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EDITORIAL

Radiomics and Deep Learning in Clinical Imaging: What Should We Do?

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During the past several years, radiomics and deep learning (DL) became hot issues in medical imaging field, especially in cancer imaging. Radiomics is an emerging field of medical imaging that uses a series of qualitative and quantitative analyses of high-throughput image features to obtain diagnostic, predictive, or prognostic information from medical images. Recently, radiomics methods have been used to analyze various medical images including CT, MR, and PET to provide information regarding diagnosis, patients' outcome, tumor phenotypes, and the gene-protein signatures in various diseases including cancer. Texture analysis is one of representative methods in radiomics. Machine learning (ML), a subset of artificial intelligence (AI), is a series of methods that automatically detect patterns in data, and utilize the detected patterns to predict future data or to make a decision making under uncertain conditions. DL is a kind of ML, which originated from artificial neural network in 1950. After resolving several critical limitations, deep learning has been applied in medical field since the 2000s. The most representative characteristic of ML and DL is that it is driven by data itself, and the decision process is finished with minimal interaction with a human. The ML and DL program can learn by analyzing training data, and make a prediction when new data is put in. DL is suitable to draw useful knowledge from medical big imaging data. This new AI technology in medical imaging has a potential to perform automatic lesion detection for differential diagnoses and, also, to provide other useful information including therapy response and prognostication. In these aspects, both radiomics and DL are closely related to each other in medical imaging field. For example, the radiomics data can be easily analyzed and clinically applied by the DL method, which facilitate precision medicine. Figure 1 shows the recent dramatic increased publications regarding radiomics and DL in the imaging fields.

This and next issues of our journal deal with several review articles related to the radiomics and DL in clinical imaging, mainly focusing on cancer imaging. These may be helpful to understand the concept and current status of radiomics and DL in clinical imaging. Due to the recent progress of DL, there is a belief that nuclear medicine physician or radiologist will be replaced by the AI. For instance, the number of applicants for residency in nuclear medicine or radiology was much decreased last year in Korea. Although it is difficult to predict the future medical situation, it may be inevitable that simple diagnostic tasks are replaced by the AI system. That means that the role of nuclear medicine physician and radiologist will be changed, and the understanding and dealing with the DL and AI may be become essential for the nuclear medicine physician and radiologist in the future. For example, as several experts expected, the key role of nuclear medicine physician may become the integration and translation of clinical and imaging biomarkers automatically derived from imaging data by the radiomics and DL methods, and its application to clinical decision making.

In these aspects, what should we do? First, the most important thing is the persistent interest in the radiomics and DL of our society focusing on the research and education. We, ourselves, should be an expert in the radiomics and DL of molecular imaging. We should do the active role

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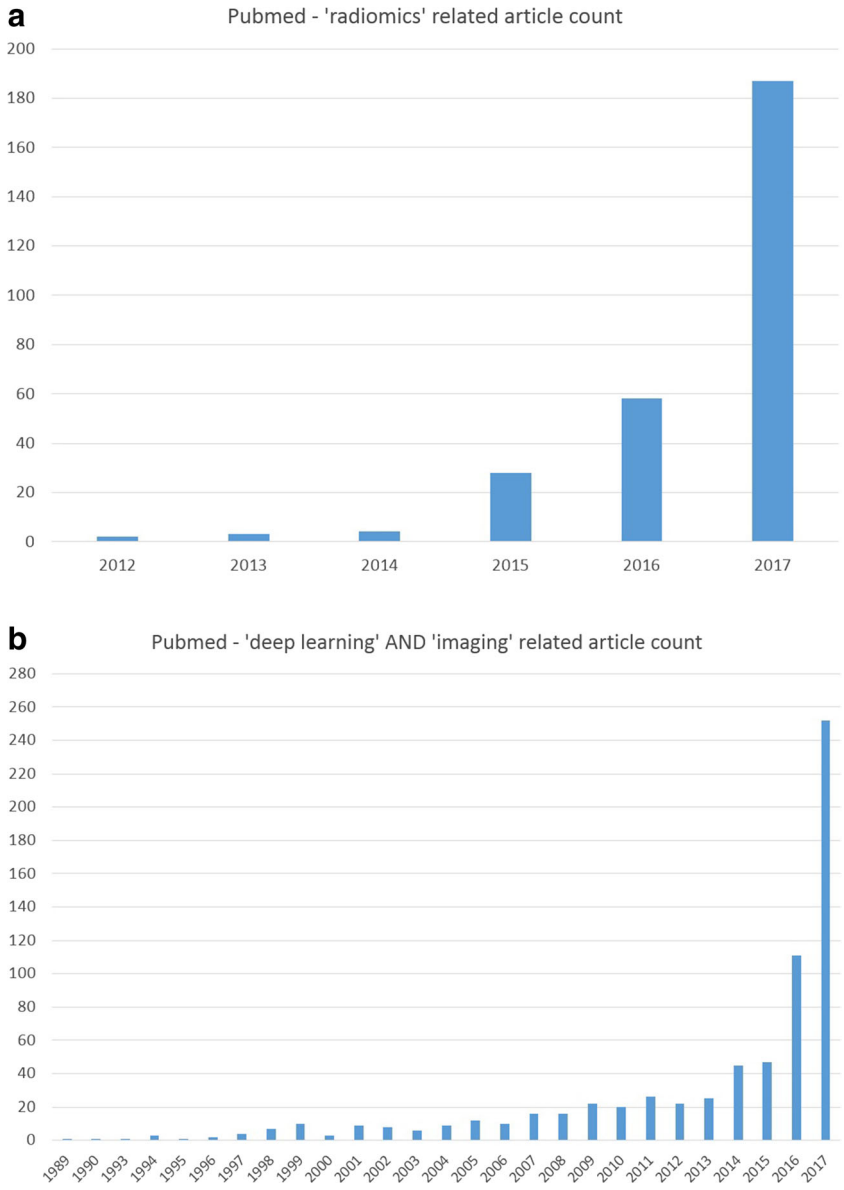

Fig. 1 **a** The graph showing the number of published articles regarding the radiomics in the Pubmed database according to the published year. **b** The graph showing the number of published articles regarding the deep learning of imaging in the Pubmed database according to the published year

for the proper clinical adoption of them. Second, the radiomics and DL should be included in the nuclear medicine residency training program. In the near future, a nuclear medicine physician who cannot do the AI and DL may not survive. Finally, we should have an interest and actively participate in the changes in the laws and healthcare system related to the AI and DL in the medical field. We can contribute to solve the ethical, regulatory, and legal issues raised in the development and clinical application of AI. Also, we should find an appropriate role of nuclear medicine physician in the era of AI.

Compliance with Ethical Standards

Conflict of Interest Joon Young Choi declares no conflict of interest.

Ethical Statement This article does not contain any studies with human participants or animals performed by the author.