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Editorial

Radiomics in Oncology

Houman Sotoudeh*

Assistant Professor of Radiology and Neurology, University of Alabama at Birmingham (UAB), USA

***Corresponding Author:** Houman Sotoudeh, Assistant Professor of Radiology and Neurology, University of Alabama at Birmingham (UAB), USA.

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Radiology is the backbone of cancer diagnosis and management. Traditionally the radiologic diagnosis is made by human and visual evaluation of the images, but this approach has some limitations. Usually, the human radiologist uses a few features (e.g. the size of lesion, density, sharpness of the lesion, and the enhancement after contrast injection). However, the medical images contain much more information that is not visible by the naked human eyes. In this context, Radiomics has great momentum in the oncologic imaging field. In Radiomics, medical images are analyzed by the software, and hundreds and thousands of different features are extracted from the medical images and lesions. These features are mainly calculated by a mathematical formula from the variation of the pixels' intensities and densities. The main features in the Radiomics include the first-order features, the shape features, and the texture features. After feature extraction, the most important features are selected by a mechanism called "feature selection" or "dimensionality reduction." The selected features are then used by different artificial intelligence and machine learning models to make different predictions. The Radiomics approach can add mulch to the human radiologist diagnosis; it can predict the tumor grade, the histopathology of the neoplasm, gene mutation and molecular fingerprints of the neoplasm, treatment response, recurrence, and the probability of the complication and overall survival rate. Such extensive information provided by Radiomics is not available by traditional radiology diagnosis.

Despite the facts mentioned above regarding the exciting ability of Radiomics, this technique is still in the research phase. It is not a part of a standard of care in oncology management. Some challenges in Radiomics must be resolved before integrating this technique into daily practice. The main challenges of the Radiomics can be summarized as below:

- **Retrospective studies**: So far, almost all of the published research regarding Radiomics is retrospective in design. Such respective studies are susceptible to selection bias and controversial results.
- **Small data-sets**: The machine learning and artificial intelligence models are data-hungry platforms, and to train them with acceptable performance, hundreds and thousands of cases and images are needed. However, most of the published research regarding the Radiomics have been done on relatively small-sized data-sets.
- **Public data-sets**: In the Radiomics approach, it is very common to use public data-sets to train and test the models. Such data-sets are usually old, and their images have been obtained using relatively old and out-of-use scanners. Such studies based on the old public data-sets cannot be generalized to the modern scanners and current medical practice.
- **Class imbalance**: The class imbalance is a common challenge in artificial medical intelligence using medical data sets. In medical data sets, it is very common that the number of cases with normal scans or benign neoplasm is more than the patients with malignancy. Also, such phenomena can be seen between different grades of a single neoplasm. For example, a glioma data-set usually contains more grade IV (GBM) cases than grade I glioma. The developed Radiomics model based on such a data-set will suffer from overfitting. Overfitting is one of the main concepts of artificial intelligence. That means the developed model works perfectly on

the train data set; however, the model's performance will be abysmal in the real world.

- **Overestimation of the Radiomics performance**: It is very common to measure the Radiomics performance using the cross-validation technique. This technique is not optimum to estimate the performance and may overestimate it.
- **Lack of external data set**: The best technique to evaluate the performance of Radiomics is testing the model on a new data-set from another medical institute called an external data-set. There are very few published studies using the external data set in the field of Radiomics.
- **Rapid evolution of the oncology classification**: The criteria for grading and staging neoplasms are under constant evolution. Every year, new criteria are released by the responsible organization such as WHO. This continually changing criteria will challenge the new Radiomics model's development based on the old data sets.
- **Heterogeneity of Radiomics pipeline**: At this time, there is no universal agreement about the software used for feature extraction, feature selection, and machine learning. Different studies use different software, different numbers of extracted features, and various artificial intelligence pipelines. Search heterogeneity of the Radiomics approaches is a significant barrier against using the Radiomics in daily practice.

In conclusion, Radiomics is a promising technique in oncology imaging that can provide the referring physician with much more information than the traditional radiologic approach. However, many challenges must be solved before integrating Radiomics into daily clinical practice.