ESTRO Technology Transfer Grant (TTG) Report

Stereotactic body radiotherapy for liver metastases (special focus on expiration breath-hold technique)

Location visited: Division of Radiotherapy, University of Zurich, Switzerland
Period of visit: 11 November – 6 December 2019

As a mobility grant fellow of the European SocieTy for Radiotherapy and Oncology (ESTRO), I had the chance to attend the Division of Radiotherapy of the University of Zurich, which is led by Professor Matthias Guckenberger.

My practical training during my 3.5 week visit was mainly on all aspects of stereotactic body radiation therapy (SBRT). In particular I followed all the treatment steps required for SBRT, including planning and theoretical sessions that were focused on the dose prescription. It was really interesting for me to compare the two different modalities used in my centre in Milan and in the Zurich university to prescribe the SBRT dose. The main difference is related to the dose distribution: in Zurich this is inhomogeneous, whereas in Milan we prescribe it homogeneously.

The SBRT treatments were performed either with a conventional linear accelerator (linac) or with a MRI linac. In the last case in which I was involved, I had the opportunity to attend some adaptive radiotherapy sessions for prostate cancer, liver metastases and lympho-nodes.

My main project was on liver metastases, based on ongoing work that aimed to evaluate the feasibility of an expiration breath-hold technique (EBH) with regard to the patients' ability to tolerate the technique and the reproducibility of target localisation during SBRT of abdominal and liver tumours. From February 2017 to December 2018, 37 patients at the host institution had been identified as eligible for EBH abdominal SBRT. Radiation delivery was performed in EBH within a defined gate. Patients were guided by speech commands and visualisation with a monitor. Before treatment, kV-conebeam-computerised tomography (CBCT) was performed with use of EBH. After the first treatment, an additional post-CBCT was performed in most patients. Seven patients (11 volumes) were treated with use of an internal target volume (ITV) concept instead of EBH due to short breath-hold. For the patients treated with the ITV concept, 4D-CT imaging data was available. Using these images, the planning target volumes (PTVs) based on the ITV concept were compared with the PTVs used in EBH.

It was calculated that use of EBH instead of the ITV method could lead to a potential PTV size reduction of mean -18% (std±14%, range -4%-38.2%). However, EBH is only feasible with carefully selected patients.

The conclusion of the first part of the study was that the EBH set-up enables treatment without need for an ITV. Gated-beam delivery in EBH achieved a relevant reduction in PTV size compared with the ITV-based concept. Although not quantitatively analysed, target delineation on EBH CT was facilitated by simultaneous contrast enhancement and co-registration with MRI in the treatment position, compared with a non-contrast-enhanced 4D CT workflow.

SBRT relies on the delivery of accurate high doses to the target, and errors in localisation can result in increased toxicity and geometric tumour miss that cannot be easily "corrected" in later fractions. Therefore, the use of techniques or devices to localise the radiation to the tumour, minimise margins and optimise on-treatment quality assurance is critical.

During my visit, I analysed the intrafractional and interfractional positional changes in order to investigate whether PTV margins were modified and could be reduced with this EBH approach. Intrafraction and interfraction changes in amplitude of breathing motion will be analysed to assess whether the EBH approach could deal with respiratory motion in order to treat liver metastases safely with SBRT.

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