PO-RT-09 Spine SBRT: benefit of Magnetic Resonance Imaging acquisition in treatment position and first results of Volumetric Modulated Arc Therapy dose plan

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Résumé

Purpose:
In stereotactic body radiotherapy (SBRT), high-gradient dose is delivered and target volumes have to be delineated precisely in order to avoid irradiation of healthy tissue. Magnetic Resonance Imaging (MRI) acquisition in treatment position allows same spine curvature reproduction and shows to be useful to delineate organs at risk such as spinal cord. The aim of this study is to report the benefit of setting out an imaging protocol optimized for SBRT planning and to present a Volumetric Modulated Arc Therapy (VMAT) methodology to treat spine metastasis.

Material and methods:

Patient immobilization and positioning was first set up at the GE Healthcare Planning CT scan with dedicated thermo-plastic nets, supports and cushions. An MR compatible table was designed by Orfit Industries and approved for testing by Siemens Healthcare. The same patient's immobilization devices were used at the MR scan to perform optimized imaging series to reproduce treatment position.

At the 1.5T Siemens Aera MR scan, head and body flex coils were used and imaging sequences were optimized to account for the table and immobilization devices. Coronal 3D Turbo Spin Echo T2-weighted and T1-weighted (3D TSE T2-w and 3D T1-w TSE) had the same acquisition matrix size and field-of-view with 1.00 mm slice thickness, resulting in isotropic voxel size of 1.00 mm3. TR/TE were 1100ms/132ms (T2-w) and 400ms/18ms (T1-w), respectively.

Gross Target Volume (GTV) was contoured as the visible lesion on CT scan or hyper-signal on MR images. Clinical Target Volume was delineated upon GTV location according to [1]. The Planning Target Volume was defined as CTV+2mm. An optimized PTV was created: PTV2= [PTV – (medullary canal + (spinal cord+3mm))].

*Intervenant

VMAT dose plans were performed with AAA algorithm (Eclipse v11), 6MV fields and 1mm calculation grid. The prescription was 3* 9Gy on the median volume of the PTV2.

We compared different methods to decrease the dose outside the PTV2 (NTO function (Normal Tissue Objective) vs. ; NTO automatic vs. rings).

A second study was performed to compare different configurations: 2 coplanar $360\circ$ arcs (collimators $15\circ/345\circ$ or $100\circ/80\circ$) and 4 coplanar $360\circ$ arcs (collimators $15\circ/345/100\circ/80\circ$).

Results:

There was no problem of registration on the spine curvature between CT and MR images thanks to the table and immobilization devices (Figure 1A)

Examples of MR/Planning CT registration with benefit for target volume and organs at risk delineation are illustrated on Figure 1B.

Different geometries of PTV were considered, when spinous process was involved, 4 arcs are needed to better conform the PTV and respect the dose to the spinal cord.

Dose plans reach good coverage of PTV2 (95% PTV received 96.8% of the prescribed dose), maximum dose for PTV2 was 105%. For the spinal cord+2mm, max dose was 19.85 Gy, V11.1Gy=0.64cc and V18Gy$<$ 0.01cc.

Conclusion :

Optimized imaging protocol in RT treatment position allows high precision registration with planning CT scan for a better delineation of target volume and organs at risk.

All dose planning simulations fulfilled [2-4] the international recommendations.

Cox et al. 2012

Grimm et al. 2011

Timmerman et al. 2007

Mots-Clés: Spine Stereotactic Body Radiation Therapy, VMAT, MRI