Spontaneous intracerebral hemorrhage expansion radiomics

Radiomics analysis of spontaneous intracerebral hemorrhages on computed tomography (CT) images has been proven effective in predicting hematoma expansion and poor neurologic outcomes. In contrast, there is limited evidence on its predictive abilities for traumatic intracerebral hemorrhage (IPH).

A retrospective analysis of 107 traumatic intracerebral hemorrhage patients was conducted. Among them, 45 patients (42.1%) showed hemorrhagic progression of contusion (HPC) and 51 patients (47.7%) had a poor neurological outcome. The traumatic intracerebral hemorrhage on the initial CT was manually segmented for radiomics analysis. After feature extraction, selection and repeatability evaluation, several machine learning algorithms were used to derive radiomics scores (R-scores) for the prediction of HPC and poor neurologic outcome.

The AUCs for R-scores alone to predict HPC and poor neurologic outcome were 0.76 and 0.81, respectively. Clinical parameters were used to build comparison models. For HPC prediction, variables including age, multiple IPH, subdural hemorrhage, Injury Severity Score (ISS), international normalized ratio (INR) and IPH volume taken together yielded an AUC of 0.74, which was significantly ($p = 0.022$) increased to 0.83 after incorporation of the R-score in a combined model. For poor neurologic outcome prediction, clinical variables of age, Glasgow Coma Scale, ISS, INR and IPH volume showed high predictability with an AUC of 0.92, and further incorporation of the R-score did not improve the AUC. (4) Conclusion: The results suggest that radiomics analysis of IPH lesions on initial CT images has the potential to predict HPC and poor neurologic outcome in traumatic IPH patients. The clinical and R-score combined model further improves the performance of HPC prediction [1].

An open-source python package was utilized for the extraction of radiomic features from both non-contrast computed tomography (NCCT) and magnetic resonance imaging (MRI) scans through characterization algorithms. A total of 99 radiomic features were extracted and different features were selected for network inputs for the NCCT and MR models. Seven supervised classifiers: Support Vector Machine, Naïve Bayes, Decision Tree, Random Forest, Logistic Regression, K-Nearest Neighbor and Multilayer Perceptron were used to build the models. A training: testing split of 80:20 and 20 iterations of Monte Carlo cross-validation were performed to prevent overfitting and assess the variability of the networks, respectively. The models were fed training datasets from which they learned to classify the data based on pre-determined radiomic categories.

The highest sensitivity among the NCCT classifier models was seen with the support vector machine (SVM) and logistic regression (LR) of 72 ± 0.3% and 73 ± 0.5%, respectively. The MRI classifier models had the highest sensitivity of 68 ± 0.5% and 72 ± 0.5% for the SVM and LR models, respectively.

This study indicates that the NCCT radiomics model is a better predictor of HE and that SVM and LR classifiers are better predictors of HE due to their more cautious approach indicated by a higher sensitivity metric [2].

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[1]

Shih YJ, Liu YL, Chen JH, Ho CH, Yang CC, Chen TY, Wu TC, Ko CC, Zhou JT, Zhang Y, Su MY. Prediction of Intraparenchymal Hemorrhage Progression and Neurologic Outcome in Traumatic Brain Injury Patients Using Radiomics Score and Clinical Parameters. Diagnostics (Basel). 2022 Jul 10;12(7):1677. doi: 10.3390/diagnostics12071677. PMID: 35885581; PMCID: PMC9320220.

2)

Seymour SE, Rava RA, Swetz DJ, Monteiro A, Baig A, Schultz K, Snyder KV, Waqas M, Davies JM, Levy EI, Siddiqui AH, Ionita CN. Predicting Hematoma Expansion after Spontaneous Intracranial Hemorrhage Through a Radiomics Based Model. Proc SPIE Int Soc Opt Eng. 2022 Feb-Mar;12033:120332X. doi: 10.1117/12.2611847. Epub 2022 Apr 4. PMID: 35990197; PMCID: PMC9390077.