Multi-Field Optimization Intensity-Modulated Proton Therapy for Nasopharyngeal Carcinoma- A dosimetry comparison study in two sets of three-angle beam arrangement

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Purpose

The aim of this study was to compare two different sets of beam arrangements in multi-field optimization intensity-modulated proton therapy (MFO-IMPT) plan for nasopharyngeal carcinoma (NPC).

Materials and methods

Ten patients with NPC selected retrospectively from October 2016 to August 2018 in our institution were studied. Patient characteristics were shown in table 1. Two different sets of three-angle arrangement were designed as the following: 1. posterior and two posterior oblique angle (PPO), 2. posterior and two anterior oblique angle (PAO) . Angle selection schematic diagram was shown in Fig 1.

Fig 1. Demonstration of beam angle:
left figure (PPO), and right figure (PAO)

All treatment plans were optimized by the Eclipse (Varian Medical, Palo Alto, CA) treatment planning software version 13.7. The dose of 6996 cGy and 5412 cGy in 33 fractions were prescribed to the CTV_{6996} and CTV_{5412}, respectively. All plans were following the dose constraints: V_{CTV} >99%, $D_{max,\ stem}$ <5400 cGyE , $D_{max,\ cord}$ <4500 cGyE, and $D_{mean,\ parotid\ galnd}$ <2600 cGyE. The conformal index (CI) and homogeneity index (HI) of CTV_{6996} were calculated according to the formula:

CI: $(TV_{RI})^2/(TV \times V_{RI})$

TV_{RI} : Target volume covered by the reference isodose

- TV: Target volume
- V_{RI}: Volume of the reference isodose

HI: D2%-D98% /Dp

- D2% and D98% : minimum dose to 2% and 98% of the target volume
- Dp: is the prescribed dose

Patient stage	N(%)	CTV mean (C.C)
Stage II	9(90%)	96.9
Stage III	1(10%)	115.2

Table 1. Patient characteristics

Results

We analyzed the DVHs and isodose distributions between two different angle sets. For CTV_{6996} , the average CI were 0.6787 and 0.71, the average HI were 0.0658 and 0.0797, in the PPO and PAO respectively. We noted the similar coverage of the target volumes in the high-risk (*p*=0.0721) and low-risk areas (*p*=0.333). The PPO had lower mean dose of the left (*p*=0.043) and right (p=0.045) parotid glands. The PAO were observed with lower maximum dose in the spinal cord (*p*=0.013), brainstem (*p*=0.017), right cochlear (*p*=0.042) and left cochlear (*p*=0.043), shown in table 2. The mean dose of oral cavity (p=0.368) and larynx (p=0.093) were similar in the two angle sets.

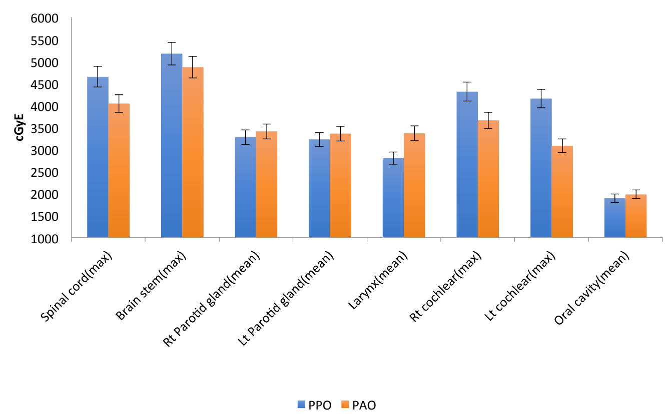

Table 2. Dose comparison of two angle sets according to critical organs

Discussions and Conclusions

The dose comparison in two sets of three-angle beam arrangement exhibited different advantages and disadvantages in patients with NPC. The PAO were observed with lower maximum dose in the brainstem and spinal cord because of proton distal end. The PAO also had lower maximum dose in the right cochlear and left cochlear, because the PAO angle set can avoid the cochlear in the field. However, dose uncertainty is often caused by dental artifacts and implants in head and neck cancer. When we select optimized beam angles for NPC patients treated with MFO-IMPT, it should be considered to minimize the dose uncertainty produced in beam path.

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