The feasibility of using radiomics to detect T-Spine lytic bone metastases in simulation-CT images

H. NASERI[1,2], **J. KILDEA**[1,2]
1 Medical Physics Unit, McGill University Health Center, Montreal, QC, Canada
2 Physics Department, McGill University, Montreal, QC, Canada

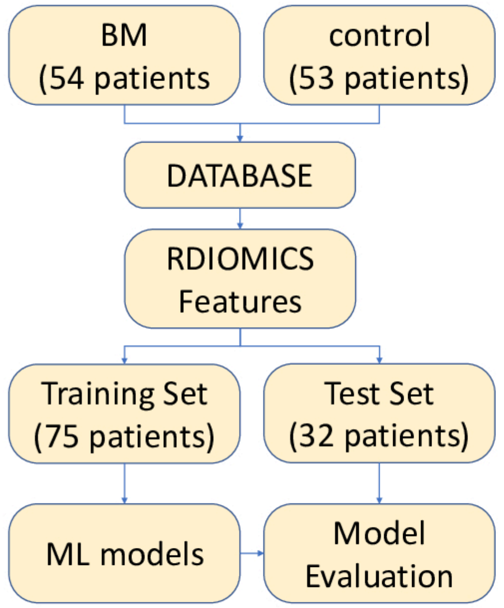
INTRODUCTION

- Bone is one of the most common sites for cancer to spread (metastasis) [1].
- Early diagnosis and treatment of bone metastases (BM) improves the quality of life of cancer patients and improves treatment outcomes [2].
- Radiotherapy treatment planning for bone metastases is often based solely on a patient's simulation-CT scan without recourse to diagnostic CT or PET images.
- Accurate detection of metastases regions is difficult when using the simulation-CT alone.

AIM

The aim of this project was to develop a radiomics-based machine learning (ML) technique to detect lytic bone lesions in simulation-CT images alone.

METHOD



- The simulation-CT-dataset comprised 54 patients with lytic T-spine metastases and 53 control patients with non-metastatic lung cancer.
- The training set is comprised of 75 patients (38 controls and 37 metastatic) and the remaining 32 were reserved to validate the accuracy, sensitivity, and specificity of method.
- The location of either metastases or healthy bones were identified with the help of a collaborating radiation oncologist (Fig. 1).
- Regions of interest (ROIs) with various geometric shapes (spherical, cubic and cylindrical-along-z-axis volumes) were delineated on the images
- 104 radiomics features were extracted from each ROI using pyradiomics [3].
- These radiomic features were used to train and test several ML classifiers including Support Vector Machines (SVM), Random Forest (RF) and Neural Network (NN).

RESULTS

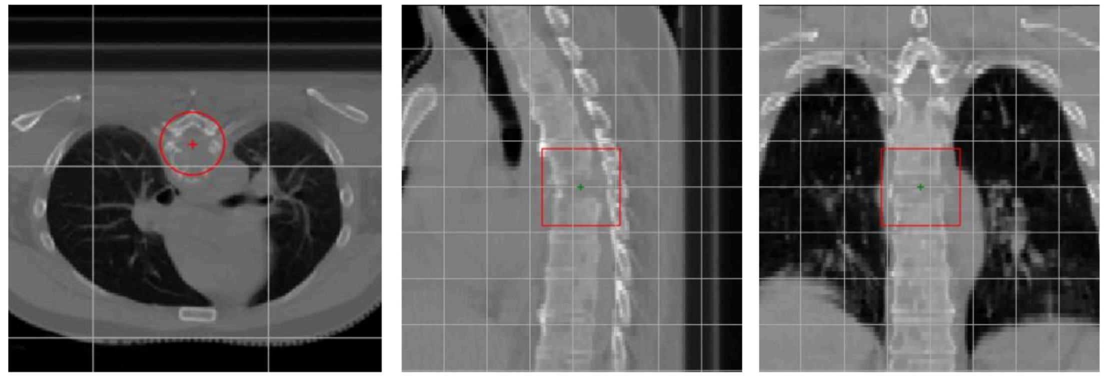


Fig. 1. Screenshot of our ROI extraction software. A cylindrical ROI (5 cm length 5cm diameter) is shown in x, y, and z planes. Delineation of the BM ROIs for the training of a machine learning algorithm is performed by a semi-automated algorithm that allows radiation oncologists to label the center of each BM in 3D images.

The ML algorithm performed best when used with a 5 cm diameter and height cylindrical ROI. For this ROI, NN, RF, and SVM classifiers resulted in 82%, 76% and 73% accuracy respectively. The accuracy of the NN model dropped to 76% and 73% when using cubic and spherical ROIs of the same dimensions. The sensitivity and specificity of our best model were 86% and 79%, respectively.

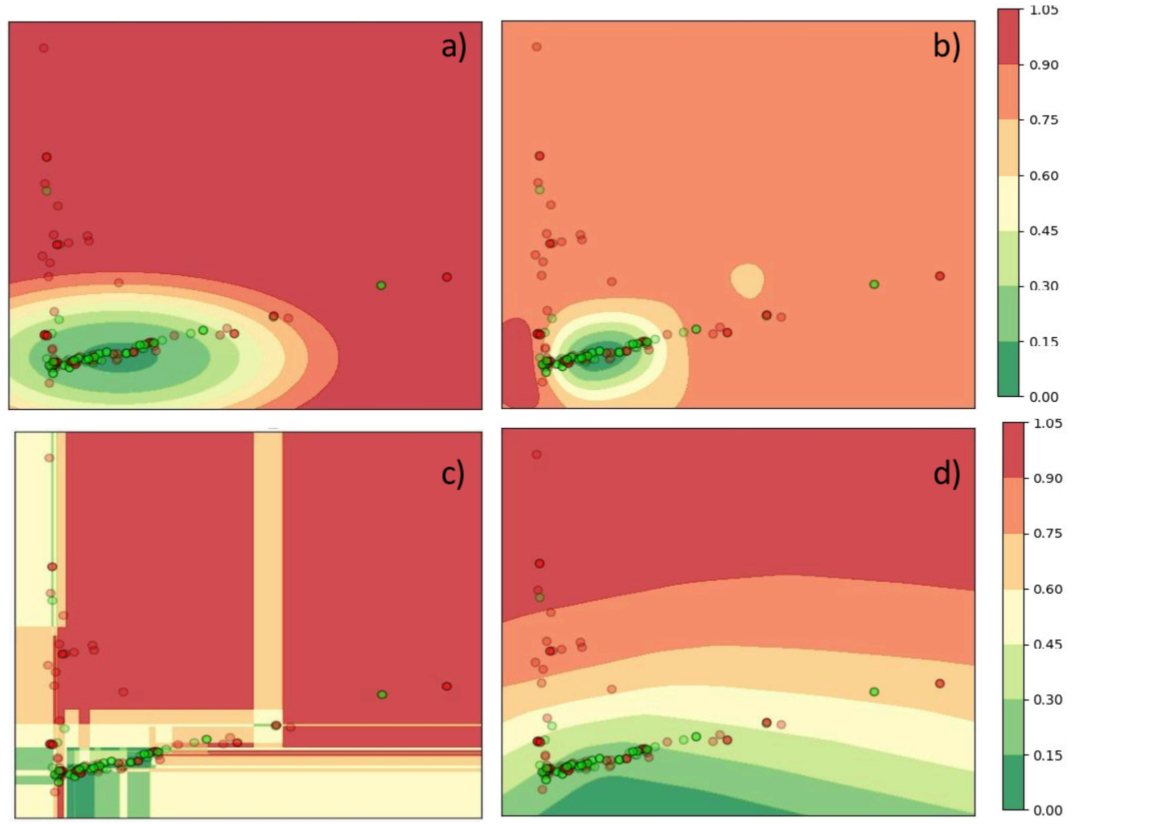


Fig. 2. Performance of various classifiers in detecting lytic bone metastasis using 5 cm cylindrical ROI. For visualization, principal component analyses applied to map 104-dimensional feature space into 2D image. The color map shows the prediction boundaries, green being 0% metastatic and red being 100% metastatic. a) Naive Bayes (NB), b) Support Vector Machines (SVM), c) Random Forest (RF), and d) Neural Network (NN)

CONCLUSIONS

Our radiomics-based ML method identified lytic bone metastases regions in simulation-CT images using a single point based cylindrical ROI with 82% accuracy.

The goal is to develop a tool to assist radiation oncologists to better pinpoint metastatic bone lesions in the simulation-CT images of palliative-intent radiotherapy patients.

REFERENCES

1. Mundy GR. Metastasis to bone: causes, consequences and therapeutic opportunities. Nat Rev Cancer 2002;2(8):584–593.

2. Coleman RE. Management of bone metastases. Oncologist 2000;5(6):463–470.

3. Griethuysen, J. J. M., Fedorov, A., Parmar, C., Hosny, A., Aucoin, N., Narayan, V., Beets-Tan, R. G. H., Fillon-Robin, J. C., Pieper, S., Aerts, H. J. W. L. (2017). Computational Radiomics System to Decode the Radiographic Phenotype. Cancer Research, 77(21), e104–e107.

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CONTACT INFORMATION

hossein.naseri@mail.mcgill.ca