Contribution ID: **16** Type: **Proffered Papers**

Characterization of helical tomotherapy plans complexity

Thursday, 18 February 2021 10:05 (10 minutes)

Introduction
Complexity analysis has proven to be an important tool for treatment plans characterization and comparison, contributing to improve the quality, efficiency and safety of the planning and delivery processes [1]. The purpose of this work is to evaluate the complexity of helical tomotherapy (HT) plans using some indicators recently proposed [2] and assess their potential to predict the plan deliverability.

Methodology
100 head and neck HT clinical treatment plans generated with simultaneously integrated boost for two and three dose levels were retrospectively analysed. The prescribed dose per fraction to the high-risk planning target volume was either 2 or 2.12 Gy. All plans were created in the Tomotherapy treatment planning system v.5.1.1.6 and delivered by a Tomotherapy HD unit (Accuray Inc., Sunnyvale, CA, USA). For each plan, six complexity indicators have been calculated from the planned sinogram saved in the corresponding DICOM RT file, using a home-made MATLAB program (Mathworks, Natick, MA, USA). The computed parameters and indices included: the modulation factor (MF), the percentage of leaves with an opening time below 100 ms (%LOT < 100 ms), the percentage of leaves with an opening time close to the projection duration (%LOT > pT-20 ms), leaf open time variability (LOTV), plan sinogram time variability (PSTV) and modulation index (MI) recently adapted for HT [2].
To assess the plans deliverability, pre-treatment quality assurance (QA) verifications were performed. Plans were recalculated in the Tomotherapy phantom (Cheese phantom) and delivered in the HT unit with the couch out of the bore. Dosimetry Check software v.5.5 (LifeLine Software Inc., Austin, TX, USA) was used to reconstruct the measured dose distribution from the acquired sinogram. The agreement between the planned and reconstructed dose, was evaluated using 3D global gamma analysis. The passing rate acceptance limit was 95% for a 3%/3 mm and 10% dose threshold (TH) criterion. In this work, more stringent criteria were also adopted, namely 3%/2 mm 10% TH, 2%/2 mm 10% TH and 2%/1 mm 10% TH.
The correlation between the complexity metrics and the pre-treatment verification results was investigated using Spearman's rank correlation coefficients rs. The identified dependencies were classified as: $|rs| < 0.4$ "weak", $0.4 \leq |rs| < 0.6$ "moderate"and $|rs| \geq 0.6$ "strong", for a significance level of 5%.

Results
The average values of the complexity indicators and corresponding standard deviation for the head and neck HT plans were: MF 2.096 ± 0.175, %LOT< 100 ms 27.792 ± 3.571, %LOT > pT-20 ms 8.658 ± 3.746, LOTV 0.931 ± 0.010, PSTV 5.406 ± 0.729 and MI 10.726 ± 0.895.
All plans were considered clinically deliverable, with an average passing rate of 98.6 ± 1.0 % (3%/3 mm, 10% TH) for the entire group. The use of more stringent criteria for gamma analysis, resulted in a wider spread in the obtained passing rates, as expected.
Only weak associations have been identified between the complexity indicators and the verification results, regardless the adopted criteria, as can be seen in Table 1.

The lack of correlations may be explained by the homogeneity of the considered set of plans, which led to a limited variation of both the complexity indicators and the deliverability results.

Conclusion
Despite the reported lack of correlations, the complexity indicators values can be taken as reference in our clinic to evaluate future plans, given that the pre-treatment QA results of the entire set included in this study were all clinically acceptable. Treatment plans with a complexity out of these limits for any of the computed metrics should be further evaluated and eventually be subjected to a more rigorous QA.

References
[1] Santos T, Ventura T, Lopes MC. Evaluation of the complexity of treatment plans from a national IMRT/VMAT audit –Towards a plan complexity score. Phys Med. 2020; 70:75-84; doi:10.1016/j.ejmp.2020.01.015
[2] Santos T, Ventura T, Mateus J, Capela M, Lopes MC. On the complexity of helical tomotherapy treatment plans. J Appl Clin Med Phys. 2020; doi:10.1002/acm2.12895

Country or Int. Organization

Portugal

Affiliation

University of Coimbra, Coimbra, Portugal | Medical Physics Dept., IPOCFG, E.P.E., Coimbra, Portugal

Primary authors: Ms SANTOS, Tania (University of Coimbra | IPOCFG,E.P.E.); Mr VENTURA, Tiago (IPOCFG, E.P.E.); Ms MATEUS, Josefina (IPOCFG, E.P.E.); Mr CAPELA, Miguel (IPOCFG, E.P.E.); Dr LOPES, Maria do Carmo (IPOCFG, E.P.E.)

Presenter: Ms SANTOS, Tania (University of Coimbra | IPOCFG,E.P.E.)

Session Classification: Physics Papers 1