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Assessment of deep convolutional neural network models for mandibular fracture detection in panoramic radiographs

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Abstract

The aim of this study was to develop automated models for the identification and detection of mandibular fractures in panoramic radiographs using convolutional neural network (CNN) algorithms. A total of 1710 panoramic radiograph images from the years 2016 to 2020, including 855 images containing mandibular fractures, were obtained retrospectively from the regional trauma centre. CNN-based classification models, DenseNet-169 and ResNet-50, were fabricated to identify fractures in the radiographic images. The CNN-based object detection models Faster R-CNN and YOLOv5 were trained to automate the placement of the bounding boxes to detect fractures in the radiographic images. The performance of the models was evaluated on a hold-out test set and also by comparison with residents in oral and maxillofacial surgery and oral and maxillofacial surgeons (experts) on a 100-image subset. The binary classification performance of the models achieved promising results with an area under the receiver operating characteristics curve (AUC), sensitivity, and specificity of 100%. The detection performance of the models achieved an AUC of approximately 90%. When compared with the accuracy of clinician observers, the identification performance of the models outperformed even an expert-level classification. In conclusion, CNN-based models identified mandibular fractures above expert-level performance. It is expected that these models will be used as an aid to improve clinician performance, with aided resident performance approximating that of expert level.

Section snippets

Dataset acquisition

A radiology report database was queried retrospectively to obtain panoramic radiographs of patients aged ≥18 years treated in the oral and maxillofacial clinic of a regional trauma centre between 2016 and 2020. A total of 1710 radiographic images were retrieved. These were divided into 855 images containing mandibular fractures (1423 fracture sites across six anatomical regions of the mandible, as shown in Table 1) and 855 images without fractures. The panoramic radiographs containing a…

Performance of the binary classification models

The binary classification performance of the models for the presence of a fracture when evaluated on the overall hold-out test set is reported in Table 2. The image classification of DenseNet-169 achieved a precision of 100%, recall of 100%, F1 score of 100%, sensitivity of 100%, and specificity of 100%. The image classification of ResNet-50 achieved a precision of 99%, recall of 100%, F1 score of 100%, sensitivity of 100%, and specificity of 99%. In addition, the binary classification ROC…

Discussion

Misdiagnosis is the primary cause of malpractice. There are multiple factors that can contribute to radiographic misinterpretation of fractures by clinicians, including clinician fatigue, lack of specialized expertise, and inconsistency among reading clinicians.6, 7 Misinterpretation of mandibular fractures in radiographs may have grave consequences, resulting in complications including infection, non-union, or malunion, which may lead to problems with masticatory functions and facial…

Funding

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Ethical approval

Approval was obtained from Thammasat University Research Ethics Committee (COA 114/2564).…

Patient consent

Not required.…

Competing interests

None.…

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