JULY 12–16
2020 VIRTUAL
JOINT AAPM | COMP MEETING
EASTERN TIME [GMT-4]

Predicting the severity of white matter hyperintensities using structural MRI and machine learning

W. Lu[1], **H. Li**[2], **L. Zheng**[1], **L. Shi**[1], **W. Lu**[1], **J. Qiu**[1]

1Shandong First Medical University & Shandong Academy of Medical Sciences, Taian, Shandong, China

2Shandong University Of Science And Technilogy, Qingdao, Shandong, China

INTRODUCTION

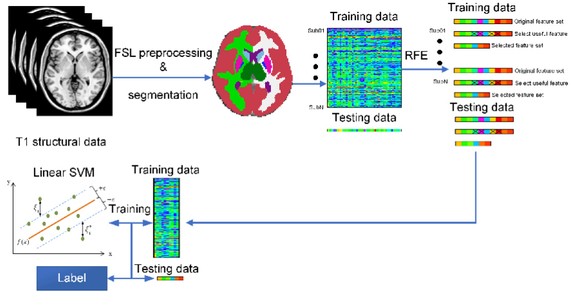
The Fazekas scale is widely used clinically to quantify the severity of white matter hyperintensities (WMHs) by the amount of white matter T2 hyperintense lesions[1]. Although imaging features of WMHs are hyperintense lesions, WMHs have an influence on the entire brain.

AIM

It is supposed that structural measures from routine T1-weight images could predict the severity of WMHs.

METHOD

38 subjects with WMHs were collected and rated on Fazekas scale by an experienced doctor. The enrolled subjects included 10 scale-0 subjects, 17 scale-1 subjects, 6 scale-2 subjects and 5 scale-3 subjects. T1-weighted structural images were obtained from the enrolled subjects. FSL was used for the processing of T1-weighted images. Structural features were extracted from the processed T1-weighted images via Harvard-Oxford atlas[2]. Structural features were normalized to a range from 0 to 1. A quaternary label for Fazekas scale 0-3 was used. Recursive feature elimination was used for feature selection and a linear support vector machine was configured to predict the severity of WMHs via the selected structural features[3]. Leave-one-out-cross-validation was used for performance evaluation with accuracy, sensitivity, specificity and receiver operating characteristics curve as evaluating metrics.



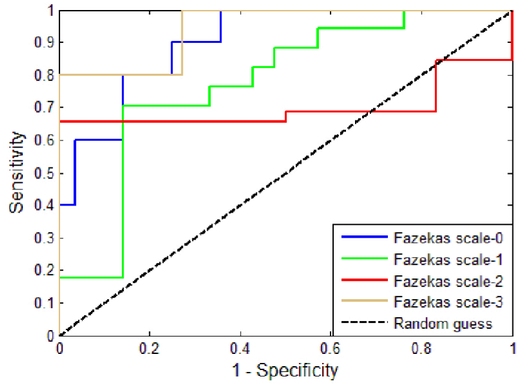
The framework of the study.

RESULTS

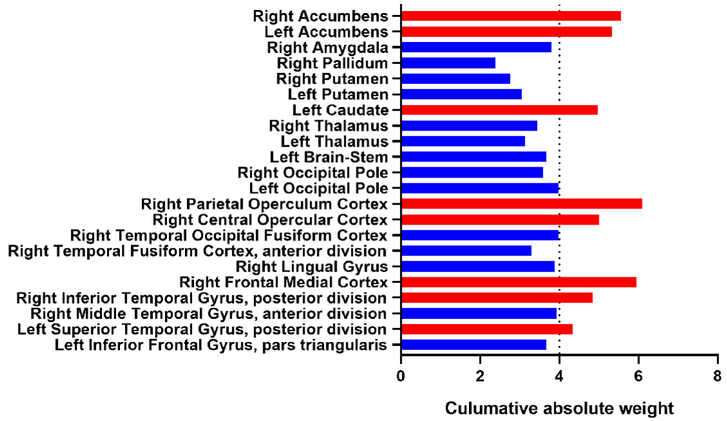
The configured SVM classifier achieved an average accuracy of 86.8421% for the prediction of WMHs severity. The prediction accuracy for Fazekas scale 0-3 subjects were 84.2105%, 79.8474%, 84.2105% and 89.4737%, respectively. The brain regions contributed most to the prediction were the left superior temporal gyrus, right inferior temporal gyrus, right frontal medial cortex, right central opercular cortex, right parietal operculum cortex, left caudate and bilateral accumbens.

Subject type	Accuracy	Sensitivity	Specificity	AUC	p
Fazekas scale-0	84.2105%	0.8000	0.8571	0.9063	< 0.001
Fazekas scale-1	78.9474%	0.7059	0.8571	0.7731	0.001
Fazekas scale-2	84.2105%	1	0.6563	0.6979	0.05
Fazekas scale-3	89.4737%	0.800	1	0.9455	< 0.001

Quantification result for WMHs subjects with different Fazekas scales.



ROC curves of the proposed linear SVM model.



Twenty-two brain regions after feature selection and brain regions contributed most to the prediction (marked in red).

CONCLUSIONS

We consider this study to be innovative because quantification of white matter hyperintensities (WMHs) severity is usually based on lesions in T2 fluid attenuated inversion recovery (FLAIR) MRI images and Fazekas scale. The traditional quantification approach is time-consuming and requires a lot of expertise and experience. In this study, we proposed an automatic quantification method based on routinely structural MRI images and machine learning, which is accurate and efficient. Structural MRI features and machine learning could accurately predict the severity of WMHs. The result also demonstrated that certain brain regions could be used as potential biomarkers for clinical diagnosis of WMHs.

REFERENCES

1 **Wahlund L-O**, **Barkhof F**, **Fazekas F**, **et al**. A New Rating Scale for Age-Related White Matter Changes Applicable to MRI and CT. *Stroke 2001; 32: 1318-1322*.

2 **Desikan R-S**, **Ségonne F**, **Fischl B**, **et al**. An automated labeling system for subdividing the human cerebral cortex on MRI scans into gyral based regions of interest. *Neuroimage 2006; 31: 968-980*.

3 **Chang C-C**, **Lin C-J**. LIBSVM: a library for support vector machines. *ACM T Intel Syst Tec 2011; 2: 27*.

ACKNOWLEDGEMENTS

This work was supported by the Key Research and Development Program of Shandong Province (2017GGX201010), Academic Promotion Programme of Shandong First Medical University (2019QL009), Traditional Chinese Medicine Science and Technology Development Plan of Shandong Province (2019-0359), and Taishan Scholars Program of Shandong Province (TS201712065).

CONTACT INFORMATION

Weizhao Lu

No. 619 Changcheng Road, Taian, Shandong Province, China, 271016

Phone: +8615621521980

E-Mail: mingming9053@163.com