Göteborg, 2019

INTRACRANIAL VOLUME IN NEUROIMAGING

Akademisk avhandling

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademin, Göteborgs universitet kommer att offentligen försvaras i Kammaren, Vita stråket 12, den 2019-03-15, klockan 09:00

av Niklas Klasson

Fakultetsopponent:
Joel Kullberg, Docent
Uppsala universitet, Sverige

Avhandlingen baseras på följande delarbeten

I. Klasson Niklas, Olsson Erik, Rudemo Mats, Eckerström Carl, Malmgren Helge, Wallin Anders. Valid and efficient manual estimates of intracranial volume from magnetic resonance images. BMC Medical Imaging. 2015; 15:5.

II. Klasson Niklas, Olsson Erik, Eckerström Carl, Malmgren Helge, Wallin Anders. Delineation of two intracranial areas and the perpendicular intracranial width is sufficient for intracranial volume estimation. Insights into Imaging. 2018;9(1):25-34.

III. Klasson Niklas, Olsson Erik, Eckerström Carl, Malmgren Helge, Wallin Anders. Estimated intracranial volume from FreeSurfer is biased by total brain volume. European Radiology Experimental. 2018; 2:24.

IV. Klasson Niklas, Olsson Erik, Eckerström Carl, Malmgren Helge, Wallin Anders. Statistics of brain estimates normalized by intracranial volume. Manuscript.

SAHLGRENSKA AKADEMIN
INSTITUTIONEN FÖR NEUROVETENSKAP & FYSIOLOGI

GÖTEBORGS UNIVERSITET

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Abstract

The aim of this thesis is to validate methods for estimation of intracranial volume in magnetic resonance images and to improve our understanding of the effect of intracranial volume normalization.

To achieve the first part of the aim, 62 gold standard estimates of intracranial volume were generated by manually segmenting 1.5 T T1-weighted magnetic resonance images. These estimates were then used to validate a more work-efficient manual method that is frequently used in neuroimaging research. We also proposed an even more work-efficient method for situations where only a strong linear association between estimate and gold standard are required (rather than a strong agreement). Finally, we evaluated the validity of a frequently used automatic method for estimation of intracranial volume. To achieve the second part of the aim, we presented mathematical functions that predict the effect of intracranial volume normalization on the mean value and variance of the brain estimates and their Pearson's correlation to intracranial volume.

We found that segmentations of one intracranial area every 10^{th} mm in magnetic resonance images will result in valid estimates of intracranial volume (intraclass correlation with absolute agreement to gold standard estimates >0.998). The segmentation of two intracranial areas and the estimation of the perpendicular intracranial width will result in estimates with strong linear association to gold standard estimates (Pearson's correlation >0.99). It was also shown that FreeSurfer's automatic estimates of intracranial volume risk being biased by total brain volume. Further, the presented mathematical functions closely predicted the effect of intracranial volume normalization on certain statistics of brain estimates, both in a simulation and compared to actual data from other studies. All these findings contribute to an improved intracranial volume estimation and a better use of intracranial volume in regional brain volume normalization.

Keywords: magnetic resonance imaging, intracranial volume, normalization

ISBN: 978-91-7833-304-2 (TRYCK) http://hdl.handle.net/2077/58238
ISBN: 978-91-7833-305-9 (PDF)