Semi-Automated Landmark Identification Using Label Maps in an MNI Atlas

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ABSTRACT

The objective of this study is to develop a semi-automated method for acquiring landmark data representing external surfaces and internal divisions of brain structures. Manual landmark identification methods have been previously published to describe the shape and size variations of the brain. However, these methods are limited as they describe large structures of the brain as a whole and do not assure homologous landmarks. The methodology developed is a multiple-step processing of magnetic resonance images (MRI) in a brain atlas. The MRI data was collected for patients ranging from ages 0 to 100 years old. First, the pediatric scans were grouped based on stage of development. Adult scans were grouped by decade from ages 20 to 100. Images within each group were aligned to create a group-specific template. Each template was then normalized to an atlas in Montreal Neurological Institute (MNI) space using a high-dimensional non-linear transformation procedure. Pre-existing label maps in MNI space were applied to segment structures of the brain and establish homologous landmarks. The homologous landmarks were then transformed back to patient specific space for output of each landmark as point cloud data. Each landmark contains metadata representing brain anatomy including lobar, hemisphere, anatomic label, tissue type and Brodmann areas. This novel method of semi-automated landmark identification will allow for the creation of mapping functions to describe age-associated changes of the brain with regard to structure. This work is important, as it may lead to a better understanding of how brain morphology is correlated to the biomechanics and functional outcomes of traumatic brain injury.