

Project report – A national investigation of the safety of dose delivery in a daily treatment adaption workflow in MR-Linacs

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1. Project update

Magnetic resonance imaging (MRI) has exquisite soft-tissue contrast and is the foundation for image-guided radiotherapy (IGRT) with integrated MR-Linacs, where radiotherapy and MRI imaging is combined. However, MRI suffers from geometrical distortions, which can compromise the images used for the guidance and daily adaption of the radiotherapy. Therefore I have investigated the distortions in the MR-linac at OUH (Elekta Unity MR-linac) for patients with four different tumor-sites: adrenal gland (7 patients), liver (4 patients), pancreas (6 patients), prostate (20 patients). The patient groups were investigated to examine whether an anatomical site is prone to larger distortions than others. This could be e.g. the influence of rectal gas for pelvic patients that can cause large distortions.

Total tumor-site distortion was found by adding distortions that a patient introduce and the distortions that is within the MR scanner itself. The geometric distortion within the tumor (the gross-tumor-volume) for 37 patients were examined. The differences in distortion level between the abdominal patients (adrenal gland, liver, pancreas) and pelvic patients (prostate) was then investigated to check whether we should be concerned with more distortions in one group than the other.

No significant difference in total geometric distortion was found when comparing the abdominal and pelvic groups. Therefore, there is no reason to believe that there is difference in the distortions for the two patient groups. Furthermore, the largest distortion found within the gross-tumor-volume (GTV) of the 37 patients was below 1 mm.

I have recently acquired data at Rigshospitalet (ViewRay MRIdian MR-linac), and this data is about to be processed to be able to compare the two MR-linac systems. Next project is to estimate the influence of hip prostheses and movement of organs on the distortion level and thereby the influence on the daily adaptive workflow of radiotherapy.

2. Publications

The work from the first part of the phd-project has been published in the journal *Physics and Imaging in Radiation Oncology (phiRO)*: <https://www.sciencedirect.com/science/article/pii/S2405631620300403>

3. Poster presentations

Poster presentations have been given at

- Øresund Workshop on Radiotherapy, February 2020
- Poster highlight presentation at ESTRO '20 with the title "Tumor-site specific geometric distortion in high field MR-linac treatments". November 2020.

4. Oral presentation

Oral presentations have been given at

- International Elekta MR-linac consortium meeting (fall 2020)
- DCCC-RT annual meeting (flash talk)

5. Planned activities for 2021

For 2021, the following is currently planned:

- Finish patient-specific MRI geometric distortions by looking at dosimetric impact of distortions.
- Begin project on organ motion during RT and influence geometric distortions in MR images.
- Begin on project about hip prostheses and geometric distortions.
- Send abstract for ESTRO'21 with national results on geometric distortions in the two CE-marked MR-linac types. I now have data from both OUH, RH and I have planned to acquire data at Herlev Hospital in end January 2021. Up until now I have only had data from OUH (one MR-linac type).
- I have planned to have 10.8 ECTS points in the spring of 2021 regarding biostatistics, AI in health technology, and dosimetry.
- External stay: in fall of 2021. Preferably a MR-linac site in Europe.