PTCOG-AO 2025
HONG KONG
NOV 7-9
PTCOG-AO

Theme: Clinical

Abstract No: PTCOG-AO2025-ABS-0170

MRI-Based Target Volume Dynamics for Patients with Nasopharyngeal Carcinoma Treated by Intensity-Modulated Proton Therapy

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Background / Aims:

Induction chemotherapy (IC) followed by concurrent chemoradiotherapy (CCRT) is the standard of care for advanced-stage nasopharyngeal carcinoma (NPC). Proton beam therapy (PBT) offers superior tumor control and reduced toxicity compared to photon therapy. Given the sharp dose gradients of PBT, changes in gross tumor volume can significantly affect dose distribution. However, tumor volume dynamics remains poorly characterized. This study evaluated MRI-based tumor volume changes in NPC patients receiving IC and intensity-modulated proton therapy (IMPT).

Subjects and Methods:

This retrospective study included patients with stage III–IV NPC (AJCC 8th edition) treated with IMPT at Kaohsiung Chang Gung Memorial Hospital. Serial contrast-enhanced MRIs were obtained at four time points: pre-IC, post-IC, mid-CCRT (15th fraction), and 12 weeks post-CCRT. The primary tumor (Tvol) and largest nodal metastasis (Nvol) were delineated at each time point. Volume changes were analyzed using paired t-tests or Wilcoxon signed-rank tests; associations with clinical variables were evaluated using the Mann–Whitney U test.

Result:

Thirty patients (median age 48 years; 24 male) were included, with 96.7% having nonkeratinizing carcinoma. Median follow-up was 26.6 months, with 2-year overall survival and locoregional progression-free survival both at 100%. All patients achieved complete response at the primary site; one had residual nodal disease (3.2 mL) successfully treated by neck dissection. Baseline Tvol averaged 22.9 mL (median: 13.8 mL; range: 3.7–142.3), and Nvol 13.1 mL (range: 1.0–38.7). Mean residual Tvol ratio declined from 57.0% at post-IC to 43.4% at mid-CCRT, and 0% post-CCRT (Figure 1); mean Nvol ratio dropped from 45.2% to 26.2% and 0.4%, respectively (all $p < 0.001$) (Figure 2). Significant volume reduction among the primary tumor and metastatic lymph nodes can be observed during the treatment.

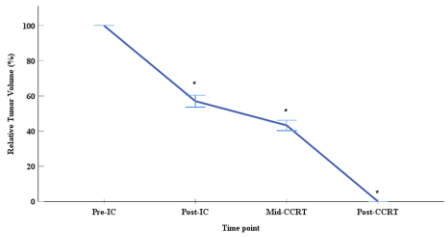

Figure 1. Changes in mean relative tumor volume percentages at four treatment time points: pre-induction chemotherapy (pre-IC), post-induction chemotherapy (post-IC), Mid-concurrent chemoradiotherapy (CCRT), and post-concurrent chemoradiotherapy CCRT follow-up.
Error bars present the standard error of mean. * p < .001

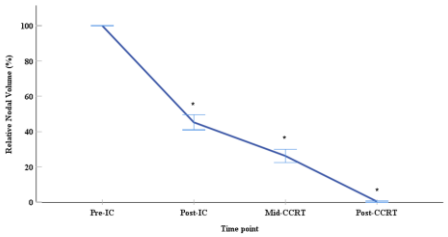

Figure 2. Changes in mean nodal tumor volume percentages at four treatment time points: pre-induction chemotherapy (pre-IC), post-induction chemotherapy (post-IC), Mid-concurrent chemoradiotherapy (Mid-CCRT), and post-concurrent chemoradiotherapy CCRT follow-up.
Error bars present the standard error of mean. * p < .001