

A 3D surface based correlation analysis of the putamen and thalamus in premature neonates

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INTRODUCTION: Finding the neuroanatomical correlates of prematurity is vital to understanding which structures are affected, and in designing treatments. Studies revealed that deep gray matter alterations, notably in the thalamus, are important indicators of prematurity [3,1]. However, little is known about the association of altered thalamic development with other deep gray matter disturbances. Here, using brain structural MRI, we tested the hypothesis that thalamic alterations due to prematurity are correlated with those of the ventral striatum. We performed a novel 3D correlation of the thalamus and the ventral striatum structures using 17 preterm and 19 term-born neonates, in terms of the surface determinant and radial distance. The results are compared with previously found group differences in the same dataset, to obtain a more comprehensive assessment of the deep gray matter involvement in premature injuries.

METHOD: T1-weighted MRI scans from 17 premature neonates (gestational ages 25-36 weeks, 41.1 \pm 5.0 weeks at scan time) with normal MR scans and 19 healthy term born infants (gestational ages 37-40 weeks, 45.1 \pm 5.1 weeks at scan time) were acquired on a 1.5T GE scanner spoiled gradient echo sequence. First, we reconstruct the surfaces of the thalamus and ventral striatum from manually segmented brain MR images and build conformal parametric meshes on them [6]. Then, surfaces are fluidly registered on the parametric domains and one-to-one corresponding determinant and radial distance are obtained in a vertex-wise [6]. To investigate regional correlation of the thalamus with putamen, a vertex-wise correlation analysis is performed between the determinant or radius on that vertex in the thalamus and the total volume of putamen. A similar test is also performed on the putamen, correlated with the total volume of the 2 thalami. 10,000 permutations were employed in all the cases to avoid the assumption of normal distribution.

RESULTS AND DISCUSSION: In Fig. 1, several subdivisions of the thalamus are significantly correlated with the volume of the putamen, such as the medial dorsal nucleus and pulvinar. The same regions have been reported to be interconnected with the anterior and inferior part of the putamen in a probabilistic tractography study [2]. However, although these regions have different levels of atrophy as detected in our previous morphometry study in the same dataset, they failed to reach a significant group difference. As for the putamen, areas include the anterior and the inferior nuclei are significantly associated with the volume of the thalamus. These are in line with results of [2]. Furthermore, these regions largely overlap with areas of significant group difference [4]. This suggests that the vulnerability of the putamen to prematurity is possibly a secondary effect of the thalamic injury, via cortico-striato-thalamo-cortical neural circuitry. Our results showed that some of the regional abnormalities on the thalamus are associated with the alterations in ventral striatum, possibly due to the disturbance on the development of the shared cortical-striatum-thalamus pathway. These findings extend knowledge gained from traditional volume based analyses of neonates in the literature, and provide anatomical evidence to the concept of 'encephalopathy of prematurity' as proposed by [5].

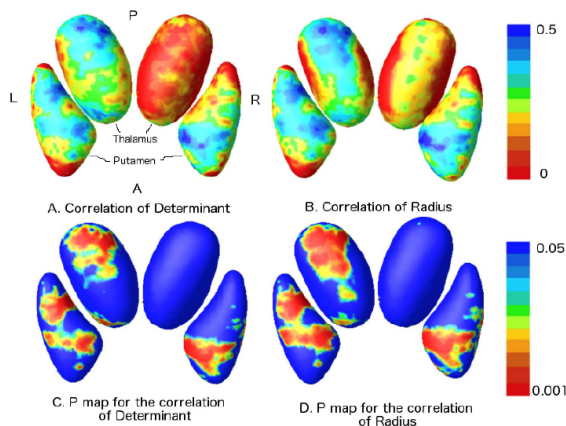


Figure 1: Vertex-wise correlation coefficient maps have been generated based on determinant (Left) and radius (Right), with their corresponding P maps, respectively.

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