# Osteoporosis Risk Assessment on Dental Panoramic Radiographs Using Convolution-based and Metaformer-based Networks

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***Abstract*— Eroded mandibular cortical bone on dental panoramic radiographs can suggests patients at risk of osteoporosis. Our purpose of this study is to investigate deep learning models to classify panoramic images with normal, moderate, and high risk of osteoporosis so that suspected patients can be found early to reduce risk of bone fractures. The proposed method that combines CNN and metaformer-based model achieved performance comparable to junior dentists.**

## I. Introduction

Osteoporosis is regarded as a major public health problem in the aging society. It is estimated that 500 million men and women are affected by the disease worldwide causing more than 8.9 million fractures annually [1]. Early detection and treatment can help reduce the number of severe morbidities. However, the disease can progress asymptomatically leading to bone weakness and elevating susceptibility to fractures.

Studies have reported an association between the mandibular cortical bone condition and osteoporotic risk [2]. Klemetti et al. suggested mandibular cortical index (MCI) which classifies the degree of cortical erosion to three grades [3]. We have previously proposed machine-learning and rule-based methods to quantify the mandibular cortical bone width and condition on panoramic radiographs for osteoporotic risk assessment [4]. In this study, we investigated a new method combining a convolutional-based network and a metaformer-based network [5] for classifying MCI.

## II. Methods

Our dataset consists of 892 dental panoramic radiographs obtained at 10 facilities, including one university hospital and 9 dental clinics. The number of images in Class 1, 2, and 3 of MCI are 600, 176, and 116, respectively, corresponding to non-osteoporotic, osteopenic, and osteoporotic bone. The classes were determined subjectively by an expert dental radiologist. Other two junior dentists also provided the classes for examining interreader agreement.

As preprocessing, images were first resized to have 3000 pixels in width without changing the aspect ratio. The bottom center region of the images, 300 x 1500 pixels in size, were cropped so that mandibular cortical bone around mental foreman is included and unwanted regions were excluded. Finally, center part in 300 x 500 pixels was cut out to exclude vertebral region.

Because of the limited number of data, training and testing was performed by 4-fold cross validation with stratified sampling. For reducing the effect of data imbalance, left and right regions were randomly mixed within the class to synthetically oversample classes 2 and 3 images as shown in Fig.1.

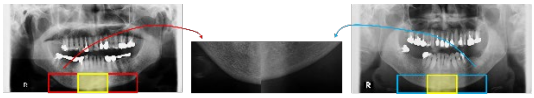

Figure 1. Cropping and mixing regions of interest

There are several models combining convolution-based and transformer-based networks, such as ConVit and CAFormer. In this study, we combined two models, ResNet50 and poolformer, by concatenating the layers before the last full connection (FC) layers and added a FC layer for output.

## III. Result and Conclusion

The proposed model obtained the accuracy and F1-score of 0.828 and 0.758, respectively, which is comparable or slightly higher than the individual models, 0.814 and 0.730 for CNN and 0.820 and 0.756 for poolformer, respectively, and slightly better than agreement between the expert and junior dentists (0.78 and 0.76). The proposed method has a potential in early detection of osteoporosis.

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