Cortical Gray Matter Segmentation on Ex Vivo T2W Imaging and the Effect of Neurodegenerative Pathologies on Cortical Thinning

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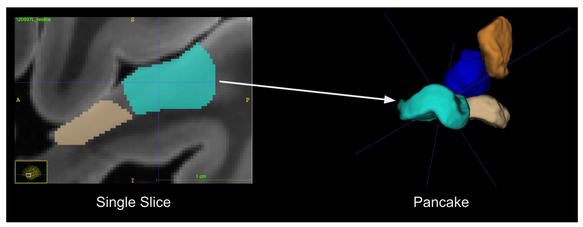
Introduction

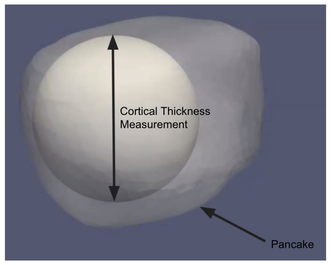
- Alzheimer's disease neuropathological change is classically defined by tau and amyloid inclusions, but other pathologies including TDP-43 and alpha-synuclein may be present.
- Cortical thickness serves as a biomarker of neurodegeneration and relates to disease progression.
- Reduced cortical thickness in different brain regions correlates to different pathologies.
- **The purpose of this study is to determine the cortical thickness of various brain regions and assess whether they correlate with the neuropathology present.**

Methods

- **ITK-SNAP was used to model the cortical thickness of 18 brain regions in 35 subjects.**
- Cortical grey matter was manually segmented in one slice of a post-mortem T2-weighted MRI scan.
- A trained classifier semi-automatically segmented the other slices, with some manual edits necessary.
- A 3D patch of cortex called a "pancake" was produced by stitching together multiple layers of segmented cortex.



- **ParaView was used to calculate the cortical thickness of the brain regions.**
- The fully-segmented "pancakes" were uploaded and a sphere was inscribed in each one.
- The diameter of the sphere was equivalent to the width of the pancake and therefore the cortical thickness of the brain region.



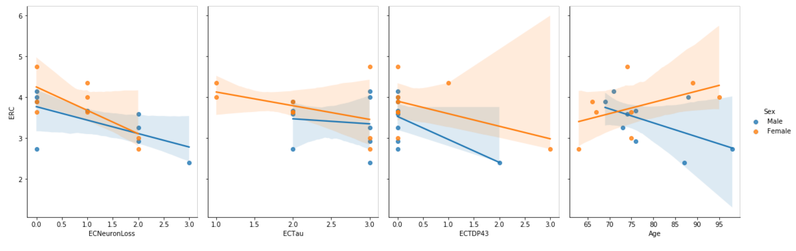
Analysis and Results

- Each pathology was plotted against cortical thickness to determine which pathologies may lead to cortical thinning.
- Evaluated data from 21 subjects with autopsy confirmation of Alzheimer's Disease

The Correlation between Cortical Thickness and Neuropathologies/Age

		Pathologies			
		Tau	TDP-43	Neuron Loss	Age
Cortical Thickness of Brain Regions	Angular Cortex	r = -0.42 p = 0.0602	N/A	r = -0.51 p = 0.0194	r = 0.33 p = 0.1441
	Hippocampal Subregion CA1	r = 0.26 p = 0.3237	r = -0.35 p = 0.1858	r = -0.38 p = 0.1443	r = 0.03 p = 0.9218
	Entorhinal Cortex	r = -0.35 p = 0.1635	r = -0.46 p = 0.0638	r = -0.66 p = -0.0041	r = -0.06 p = 0.8119
	Middle Frontal Cortex	r = -0.26 p = 0.2625	r = 0.06 p = 0.8058	r = -0.23 p = 0.3158	r = -0.10 p = 0.6667
	Visual Cortex	r = -0.15 p = 0.5098	N/A	r = 0.31 p = 0.1702	r = -0.15 p = 0.5035
	Superior Temporal Cortex	r = -0.27 p = 0.2529	r = 0.01 p = 0.9724	r = -0.00 p = 0.9955	r = -0.29 p = 0.2218

Example Graphs:
Pathologies/Age vs. Cortical Thickness in the Entorhinal Cortex



Conclusions

- As neuron loss increases, cortical thickness decreases.
- As the presence of tau and TDP-43 pathologies increase, cortical thickness tends to decrease.
- There does not appear to be a significant correlation between age and cortical thickness.
- Future work will include a larger sample size and statistical analyses that take additional potentially confounding variables into account.
- Future work may also involve using the method described to segment additional brain regions.