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Quality assurance for implementation of online adaptive radiotherapy

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Purpose

The aim of this project is to verify the entire treatment quality of Ethos (Varian, Pola Alto, USA) online adaptive radiotherapy (oART).

Methods

An end-to-end test, specifically designed for oART, was conducted with a water-equivalent 3D printed pelvis phantom. Five organs were included in this phantom: bladder, prostate, rectum and femoral heads. The organs were modeled from the anatomy of a real patient, and simplified to elliptic cylinders. Nine cases of deformation on the bladder, the prostate and the rectum were created with ImSim QA (Oncology Systems Limited, Shrewsbury, UK). The organs were translated, rotated and scaled; the displacement magnitude varied between 0 and 25 mm. These deformed CT images were used for initial planning. For each case, oART was performed with Ethos with prescribed dosimetric goals. The dose delivered to the 3D printed pelvis phantom was measured with a 0.125 cm³ Semiflex Chamber 31002 (PTW, Freiburg, German) and an EBT3 GafChromic film (Ashland, NJ, USA).

The patient-specific quality assurance (QA) for oART was also verified. The adapted dose calculation was compared between the Ethos treatment planning system and a second dose calculation software Mobius3D (Varian, Pola Alto, USA). The dose delivery of the adapted plans was checked with the ArcCheck phantom (Sun Nuclear, Boulevard, USA).

Results

In the end-to-end test, the single point dose difference was below 2.1% the film measurement showed a 2D gamma passing rate (3%, 2 mm) of 99.2%.

For patient-specific QA, the second dose calculation showed a 3D gamma passing rate (3%, 2mm) higher than 98%; the measurements with the ArcCheck phantom showed a 3D gamma passing rate (3%, 2 mm) above 95%.

Conclusion

A water-equivalent 3D printed phantom was developed for an end-to-end test for oART on Ethos. The dosimetric agreement between the measured dose and calculated dose shows the high quality of treatment adaptation and delivery of Ethos. In conclusion, Ethos oART can be used to treat patients.

Primary authors: QI, Beiqian (Réseau Hospitalier Neuchâtelois); RISSE, Térance (Réseau Hospitalier Neuchâtelois); Dr GUIBERT, Geoffroy (Réseau Hospitalier Neuchâtelois); Dr WEBER, Patrick (Réseau Hospitalier Neuchâtelois)

Presenter: RISSE, Térance (Réseau Hospitalier Neuchâtelois)

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