Deep radiomics-based approach for the diagnosis of osteoporosis using hip radiographs

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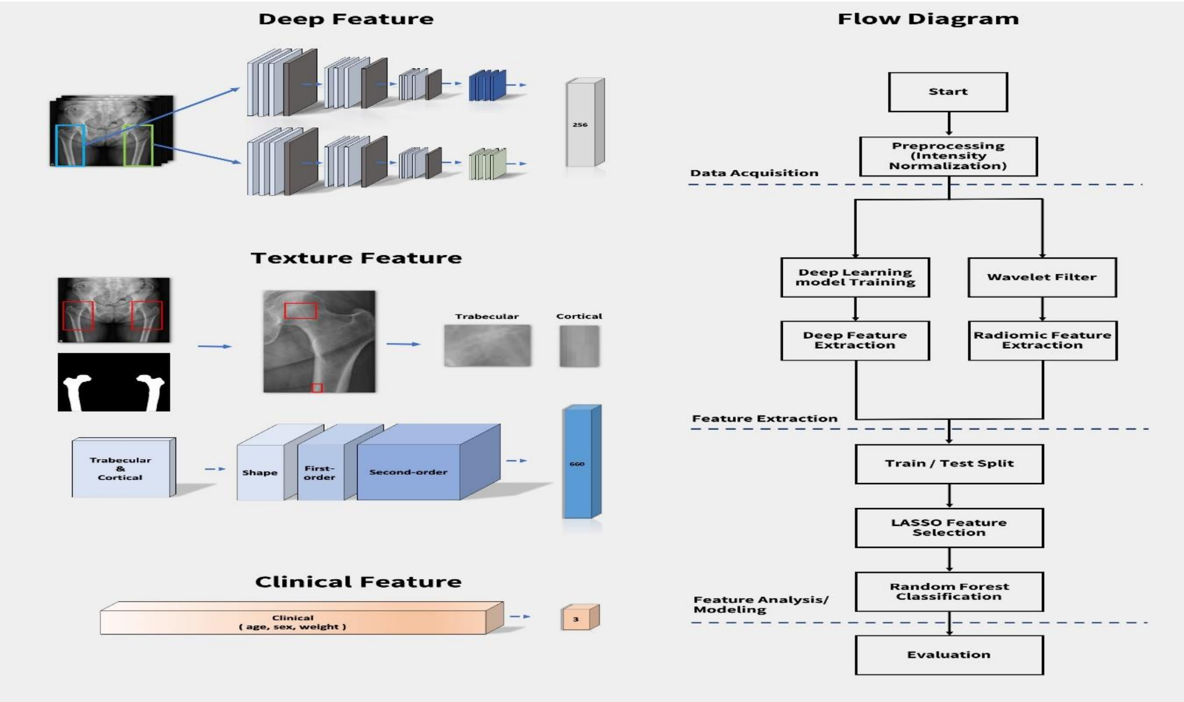
Background

Deep learning and radiomics techniques using pre-existing imaging recently garnered much attention for osteoporosis diagnosis and osteoporosis related fracture prediction. Although it is suggested that the deep learning approach is useful to recognize images, micro-architectural change of trabecular bone according to the BMD can be better represented by texture feature. Our purpose is to develop and assess the performance of a deep-radiomics model for diagnosing osteoporosis using hip radiographs.

Method and materials

A total of 4924 hip radiographs (normal 4306, osteoporosis 618) of 4308 patients between 2009 and 2020 were used for the training and validation dataset. Temporally-separated internal test set was comprised of 497 hip radiographs (normal and osteopenia 452, osteoporosis 45) between 2008 and 2009. For the spatially independent external test set, 444 hip radiographs (normal and osteopenia 452, osteoporosis 111) were collected between 2019 and 2020 from the other institution. After femur segmentation using U-net, radiomics features were extracted by automatically placing the bounding box in the trabecular bone of the femur neck and medial femoral cortex. We proposed a model with CNN architectures and Siamese network by utilizing both sides of proximal femur. Three clinical (age, sex, and weight), 256 deep features, and 660

radiomics features were used to train deep learning model. The lowest T-score of hip DXA were used as a reference standard. Two radiologists assessed the possibility of osteoporosis using a 5-point scale and the performance of the radiologists was compared with the deep radiomics-model for the external validation set. Receiver operating characteristic curves was used to assess diagnostic performance.



Results

For the internal test set, deep-radiomics model using deep feature with clinical data (AUC 0.938) had superior diagnostic performance to other models (AUC 0.784 for clinical data only model, 0.852 for texture data only model, 0.933 for deep feature only model and 0.932 for deep feature with texture and clinical data model, respectively). While for the external validation dataset, the deep feature with texture and clinical data model (AUC 0.916) showed superior diagnostic performance to other models (AUC 0.832, 0.808, 0.878 and 0.903, respectively). The performance of the deep radiomics-model was significantly higher than the two board-certified radiologists (AUC 0.749 and 0.700) for the external test set.

Conclusion

A deep radiomics-model for the diagnosis of osteoporosis using hip radiographs showed higher diagnostic accuracy to those of the radiologists and can help in the automatic screening of osteoporosis in plain radiographs. A deep radiomics method can be used to improve the early screening of elderly patients, which can aid in the patient-specific treatment of osteoporosis patients.

Reference

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