Reviewer’s report

Title: Skeleton-based Cerebrovascular Quantitative Analysis

Version: 0 Date: 01 May 2016

Reviewer: Jan Bruse

Reviewer's report:

This is a study describing an automated shape analysis method for characterising the geometry of the Circle of Willis (CoW) using automated segmentation and shape approximation via B-spline skeletonisation. While the motivation for developing a robust, automated method to quantify CoW geometry is well (yet too exhaustively) explained, the paper lacks structuring and clarification of the applied methodology and consequently presents inconclusive results. The concluding statement that the example data "verified the stability" of the method is unclear and is not supported by the data.

The abstract omits the methods section, which makes it more difficult to grasp the purpose of the study. The actual methods section, however, is full of equations referring to known relations such as arc length, curvature or torsion, which have been described previously and which do not represent a novel contribution. In fact, large parts of the work seem to rely on known frameworks such as ITK/VTK or VMTK (The Vascular Modeling Toolkit [1]). This is not an issue in itself, however, the shape analysis pipeline is sold as a novel methodology, without clearly stating the authors' original contributions. Centreline computation and vessel radius and curvature derivation, for instance, can be easily obtained via VMTK.

Very confusing indeed is the fact that until the last paragraph of the Discussion, the Reader does not know how many subjects were actually studied. The authors introduce earlier the open source TubeTK database comprising 108 subjects. Then, one subject (No. 47) is used to describe the analysis pipeline in detail (which is fine). Yet, the Results section is full of geometric data, leaving the Reviewer unsure whether the full 108 subjects were studied - until the Discussion section reveals that all data was obtained from subject No. 47.

The question remains what to do with all that data. The average and variance (one would typically expect the standard deviation or standard error instead of the variance) of radii, curvatures and lengths of certain sections of the CoW do not tell the Reader anything of relevance regarding the "stability" or goodness of the used methods. Furthermore, the Reviewer
is left unsure about the meaning of the included significance tests, i.e. p-values. What was the null hypothesis? What exactly was compared or analysed?

The most severe problem of this paper is that it lacks comparison versus an acknowledged gold standard. The Authors refer to "stability" or "confirmation" of the methods. What really should be investigated though, are validity (i.e. accuracy) and/or reliability (i.e. repeatability) of the methodology. This should already start at the point of segmenting the CoW from medical image data. This certainly being a difficult task, one could imagine a separate study presenting segmentation results of an automated segmentation algorithm compared to a reference segmentation (which presumably would be manual segmentation/labelling performed by experts). Validity should here be assessed by computing Dice scores, for example. Furthermore, results from an automated geometric vessel characterisation should be compared against reference values, which again most likely would be manual measurements taken by (clinical) experts. Ideally, such studies should involve more than one subject and could make use of the TubeTK database, as it is readily available. Once actual validity of the proposed methods has been demonstrated and properly quantified, one could finally think about a study presenting geometric CoW data of a clinically interesting cohort, and - as the Authors suggest - try to establish associations between geometric features and clinical outcome.

The current study however, does not prove the accuracy of the proposed framework nor does it provide clinically relevant insight and is thus not suitable for publication in BMC Medical Imaging.

References


Are the methods appropriate and well described?
If not, please specify what is required in your comments to the authors.

No

Does the work include the necessary controls?
If not, please specify which controls are required in your comments to the authors.

No
Are the conclusions drawn adequately supported by the data shown?
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No

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