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Combining avoidance structure and jaw-tracking techniques to reduce the dose to lens in radiotherapy for sinonasal cancer

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INTRODUCTION & AIM

Sinonasal cancer is relatively rare, comprising only 1% of all malignancies and 3-5% of head and neck malignancies[1,2]. Sparing of the eye lens poses one of the most significant challenges in radiation treatment planning, due to the close proximity to target volume and low dose threshold of lens, exceeding which may lead to development of radiation-induced cataract.

In recent years, sinonasal cancer is typically treated using intensity-modulated radiation therapy (IMRT) technology. The avoidance structure (AS) technique is a recently added functionality in the plan optimization module of the Eclipse (Varian Medical System, Palo Alto, CA) treatment planning system since version 15.5. our study evaluated the effectiveness of the AS technique by applying it to the IMRT for sinonasal cancer, in combination with jaw tracking (JT) technique, aiming to explore whether these techniques can effectively reduce lens dose in radiotherapy for sinonasal cancer.

METHOD

Thirty patients were included in the study, and three sets of intensity-modulated radiation therapy (IMRT) plans were designed in Eclipse treatment planning system: (1) original plans (O-P) with seven non-coplanar fields were optimized to meet clinical criteria; (2) duplicated O-Ps were re-optimized using AS functionality to avoid radiation to lenses and planning organs at risk (OARs) of lenses (lens-PRVs), while maintaining other optimization conditions consistent (AS-P); and (3) utilizing both AS and JT techniques to generate a third sets of plans (AS-JT-P). All three plans were normalized so that the prescribed dose covered 95% of planning target volume (PTV). Dosimetric parameters including a modified homogeneity index (MHI), a conformity index (CI), dose to target volume and OARs were evaluated. Additionally, the Lyman-Kutcher-Burman (LKB) model was utilized to predict normal tissue complication probability (NTCP) of OARs. The data including monitor units (MUs) per fraction from the three sets of treatment plans were collected and compared.

The MHI formula can be expressed as follows:

$$MHI = \frac{D_{50\%}}{D_{2\%} - D_{98\%} + D_{50\%}}$$

The CI formula can be expressed as follows:

$$CI = \frac{(TV\ within\ PIV)^2}{TV \times PIV}$$

RESULTS & DISCUSSION

Compared to O-P, the average reduction of $D_{2\%}$ for the lenses/lens-PRVs in AS-JT-P were approximately 27~36%/34~44%, with a corresponding average NTCP reduction of 0.1~0.3%/0.2~0.5%. The AS-P reduced the $D_{2\%}$ of the lenses/lens-PRVs by approximately 5~18% /18~29%, while the NTCP of contralateral lens/lens-PRVs was reduced by 0.0~0.1%/0.1~0.2% (P<0.05). The $D_{2\%}$ to the eyes were also significantly reduced in both AS-P and AS-JT-P by 6~16% (P<0.05). Additionally, the AS technique resulted in a slight deterioration in MHI and CI for the target. However, the AS-P and AS-JT-P have comparable MHI (P>0.05). While using AS technique alone, the $D_{2\%}$ of the contralateral lens were reduced for all patients, but the $D_{2\%}$ of the ipsilateral lens was increased for seven (23.3%) patients. While combining AS and JT techniques, $D_{2\%}$ of both lenses were reduced for all patients. The dose-volume variation was shown in Figure 1. Moreover, there were minimal impact on other OARs and increased MU number when using AS or combination of AS and JT.

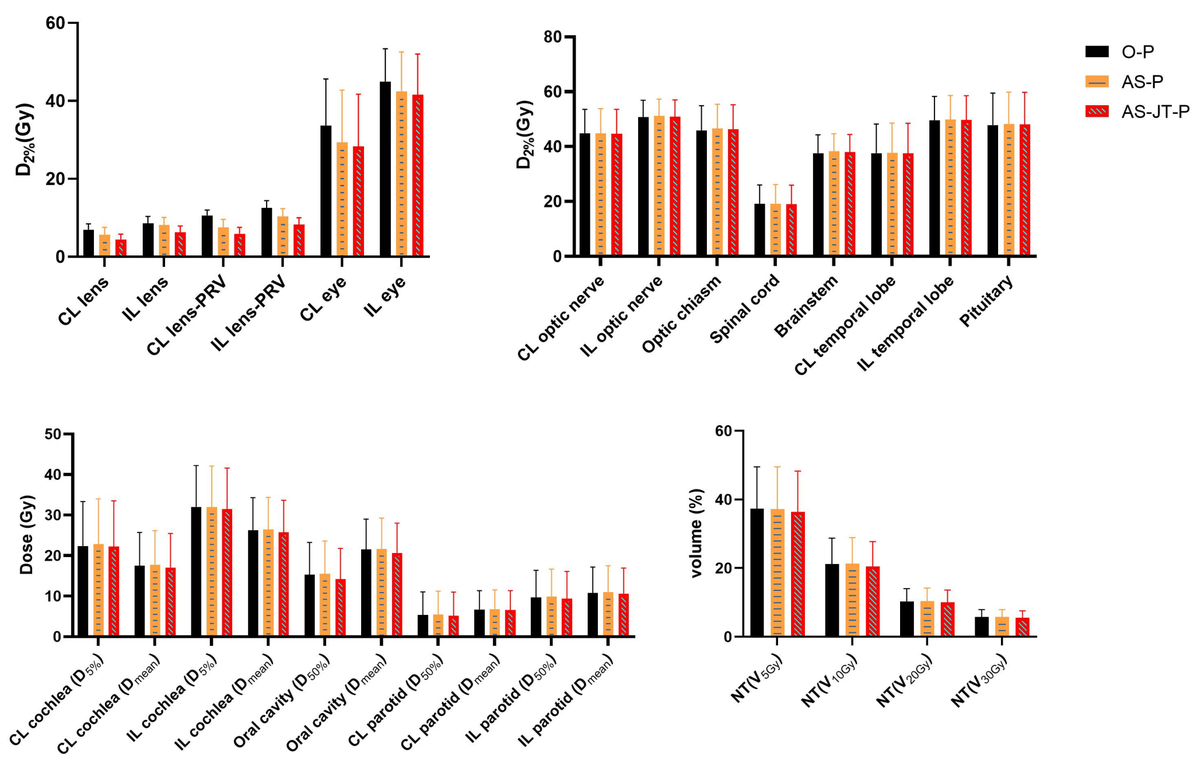

Figure 1. Dose-volume parameters in three kinds of plans: original plans (O-P), plans using avoidance structure technique (AS-P) and plans using avoidance structure and jaw-tracking techniques (AS-JT-P).

CONCLUSION

The combination of AS and JT techniques can effectively minimize the radiation exposure to the lenses, reducing the risk of radiation-induced cataract.

FUTURE WORK / REFERENCES

1. Mahalingappa YB, Khalil HS. Sinonasal malignancy: presentation and outcomes. J Laryngol Otol 2014; 128: 654-7.
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