

THALAMIC AND CAUDATE HYPERTROPHY IN RECOVERY FROM CRITICAL ILLNESS

M. L. Gunther^{1,2}, W. R. Riddle³, A. Morandi^{2,4}, M. Hooper^{2,5}, E. W. Ely^{2,5}, C. Cannistraci⁶, W. Schrader¹, K. L. Merkle¹, J. C. Gatenby^{1,3}, and J. C. Gore^{1,3}

¹VUIIS Vanderbilt Institute of Imaging Sciences, Vanderbilt University Medical Center, Nashville, TN, United States, ²Center for Health Services Research, Vanderbilt University Medical Center, Nashville, TN, United States, ³Radiology and Radiological Sciences, Vanderbilt University Medical Center, ⁴Geriatric Medicine, Vanderbilt University Medical Center, ⁵Department of Pulmonary Critical Care Medicine, Vanderbilt University Medical Center, ⁶VUIIS Vanderbilt Institute of Imaging Sciences, Vanderbilt University Medical Center, Nashville, TN

Thalamic and Caudate Hypertrophy in Recovery from Critical Illness

Introduction: Non-neurological critical illness has been shown to be independently related to a number neurological alterations along with acute confusional states such as delirium [1]. Only a handful of neuroimaging studies have examined change in the central nervous system (CNS) following critical illness. Thus, little is known about anatomical alterations that occur in the brain during care in an intensive care unit (ICU). In order to elucidate the nature of these brain changes, we examined 6 ICU survivors at hospital discharge & 3 month follow-up using deformation-based morphometry.

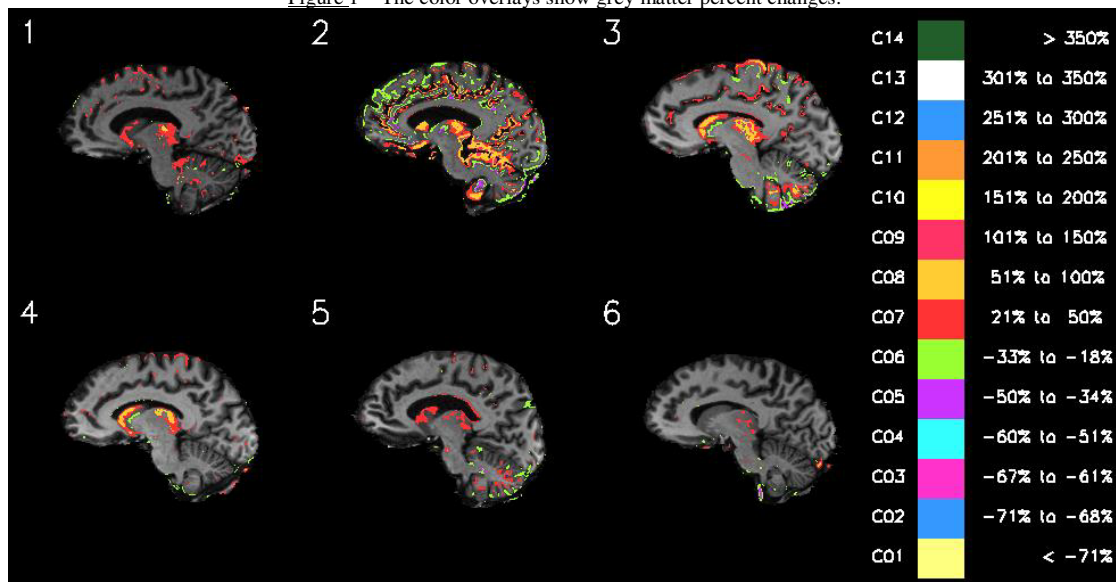
Hypothesis: Based on previous studies [2-3], it was hypothesized that patient's brains would show anatomical changes in the frontal lobe, basal ganglia and thalamus at 3 month follow-up.

Methods: All MR imaging was performed using a Philips Achieva 3T MRI scanner (Philips Medical Systems, Inc., Best, The Netherlands). Scanning included a three dimensional, 170 T1-weighted 1 mm sagittal slices of the head (TR= 7.9 ms, TE= 3.7 sec, FOV = 256mm). Images were globally registered to the participant's time 1 image using a rigid transform. Inhomogeneity corrections were then applied to the globally aligned image volumes. Non-rigid deformation fields were calculated between the first image volume the second image volume. The Jacobian of the non-rigid deformation field between the time 1 and time 2 image volumes was used to generate expansion/contraction color overlays. When the first T1-weighted image volume is warped to the second image volume, the Jacobian (J) of the deformation field at any point is equal to the ratio of the volume in the first image volume (V1) divided by the corresponding volume in the second image volume (V2), or $J = V1 / V2$. This volume ratio can be expressed as the fractional volume change with respect to the first image [$\text{change} = (1/J) - 1$].

Results: Patients had a mean age of 55 ± 11 & presented with a high severity of illness (APACHE II, 25 ± 6). All patients presented with at least one episode of acute confusional status as measured by the confusion assessment method for the ICU [4]. Notable expansions were observed in the posterior thalamus and caudate for 5 out of 6 patients with less-contraction in the cortex of the frontal lobe (Figure 1).

Conclusions: These data provide evidence that the thalamus and caudate appear to increase in size following critical illness. Changes in the volume of the thalamus and the caudate have been documented in a number of neuropsychiatric conditions. Transient thalamic and caudal atrophy may be associated with critical illness and diminished cognitive status. Subsequent hypertrophy of these brain regions may represent a process of recovery from critical illness for both cognitive and motor ability.

Figure 1 – The color overlays show grey matter percent changes.



REFERENCES

1. Jackson, J.C., et al., Six-month neuropsychological outcome of medical intensive care unit patients. Crit Care Med, 2003. 31(4): p. 1226-1234.
2. Bogousslavsky, J., et al., Manic delirium and frontal-like syndrome with paramedian infarction of the right thalamus. J Neurol Neurosurg Psychiatry., 1988. 51: p. 116-119.
3. Hopkins, R.O., S.D. Gale, and L.K. Weaver, Brain atrophy and cognitive impairment in survivors of acute respiratory distress syndrome. Brain Inj., 2006. 20(3): p. 263-271.
4. Ely, E.W., et al., Delirium in mechanically ventilated patients: validity and reliability of the confusion assessment method for the intensive care unit (CAM-ICU). JAMA: 2001. 286(21): p. 2703-2710.