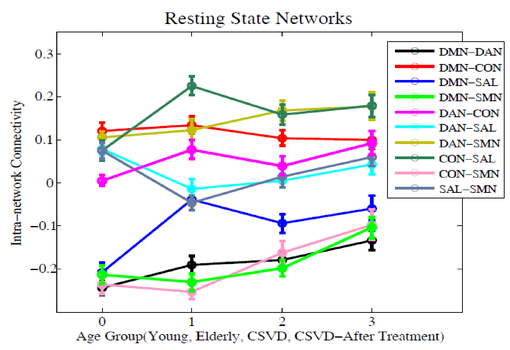

Figure 3 The internetwork composite correlation values for each group of subjects. Two cross network correlation values increased significantly after treatment: DMN-SMN networks with a p value of 0.0007 and the DAN-CON networks with a p value of 0.0261

Analysis

- 36 regions of interest associated with the following RSN were selected for analysis and divided into 5 networks [1]:
  - Default Mode (DMN)
  - Dorsal Attention (DAN)
  - Control (CON)
  - Salience (SAL)
  - Sensory-Motor (SMN)
- The correlation values between all regions were calculated for each patient (Figure 1)
- Each correlation value transformed using the Fisher z-transform to obtain normal distributions and averaged across the entire set of intra-network or internetwork values
- Within networks, a composite connectivity value was calculated using the average of the z-transformed correlation values for each network (Figure 2)
- Between networks, a similar cross-network connectivity value was calculated using the average of the z-transformed correlation values for each network (Figure 3)
- The internetwork and intra-network connectivity for these five RSN was measured and compared across groups.

Results

Preliminary results indicate that HBO treatment leads increase connectivity within the DAN and in the cross network correlation between the DMN and the SMN as well as between the DAN and the CON.

These networks are critical for normal brain function and further research is needed to confirm that these changes correlate with improvement in performance in neurocognitive testing and in activities of daily living.

References and Acknowledgements

[1] M.R. Brier, J.B. Thomas, A.Z. Snyder, T.L. Benzinger, D. Zhang, M.E. Raichle, D.M. Holtzman, J.C. Morris, B.M. Ances, Loss of intranetwork and internetwork resting state functional connections with Alzheimer's disease progression, The Journal of neuroscience : the official journal of the Society for Neuroscience, 32 (2012) 8890-8899.

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