



Contribution ID: 118

Type: Oral Presentation

SRS in Tomotherapy: What we gain, what we lose comparing to Linac based SRS?

Thursday, June 22, 2017 10:15 AM (15 minutes)

INTRODUCTION

Brain SRS has been done at our institution since June 1996. In a first phase (1996-2003) circular cones were used. Since February 2008, SRS has been performed using an add-on micro-MLC m3, from Brainlab, with full advanced integration in a Siemens linear accelerator. A total of 498 brain lesions have been treated with this technology, with outcomes in terms of overall survival and local control in close agreement with published results.

With the announced end of support for m3 and given the recent installation of a Tomotherapy HD machine, the possibility of performing SRS in Tomotherapy was raised by the clinical team. Different studies on SRS in Tomotherapy have been published [1-7] but in recent years a shift towards newer technologies seems to have withdrawn the interest to use Tomotherapy for this clinical application. Nevertheless, Tomotherapy has evolved technologically with improved performances in terms of accuracy and efficiency, providing sub-millimeter accuracy and precision in couch movements and improved dosimetric accuracy.

In this work an evaluation of the dosimetric consequences of an eventual change from linac based towards Tomo based SRS is presented.

METHODS AND MATERIALS

For Linac based SRS the standard used planning technique consisted of six dynamic conformal arcs rotating about a single isocenter. The plan assessment included coverage (CI), homogeneity (HI) and conformity (COIN) indices proposed in the literature and published elsewhere [8]. 26 brain lesions have been chosen and divided in six groups depending on the volume and the proximity to critical structures as: group I – PTV smaller than 1cc; group II – PTV between 1 and 3cc; group III – PTV between 3 and 7cc; group IV – PTV greater than 7cc; group V – metastases close to the brainstem, a critical structure with a maximum tolerance dose of 12 Gy, which is a limiting factor for treating brain metastases with a dose greater than 20 Gy; group VI – neurinomas, usually close to the brainstem but with a prescription dose of 12 Gy.

All clinical cases have been replanned for Tomotherapy, in the high performance Volo Planning station, using surrounding rings as planning aid structures to push the dose inside the PTV. A modulation factor of 2.0 and a pitch of 0.1 have been used. Given the clear larger dose gradients obtained in Tomo, the gradient index (GI) proposed by Paddick [9] was also calculated for all cases in both treatment techniques. Also the ratio $V20\%/V50\%$ was used for dose comparison assessment.

RESULTS

It is very interesting to note that $V20\%/V50\%$ ratio between iPlan and Tomo plans was always around 1.4 ± 0.1 which means that this index may be considered as an indicator of the delivery system physical constraint in terms of dose spread.

In Tomo the gradient index (GI) was around 2.0 times the GI with m3. This was the main drawback of Tomo plans which was counterbalanced by the gain of $19.6 \pm 6.5\%$ in the conformity index, COIN. These values for COIN reported to the 18 studied lesions that were away from critical structures, had volumes from 0.66 cc up to 21.1 cc and for which COIN values in iPlan were usually above 0.6 (the lower limit for conformity). The conformity in Tomo was expressively improved. This was even more advantageous for lesions close to critical structures. Neurinomas, where the close proximity of the brainstem led to COIN values below conformity, would have benefited in Tomo of an increase of around 6%, leading to conformal plans.

This improvement in conformity was coupled with a better coverage (CI usually exceeds 99% in Tomo whereas

it was most of the times in the range of 97-98% in iPlan). Minimum dose in the PTV also highly benefited from Tomo plans.

Concerning treatment times (TT), Tomo plans did not bring in general any special advantage when compared with linac based plans – the overall averages for the studied lesions were 19.7min for Tomo plans and 16min for iPlan. If we add to these times (that just concern the beam-on time in both systems) the required imaging time in Tomo (around 3-5 min) and localization time in the linear accelerator (around 10-12 min) we could come up with very similar times to be allocated for the treatment delivery in both systems.

CONCLUSIONS

SRS is feasible in Tomotherapy as it have been reported in the literature. From the dosimetric point of view, the larger gradients around the brain lesions specially in transverse plans which constitute the main loss when compared with linac based SRS plans are counterbalanced with higher conformity specially around irregular lesions. Concerning treatment times they are similar for the overall treatment delivery for single lesions but would be considerable reduced for multiple lesions in Tomotherapy.

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Session Classification: Session 16b - QA from simulation to delivery

Track Classification: QA/QC