Longitudinal Analysis of Brain Degeneration in MCI using a Biomechanical Framework

Wednesday 11:20-11:30 AM | SSK14-06 | Room: N226

PURPOSE

The purpose of this study was to characterize the brain degeneration profiles for subjects with mild cognitive impairment (MCI) under different intensities of exercise intervention. Finite strain theory was applied to analyze not only brain volume changes, but also directional/shear deformations. We hypothesize that there will be directionally different brain degeneration patterns in MCI adults according to the exercise intervention.

METHOD AND MATERIALS

Longitudinal MR images for 35 adults with MCI were acquired as part of a randomized controlled trial investigating an exercise intervention (n=16 aerobic exercise, n=19 stretching control). Brain MRI was acquired at baseline and 6-months later after the exercise intervention on 3T-Siemens Skyra using a high-resolution 20 channel head/neck coil (Siemens Healthcare, Erlangen, Germany). High-resolution structural anatomic T1-weighted images of each subject were collected from which the deformation field during the 6 months period was estimated. Volumetric and directional/shear deformation parameters were derived from the image registration and all parameter maps were warped to standard MNI152_T1 space. Voxel wise statistical analysis was applied to see the effects of the type of exercise intervention.

RESULTS

For both aerobic and stretching exercise groups, volumetric increases were observed in most regions of the gray matter ($p<0.05$ with FDR correction). However, right posterior corona radiata showed volumetric contraction in stretching control. Different volumetric increases were observed between groups around the genu of corpus callosum, right middle temporal gyrus and bilateral superior frontal gyri, showing higher volumetric expansions ($p<0.005$, cluster size threshold=608 voxels). Directional/shear deformation patterns also showed similar patterns with volume changes in most statistically significant brain regions.

CONCLUSION

Aerobic exercise intervention could preserve or possibly even improve brain volumes in MCI subjects compared to stretching control.

CLINICAL RELEVANCE/APPLICATION

The proposed biomechanical metrics appear to be sensitive biomarkers for evaluating interventions in subjects with MCI. These structural biomarkers could be used for classification of MCI and Alzheimer's disease via machine learning algorithms, which could improve the sensitivity and specificity of neurodegenerative disease prognosis and diagnosis.