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## An audit of nasopharyngeal rapidArc radiotherapy planning against ICRU 83 target volume homogeneity and conformity guidelines: a single center study

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**Introduction:** The ICRU reports number 50 and 62 guidelines for dose homogeneity and dose conformity on the PTV to be confined within 95% to 107% of the prescribed dose is difficult to be maintained for IMRT plans, and it is almost impossible for VMAT. ICRU 83 recommends assessing the target volume homogeneity by evaluating the high- and low-dose regions using dose-volume quantities such as D2% and D98%. However, the report did not elaborate on specific limits for these quantities. The variation of these quantities may vary depending on the disease site as the geometrical configuration of target volumes and organs at risks (OARs) varies, and IMRT technique due to its different capabilities in delivering and confirming the radiation dose.

Nasopharyngeal cancer (NPC) is a rare malignancy in most parts of the world, however other populations with elevated rates include Southeast Asia, the natives of the Arctic region, and the Arabs of North Africa and parts of the Middle East. In treatment planning of NPC patients with IMRT techniques, three different dose levels are usually delineated to cover the high-risk, intermediate, and low-risk disease regions. A concomitant boost radiotherapy is usually used to deliver 70 Gy to high-risk target volume (PTV70), 63 Gy to intermediate target volume (PTV63), and 56 Gy to low-risk target volume (PTV56) in a total of 35 fractions. Several publications proved the superiority of volumetric modulated arc therapy (VMAT) over other modern delivery techniques such as intensity modulated radiotherapy (IMRT), and Tomo therapy for NPC radiotherapy treatment. In these comparative studies, the judgment on the better technique was based on dose volume histogram (DVH) comparison with no correlation nor compliance with any international recommendation due to the lack of it.

**Methodology:** In this study we accessed our clinical practice in treating NPC patients using RapidArc delivery technique. All NPC patients treated with RapidArc for the past three years were evaluated (n= 115). The dose volume histograms (DVH) for the three target volumes were exported and a number of target coverage dosimetric parameters were determined and analyzed using an in-house MATLAB code. All the plans were clinically accepted and all OARs doses were within the QUANTEC constraints. These dosimetric parameters included volume parameters such as volume receiving 107%, 95%, 100% of the prescribed dose and total volume size (V107%, V95%, V100%, and Vtotal respectively), and dose parameters such as dose to 2%, 98%, 50%, and 1 cc of the target volume (D2%, D98%, D50%, D100% and D1cc respectively), and dosimetric indexes such as conformity index (CI), homogeneity index (HI), and quality of coverage (Q). All dose and volume percentages were calculated according to the prescribed dose and volume for each individual target volume.

**Results:** The average target-volume sizes recorded (mean  $\pm$  SD) were 243.5  $\pm$  151.2, 284.6  $\pm$  127.4, and 363.3  $\pm$  170.5 cm<sup>3</sup> for PTV70, PTV63, and PTV56 respectively. The average D2% as an indicator for high-dose region was 107.5  $\pm$  1.7 % (range: 102.6 – 112.6) for PTV70 while it was 111.3  $\pm$  2.6 %, and 110.7  $\pm$  3.5 % for PTV63 and PTV56 respectively. Moreover, the average V107% were 10.6  $\pm$  13.9, 29.3  $\pm$  21.2, and 25.2  $\pm$  22.5 % and the D1cc were 106.0  $\pm$  8.4, 101.1  $\pm$  6.5, and 110.3  $\pm$  4.7 % for PTV70, PTV63, and PTV56 respectively. On the other hand, the average D98% as an indicator for low-dose region were 96.3  $\pm$  3.9 %, 95.7  $\pm$  3.8 %, and 96.4  $\pm$  3.9% and the average V95% were 98.6  $\pm$  2.3, 97.9  $\pm$  2.5, and 95.7  $\pm$  14.4 % for PTV70, PTV63, and PTV56 respectively. The volume coverage parameter V100% and the dose coverage parameter D100% were 89.5  $\pm$  10 % and 89.8  $\pm$  7.7 %, 89.5  $\pm$  9.3 % and 79.5  $\pm$  7.3 %, and 89.5  $\pm$  18.2 % and 72.4  $\pm$  8.7 % for PTV70, PTV63, and PTV56 respectively. The best HI and Q were recorded for the high-risk volume (0.11  $\pm$  0.03 and 0.98  $\pm$  0.05 respectively) compared

to intermediate and low-risk volumes ( $0.14 \pm 0.05$  &  $0.14 \pm 0.06$  and  $0.96 \pm 0.05$  &  $0.97 \pm 0.05$  respectively). The CI was found to be  $0.97 \pm 0.16$  for the PTV70.

Conclusion: An average D2 was found to be 107% for high-risk target volume and 111% for both intermediate and low-risk target volume while an average D98 was found to be 96% for all target volumes. An evidence for possibility to get a target volume dose homogeneity within 10 – 15 % in NPC is presented and the need for similar studies from other centers is emerging to confirm these findings.

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