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Is tumor heterogeneity quantified by 3D texture analysis of MRI able to predict non-response to NAC in breast cancer?

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Purpose / Introduction

Recent studies based on texture analysis of breast MRI suggest that pre-NAC texture parameters may constitute biomarkers for predicting tumor response to Neoadjuvant Chemotherapy (NAC).[1,2] However, several methodological questions such as "In which dimension is the texture more informational (2D or 3D)?" remain open. We compute pre-NAC 3D texture parameters in following the assumption that the texture computed from the entire 3D lesion volume should capture the features of the tumor heterogeneity more exhaustively compared to 2D texture parameters from a single slice representative of the lesion and thus improve the identification of future non-responders to NAC.

Subjects and Methods

70 patients with invasive ductal carcinoma who underwent baseline breast MRI were studied. Patients were imaged at 1.5T with a 3D axial T1W-GRE fat-suppressed sequence followed by a dynamic study. Histopathology, immunohistochemistry and BI-RADS classification were performed. Pathological complete response (CR: absence of invasive and in situ cancer in breast and nodes), partial response (PR: decrease of invasive cancer exceeding 30%), and non-response (NR: decrease of invasive cancer lower than 30%) were determined. Lesions were segmented by two experienced radiologists. Intra-lesion texture parameters were calculated from the Grey-Level-Cooccurrence-Matrix (GLCM), Run-Length-Matrix (RLM) and Riesz-Wavelets (RW) after extension of the mathematical formalism of these methods from 2D to 3D. Two predictive models (Logistic Regression/Support Vector Machines) were tested and their performance assessed from ROC analysis and leave-one-patient-out cross-validation.

Results

Using histology, patients were classified as CR=15/PR=36/NR=19. Using SVMs as the classifier, the best predictive model relied on 3 Riesz parameters and 2 GLCM parameters and performed with a predictive accuracy of 87% (Se=63%,Sp=98%). Using LR, the best model for identifying NR patients was based on 4 Riesz parameters and 1 RLM parameter, and performed with a predictive accuracy of 76% (Se=89%,Sp=71%). These models perform better than those based either on 2D texture and LR (Se=74%,Sp=74%,Acc=74%) or on 2D texture associated with a 2D kinetic parameter (wash-in) and *k*-means nearest neighbor as the classifier (Se=84%,Sp=62%,Acc=68%).

Discussion / Conclusion

Texture analysis including Riesz wavelets improved the predictive accuracy compared to analysis based on GLCM/RLM only. In comparison to 2D texture analysis, 3D texture analysis improves the identification of future non-responders to NAC, but only slightly. This limited gain may be due to the manual 3D segmentation of breast lesions which may be difficult (and prone to inaccuracies) due to inflammation. A functional segmentation of the tissue of interest based on a multivariate combination of semi-quantitative DCE parameters may resolve this limitation.[3]

References

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