Session de perfectionnement : Real-time MR image guided radiotherapy: the time is near!

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Résumé

Introduction:
Despite the fact that several studies has shown that dose escalation improves treatment outcome, there are currently very limited clinical indications treated with high dose-high precision radiotherapy. Due to the inability to visualize tumor and critical organs sufficiently during delivery, a normal tissue margin around the tumor needs to be included in the target volume, which leads to toxicity and thereby limiting the maximum dose. If high quality (contrast) real-time MRI images of the tumor and surroundings are available during treatment, it is expected that smaller normal tissue margins are necessary (what you see is what you treat), and consequently increasing the possibility for dose escalation.

Methods:

MR guided radiotherapy is rapidly evolving from research feasibilities towards real clinical treatment machines. Cobalt systems are currently on the market and soon the first clinical MR-linac based on a 7 MV linear accelerator and a 1.5T MRI scanner will become operational.

It is a misconception to consider the MR-guided radiotherapy systems as the next generation CBCT-linacs. The combination of a radiotherapy device with an MRI scanner enables high dose-high precision radiotherapy for many complex indications, bringing a new paradigm for radiotherapy. This enables new possibilities of on-line treatment plan adaptation, including gating and tumor tracking.

However, the implications on reference dosimetry, machine QA and treatment planning due to the changed dose deposition by the magnetic field must be taken into account. This opens a whole new field of radiotherapy physics.

In this talk the different MR radiotherapy solutions currently clinically available or under development will be discussed. Furthermore, a short description of the clinical MR guided workflow is given. The impact of the magnetic field on dose deposition is large due to the Lorentz force on the electrons released in matter. This results in skewed dose distributions and different build-up and exit doses compared to distributions in conventional radiotherapy. Since the trajectories of the electrons are now curved, readings in ionization chambers will also differ.

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My talk will address these effects on dose based on the Utrecht experience but these implications also apply to the other MR radiotherapy solutions.

Conclusions: The use of MRI in radiotherapy is fast growing. To explore the patient benefits of MR guided radiotherapy almost all conventional aspects of current radiotherapy needs an overhaul, from the clinical workflow to dosimetry physics and machine QA. A short overview will be given.