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A Meaningful Journey to Predict Fractures with Deep Learning

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Osteoporotic fractures worsen patients' quality of life and increase the mortality rate [1]. The mortality rate within the first 12 months after a hip fracture in Koreans aged 50 years or older was 14.0% for women and 21.0% for men [2]. Osteoporosis is an inevitable consequence of aging, but fracture prediction is the starting point to preventing fractures; therefore, accurate fracture prediction is more important than ever. Although lower bone mineral density (BMD) increases the risk of fracture, fractures also occur in patients with less marked reduced bone mass. In Korea, the 10-year cumulative incidence of fragility fractures was 31.1% and 37.5% in postmenopausal women with normal BMD and osteopenia, respectively, whereas it was 44.3% in women with osteoporosis [3]. Therefore, BMD measurements and bone quality should be reflected in evaluations of bone strength.

Efforts are being made to evaluate bone quality by analyzing the microstructure of bone using advanced diagnostic tools such as high-resolution peripheral quantitative computed tomography. Additionally, several devices have been available to assess bone quality, such as magnetic resonance imaging, quantitative ultrasound, or high-frequency ultrasound multispectroscopy, but none provide complete information on bone quality. Furthermore, higher costs and space constraints for the equipment limit the easy accessibility of those methods for evaluating fractures. The trabecular bone score (TBS) is an indirect indicator of bone microarchitecture. It evaluates bone quality based on the information obtained by lumbar dual-energy X-ray absorptiometry (DXA) images [4]. Since it is a method of analyzing lumbar spine texture based on DXA, a disadvantage of this method is that analysis is possible only when a DXA image is available.

More than 13 web-based fracture risk calculators have been used to estimate the absolute risk of osteoporotic fracture [5]. The Fracture Risk Assessment Tool (FRAX) is a country-specific calculator that integrates several clinical risk factors for fractures and can be used with or without BMD [6]. The FRAX score is a basis for initiating osteoporosis treatment or selecting anti-osteoporotic medication in many countries [7]. Although the FRAX score provides information on fracture risk, it does not reflect all ethnicities, so large-scale validation for Koreans is still required.

It is difficult for patients to recognize the need for osteoporosis examinations because osteoporotic fractures do not have symptoms until the fracture occurs. Therefore, it is necessary to increase the accessibility of examinations for patients by choosing the most straightforward method to evaluate the bone mass and predict the risk of fractures. It should be simple, inexpensive, and non-invasive. X-ray examinations are an easily accessible imaging modality with little radiation exposure. Techniques for obtaining additional information from simple X-ray imaging using machine learning have recently been introduced in Korea [8,9]. These studies used deep

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learning algorithms to detect fractures rather than predict fractures. Kim et al. [9] used data from 339 lateral thoracic and lumbar vertebra images to train and test a deep learning model for better measurements of the vertebral compression ratio. Seo et al. [10] proposed an algorithm that aids in the diagnosis of vertebral compression fractures. Some studies have reported models for predicting fractures using image data. Previously, the present authors (Kong et al. [11]) validated a fragility fracture prediction model using another machine learning model, CatBoost, based on the information obtained during DXA measurement. Authors with experience in these analyses have reported a vertebral fracture prediction model through machine learning using spine radiographs. The present study reports a fracture prediction model based on X-ray images, which is the greatest strength of this study. As reported in the current issue, Kong et al. [12] aimed to develop a spine radiography-based fracture prediction model using deep learning with longitudinal data. In this study, based on lumbosacral radiographs of 1,595 patients aged 50 to 75 years, the authors found that a convolutional neural network-based prediction algorithm (DeepSurv) performed better than the FRAX score and the Cox proportional hazard model in predicting osteoporotic fractures. According to their work, measurements based on spine X-rays show performance comparable to the existing fracture calculator. This is, therefore, the most cost-effective and easily accessible fracture evaluation method.

Various methods have been introduced to evaluate bone quality and calculate fracture risk. Still, each examination has advantages and disadvantages, so relying only on one approach is challenging. The same will be valid for analyses using artificial intelligence (AI). For AI-based models to be validated in clinical practice, thorough verification is required over an extended period. As mentioned by the authors, the limitation of the relatively small sample size can be overcome through analyses of more patients in the future. This study will be a new milestone in the arduous journey of predicting osteoporotic fractures in a simple but accurate way if thorough verification is done. Until more validation is performed, this technique should be used as a complement to existing evaluation methods. It is necessary to identify the most effective combination for predicting fractures in harmony with the existing methods of DXA, TBS, and FRAX, and the direction of these developments should be beneficial to the patient. Congratulations to the authors for the excellent research.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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