**BACKGROUND**

Age-related white-matter changes (ARWMC) are often seen on brain MRI of elderly people and are known to be associated with a number of risk factors. Therefore, their automatic quantification may be of great importance. Data were drawn from 11 European centres participating in The Leukoaraiosis And Disability (LADIS) study. All 639 LADIS subjects (65 – 84 years) were non-disabled and had ARWMC on MRI.

**OBJECTIVE**

The objective of this study was to investigate the robustness of an artificial neural network (ANN) segmentation of ARWMC when compared to a single expert's manual delineation of the ARWMC (MAN).

**METHODS**

For segmentation MP-RAGE, TSE and FLAIR images were used (1.5 T). A supervised fully connected ANN was implemented with a single layer of hidden units and 30 inputs (3 MRI modalities, each with respective 3x3 neighbourhood and 3D spatial information). The output consisted of 4 classes: Gray Matter (GM), White Matter (WM), CSF and ARWMC. Only ARWMC will be discussed here. Before segmentation all data were pre-processed for head motion and intensity variations and strict quality criteria were applied. A total of 369 datasets from 10 centres fulfilled the criteria for inclusion in the study. The ANN was trained using manually delineated training regions from 6 subjects (4 centres). The ARWMC probability threshold was optimised using the Index of Similarity describing the overlap between ANN and manual delineated ARWMC. A threshold of 90% probability was found to be optimal. For further validation of the ANN, ARWMC were manually delineated from the FLAIR images on all subjects and resliced to 1x1x1 mm³.

**REFERENCES**


**RESULTS**

From each of the 10 centres the correlation coefficients between ANN and manually determined ARWMC volumes were generally high (0.67, 0.85, 0.89, 0.77, 0.89, 0.86, 0.63, 0.72, 0.54, 0.62). The mean correlation coefficient of the centres were 0.8. The variation in correlation coefficients was primarily dependent on the volume of ARWMC and not a consequence of getting data from different centres. This can be seen in Fig. 3 where the best correspondence (SI>0.6) was found in subjects rated after the Fazekas score as moderate to severe (mean ARWMC volume = 18.8 ml). The reason in a systematic bias was present in some anatomical regions (e.g., Septum Pellucidum, where ARWMC were not drawn manually) or regarding infarcts. The arrows (Fig. 1 and Fig. 2) indicate such discrepancy between automatic and manual delineation observed in a mild (Fig. 1) and severe case of ARWMC (Fig. 2). Nevertheless in subjects with mild ARWMC high spatial agreement can be observed. Therefore, the sensitivity parameter was less dependent on ARWMC load, indicating that false negatives were not prominent (Fig. 4).

**CONCLUSION**

In this multi-centre investigation of ARWMC segmentation, a high correlation of 0.89 between manual and automatic segmentation was reached. The cause of discrepancies fell into two categories: 1. Higher resolution in ANN than in manual segmentation and 2. Systematic bias in ANN. Improvements may be gained by adding anatomical expert knowledge when training ANN. The results demonstrate the generalisability of ANN methods, and underline the importance of rigorous standardization of MRI quality in multi-centre studies.

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