Al-Powered Precision: Revolutionizing CTV Contouring for SAVI® Brachytherapy in Breast Cancer

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Al-powered automatic contouring shows promise in improving radiotherapy planning for breast cancer, enhancing efficiency and accuracy.

INTRODUCTION

- Accurate contouring of the Clinical Target Volume (CTV) is crucial for effective radiotherapy planning in breast cancer treatment.
- Manual contouring by radiation oncologists is time-consuming and prone to variability.
- We explore the use of a Convolutional Neural Network (CNN)-based segmentation method for automatic CTV contouring in SAVI® brachytherapy, aiming to improve efficiency and consistency in radiotherapy planning.

MATERIAL & METHODS

Data Collection:
- CT images from 200 breast cancer patients post-SAVI catheter implantation
- CTV manually contoured by radiation oncologist (ground truth)

Data Split:
- Both: 147 patients in the training set and 48 in the test set
- Left breast: 101 in training set, 10 in test set
- Right breast: 74 in training set, 8 in test set

Post-processing threshold: Applied to reduce false positives

Performance Evaluation: Dice Sorensen Coefficient (DSC) measures overlap between AI-generated and manual contours

CNN Architecture: U-NET, a widely used CNN for medical image segmentation

MAIN FINDINGS

Observation 1: U-NET training resulted in a combination of false and true positives.

Figure 2: Left: False positive prediction using 0.7 validation set split with data set not divided by laterality. Right: True positive prediction with same validation set split.

Observation 2: Greater DSC median when training data sets were divided into left and right operated breast.
- Median DSC of validation set split at 0.7 and 0.8 were nearly identical (left)
- Given marginal difference, 0.7 validation set split was used for training left and right breast data sets (right)

Observation 3: Despite applying post-processing threshold, right breast had more false positives, resulting in better agreement in left breast data set with median DSC of 86.0 compared to right 82.2

Figure 3: Left: Box plot of DSC for different validation set splits, not divided by laterality. Right: Box plot of DSC for data set not divided and divided by laterality with 0.7 validation set split

DISCUSSION

Best Performance: Achieved when training data was split by breast side, left > right breast
- With 50 epochs, training took <7 hours
- Predictions can potentially improve with more complete cycles (epoch)

Limitations: Unclear cause for difference in # of false positives due to poor interpretability and explainability of CNNs
- Significant barrier for adoption of AI in clinical space
- Variability in contouring practices among radiation oncologists → challenge in obtaining ground truth for AI training

CONCLUSION

Promising application of AI in streamlining and enhancing the radiotherapy planning process for SAVI® brachytherapy in breast cancer patients. AI can potentially:
- Reduce contouring time
- Improve consistency and accuracy
- Assist physicians by capturing errors and improving workflow

REFERENCES


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