Strain fields in histological slices of brain tissue determined by synchrotron radiation-based micro computed tomography

JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

ID 1194017
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Year 2008
Title Strain fields in histological slices of brain tissue determined by synchrotron radiation-based micro computed tomography
Journal Journal of neuroscience methods
Volume 170
Number 1
Pages / **Article-Number** 149-55
Keywords brain tissue, 3D visualization, synchrotron radiation, X-ray absorption, image registration, histological strain
Accurate knowledge of the morphology of the human brain is required for minimally or non-invasive surgical interventions. On the (sub-)cellular level, brain tissue is generally characterized using optical microscopy, which allows extracting morphological features with a wide spectrum of staining procedures. The preparation of the histological slices, however, often leads to artifacts resulting in imperfect morphological data. In addition, the generation of 3D data is time-consuming. Therefore, we propose synchrotron radiation-based micro computed tomography (SRmicroCT) avoiding preparation artifacts and giving rise to the 3D morphology of features such as gray and white matter on the micrometer level. One can differentiate between white and gray matter without any staining procedure because of different X-ray absorption values. At the photon energy of 10keV, the white matter exhibits the absorption of 5.08 cm(-1), whereby the value for the gray matter corresponds to 5.25 cm(-1). The tomography data allow quantifying the local strains in the histological images using registration algorithms. The deformation of histological slices compared to the SRmicroCT in a 2D-2D registration leads to values of up to 6.3%. Mean deformation values for the Nissl-stained slices are determined to about 1%, whereas the myelin-stained slices yield slightly higher values than 2%.
Publisher Elsevier
ISSN/ISBN 0165-0270
edoc-URL http://edoc.unibas.ch/dok/A6004250
Full Text on edoc No;
Digital Object Identifier DOI 10.1016/j.jneumeth.2008.01.011
PubMed ID http://www.ncbi.nlm.nih.gov/pubmed/18313143
ISI-Number WOS:000255697400017
Document type (ISI) Journal Article