Role of Artificial Intelligence in Imaging: From A Radiologist's Point of View with A Focus on Breast Imaging

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Artificial Intelligence (AI) is the famous topic nowadays in all of the science fields. Medical imaging is the most rising area for health innovations of AI. Only 10 years ago, the total number of publications on AI in radiology just exceeded 100 per year. But today, publications about AI in radiology have increased to 700-800 per year.

As has been discussed in the previous chapter AI has started to have a prominent role in cardiac imaging modalities such as cardiac CT,cardiac MRI,SPECT and echocardiography.However when compared to cardiac imaging it has come a long way in radiological imaging modalities especially for breast imaging done for breast cancer which is the leading cause of cancer death in women worldwide (1).

Currently screening programs for breast cancer are mainly performed with mammography which has a low sensitivity for dense breast and which is overcome by Tomosynthesis (3D mammography) and breast MRI (2). However the imaging information obtained in a breast MRI study and tomosynthesis has a high dimensional and multiparametric nature, which makes reading of these images a difficult and time consuming task. To increase reading efficiency and accuracy of the radiologists, several automated tools, based on computer vision and machine learning techniques, are being developed.

In radiology images are data not just pictures. Since 2012, we have been witnessing rapid and revolutionary changes in the fields of machine learning, computer vision and consequently, medical image analysis with the advent of the algorithms named as 'deep learning'. These fields changed literally overnight when the 2012 ILSVRC ImageNet challenge was won by a Deep Convolutional Networks algorithm (3). Deep learning methods have been improved further with explosively increasing number of studies since 2012, being the method of choice in automated image analysis. The success of deep learning with convolutional neural networks (CNNs) for images in nonmedical fields has increased hopes and research towards the analysis of medical images. Although neural networks have been used for decades, in recent years three key factors have enabled the training of large neural networks: (a) the availability of large quantities of labeled data, (b) inexpensive and powerful parallel computing hardware, and (c) improvements in training techniques and architectures.

Deep learning has the benefit that it does not require image feature identification and calculation as a first step; rather, features are identified as part of the learning process.

The first CAD (Computer Aided Detection) systems were developed in early 1990s for breast cancer detection in mammography. In 1998 FDA approved mammography CAD system for breast cancer detection. And in 2002 reimbrusement for mammography CAD has begun.

The first CAD systems are supervised machine learning systems with a higher sensitivity. Due to medico legal situations they are widely used in USA but less frequent in the rest of the world.

Computer-aided detection and diagnosis (CAD) systems were introduced as an aid for radiologists trying to improve radiologist detection and diagnosis performance. It is important to minimize misses and interpretation errors of visible lesions at digital mammography, which contribute to at least 25% of detectable cancers being missed (4). However the benefit of using CAD in breast cancer screening is still unclear. Most evidence shows no clear improvement in the cost-effectiveness of screening, mainly because of the low specificity of most traditional CAD systems (5). They prompt marks on mammograms.

As mentioned before, substantial improvements in artificial intelligence (AI) with deep convolutional neural networks are reducing the difference in performance between humans

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and computers in many medical imaging applications, including breast cancer detection (6). Therefore, this new generation of deep learning–based CAD systems may finally allow for an improvement in the performance of breast cancer screening programs (7). Apart from the evolution of AI algorithms, the aid that the AI system provides can also help improve screening. Studies have shown that using CAD concurrently as a decision support tool helps radiologists more than does the traditional approach (8). Breast radiologists had a higher diagnostic performance with support from an AI system compared with reading unaided. The average reading times per case were similar under both conditions (9).

Although AI algorithms are reaching a performance similar to that of radiologists for breast cancer detection in mammography they carry certain limitations. Such as CAD systems can not compare old and news images (temporal comparison), and they can not compare right and left images (symmetry comparison). However in the near future with the development of deep learning algorithms and hardware AI will overcome these obstacles. And AI base CAD systems will become even better decision support systems.

In terms of performance of the computer-aided diagnosis systems in breast MRI the use of computer-aided diagnosis (CAD) systems may improve diagnostic accuracy by decreasing inter-observer variations, providing support for clinical decisions and reducing the number of false-positive biopsies (10). It is shown that, classification of benign and malignant breast lesions imaged with a multi-parametric ultrafast DCE-MRI protocol using AI techniques is at least as accurate as dedicated breast radiologists (11).

As a final word we have to mention that AI will surely impact radiology and more quickly than other medical fields. It will change radiology practice more than anything since Roentgen. Unprecedented success of deep learning in image recognition revived the optimism in automating image interpretation tasks at the performance level of humans. Only in the last few years have we seen applications in various domains that reach or even surpass human performance at certain image recognition tasks, such as breast imaging which is why we focused on it in this text (11, 12). Consequently, there have been discussions about the feasibility of replacing human labor with deep learning based artificial intelligence (AI) in various fields including radiology. However, in order to avoid far-fetched expectations, it is important to understand the limitations of these AI systems. Machine learning systems, including deep learning, are specialized in solving isolated tasks, while human intelligence is able to develop understanding of various concepts and is able to combine vast amount of information from different levels and domains for performing tasks.

It is important to note that AI will never replace radiologists but radiologists knowing how to handle AI will certainly be one step front.

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