Implementation of intracranial stereotactic radiotherapy in tomohelical technique : from dosimetry to treatment QA

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Résumé

Introduction: Tomotherapy, which used to be dedicated to the treatment of large fields and extensive lesions, is now increasingly used for stereotactic treatments. The helical technique allows significant intensity modulation, and treatment accuracy has been improved by the introduction of kVCT imaging and the Synchrony tracking module. However, certain apparent limitations for SRT delivery remain unchanged: a minimum longitudinal field width of 10 mm, a leaf width of 6.25 mm, and only coplanar irradiation. We here report on the methodology used to implement this technique in terms of dosimetry and quality control of the treatment plans.

Material and Methods: Ten intracranial stereotactic plans previously treated on another machine were selected with PTV volume ranging from 0.5 to 20 cc with a median of 2 cc. Tomohelical plans were generated with the three available field width sizes (10 , 25 and 50 mm), and a pitch between 0.150 and 0.200, on the TPS RayStation 12ASP2. Prescription (33 Gy in 3 fractions) and normalization were identical between the different plans (95% coverage of the PTV by 100% of the prescribed dose, corresponding to an isodose prescription of approximatively 80%). New conformity and gradient indices were calculated for each plan (nCI=(VPTVxVIso33Gy)/ (VPTV_Intersection_Iso33Gy)2); GI= VIso16.5Gy/ VIso33Gy). Statistical analyses were performed using a Wilcoxon test (significant results for $p< 0.05$). The optimized plans with the jaw sizes of 10 mm and 25 mm were delivered on the Radixact machine on the Delta4 phantom and analyzed with a global gamma index method. Dose distributions were also assessed by irradiation of XD gafchromic films in the Lucy phantom and use of FilmQAPro software. Absolute dose was measured using a PTW PinPoint chamber inserted in the Lucy phantom.

Results: Regarding dosimetric comparisons, a strong correlation between the lesion size and the GI value was observed with GI values varying from 7.2 for the smallest PTV to 3.8 for the largest one ($R2 = 0.92$ determined with a power function). Significant better values were obtained with the 10 mm field size compared to 25 and 50 mm. GI values decreased from 7 to 4 on the range of PTV volume from 0.5 to 5 cc, then remained at a threshold value

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of 4 for the largest PTV sizes. The trend was less clear regarding the nCI values. nCI were better with the 10 mm field size though not significant. Larger values were obtained for very small PTV volumes, between 1.2 and 1.3, and were below 1.2 for PTV sizes larger than 0.8 cc.

QA Delta4 dose distributions respected our criteria of more than 95% of gamma point < 1 for a dose deviation of 4% and a distance to agreement to 1 mm. Same results were obtained with film analyses but for a distance to agreement to 1.5 mm. The absolute doses measured in the center of the PTV were comprised between -0.9 % and -1.2 % compared to the TPS calculated dose.
Conclusions: Our study suggests that tomohelical technique is an option for SRT with clinically acceptable dose distribution and dose delivery validated by independent QA tools. Careful selection of field size seems primordial to obtain optimal dosimetric indices Results also showed that GI can be high for very small lesions. The clinical impact of this needs to be considered on a case-by-case basis depending on the patient's clinical context and the lesion proximity to organ at risk.

Mots-Clés: SRT, Tomohelical