Study On Intelligent Treatment Planning for Left Breast Cancer

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INTRODUCTION

Many authors have conducted smart program studies[1~4], but there is still a lack of studies related to left breast cancer. The setting up of artificial intelligentized treatment plan system especially for left breast cancer has been a challenge. Based on deep learning, we have successfully developed an intelligentized treatment planning system for radiation radiotherapy for left breast cancer. It not only obtains satisfactory optimization results, but also realizes the standardization and rapidness of plan design and optimization.

AIM

The aim of this work is to set up an intelligent treatment planning program specially for left breast cancer.

METHOD

- The treatment plans belonging to 200 patients who suffered left breast cancer were adopted.
- We set the threshold value by referring to RTOG-1005 and RTOG-1304.
- The deep convolution Generate Adversarial Network (GAN) has been used as the engine for AI dose prediction. The Generator（G）and Discriminator（D）is working via following formula,

$$\min_G \max_D V(D,G) = \mathbb{E}_{x\sim p_{data}(x)}[\log D(x)] + \mathbb{E}_{z\sim p_z(z)}[\log(1 - D(G(z)))]$$

- U-net neural network model was adopted for DVH prediction. The input of U-net network is 256*256*3 CT contour map, and the output is the dose distribution map of corresponding single-pass.
- For automatic optimization algorithm, a series of linear objective functions were used as a plan optimization engine to constitute an inverse plan optimization problem. During calculations, we turn the optimization problem into a form that optimizes the absolute dual gap.
- Set up automatic fixed collimator technology (Especially for left breast cancer patients with supraclavicular irradiation)

RESULTS

1. By inputting 256*256*3 CT contour map into U-NET network, we successfully predicted the corresponding dose distribution mapping(Fig1).

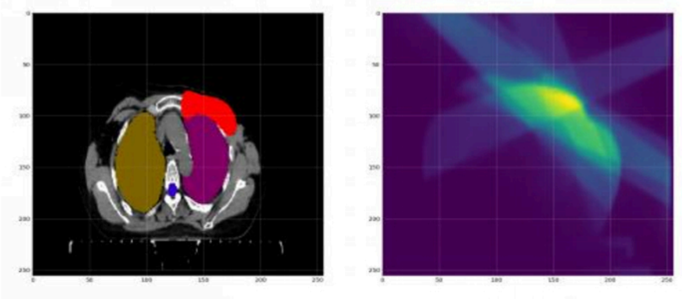

Fig1. The corresponding dose distribution mapping prediction via into U-NET network.

2. The automatic fixed collimator technology, especially for left breast cancer patients with supraclavicular irradiation, has been setting up(Fig2).

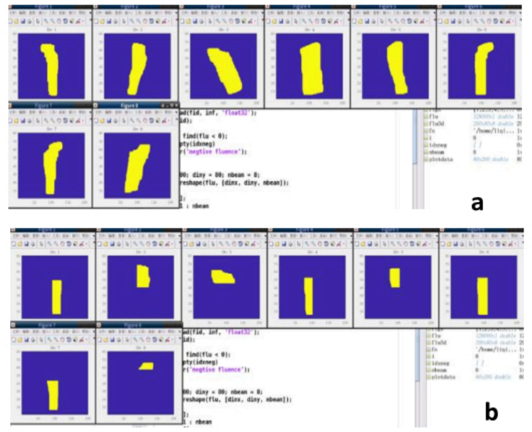

Fig.2 The effect of automatic fixed collimator technology. a.Effect before the collimator limits. b. Effect after the collimator limits.

3. For left chest wall with supraclavicular case of breast cancer: From the view of DVH generated by the optimization engine, the results on PTV and OAR from automatic plans were better than those from manual plans(Fig 3). From the predicted dose distribution graph, our results from AI dose prediction system were most equivalent to or better than those from manual plans.

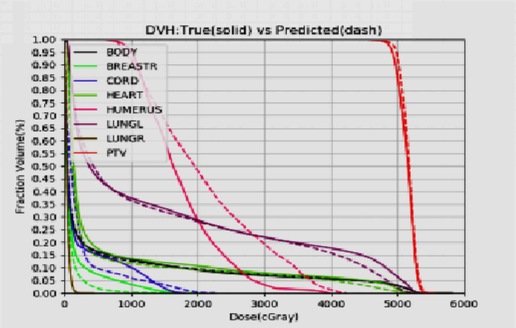

Fig 3. DVH: True(solid) vs Predicted(dash)

CONCLUSIONS

For left breast chest wall with supraclavicular fields of left breast cancer, the DVH generated by our automatic plan optimization engine were better than those from the manual plan. There is no bright spot or noise on the fluence map, which has good smoothness and can guarantee the execution of the plan.

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REFERENCES

1. Xue Bai, Binbing Wang, Shengye Wang , Zhangwen Wu , Chengjun Gou , Qing Hou. Radiotherapy dose distribution prediction for breast cancer using deformable image registration. Biomed Eng Online. 2020 ;19(1):39.
2. Dan N, Long T, Jia X, Lu W, Gu X, Iqbal Z, Jiang S, Dan N, Long T, Jia X. Dose prediction with U-net: a feasibility study for predicting dose distributions from contours using deep learning on prostate IMRT patients. arXiv preprint. 2017. arXiv:1709.09233
3. Barragán-Montero AM, Nguyen D, Lu W, Lin MH, Norouzi-Kandalan R, Geets X, Sterpin E, Jiang S. Three-dimensional dose prediction for lung IMRT patients with deep neural networks: robust learning from heterogeneous beam configurations. Med Phys. 2019;46(8):3679–3691.
4. Chen X, Men K, Li Y, Yi J, Dai J. A feasibility study on an automated method to generate patient-specific dose distributions for radiotherapy using deep learning. Med Phys. 2019;46(1):56–64.

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