Abstract: Shape Analysis in Human Brain MRI

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Structural magnetic resonance imaging data are frequently analyzed to reveal morphological changes of the human brain in dementia. Most contemporary imaging biomarkers are scalar values, such as the volume of a structure, and may miss the localized morphological variation of early presymptomatic disease progression. Neuroanatomical shape descriptors, however, can represent complex geometric information of individual anatomical regions and may demonstrate increased sensitivity in association studies. Yet, they remain largely unexplored. We have recently introduced *BrainPrint* [1] – an ensemble of shape descriptors computed for cortical and subcortical structures derived via longitudinal *FreeSurfer* segmentations [2]. *BrainPrint* naturally augments the contemporary region of interest-based volume and thickness analysis with shape information. Using *BrainPrint* to quantify lateral asymmetry, we demonstrated that neurodegeneration of subcortical structures in Alzheimer's disease is not symmetric across hemispheres [3]. The hippocampus shows a significant increase in asymmetry longitudinally and both hippocampus and amygdala show a significantly higher asymmetry cross-sectionally concurrent with disease severity above and beyond an aging effect. Based on longitudinal asymmetry measures we studied the progression from mild cognitive impairment to dementia, demonstrating that shape asymmetry in hippocampus, amygdala, caudate and cortex is predictive of disease onset. The same analyses based on lateral volume differences did not produce any significant results, indicating that shape asymmetries, potentially induced by morphometric changes in subnuclei, are associated with disease progression and can yield powerful imaging biomarkers for early classification and prediction of Alzheimer's disease. Because research has focused on contralateral volume differences, subcortical disease lateralization may have been overlooked thus far.

References

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