



# Treatment Volume Determination for Irradiation Of recurrent Nasopharyngeal Carcinoma with Multimodality Imaging: An Original Article

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## Abstract

**Objective:** RT planning for nasopharyngeal carcinoma is typically based on computed tomography (CT) simulation of the patients in treatment position. While CT is essential for dose calculations and RT planning, additional data from multimodality imaging may assist in accurate target definition. In this original research article, we assess treatment volume determination for irradiation of recurrent nasopharyngeal carcinoma with multimodality imaging.

**Materials and Methods:** Determination of treatment volume by multimodality imaging with incorporation of magnetic resonance imaging (MRI) or by CT-simulation images only has been assessed with comparative evaluation in patients receiving irradiation for recurrent nasopharyngeal carcinoma.

**Results:** Contemporary RT planning systems at our department have been utilized for precise radiation treatment planning. Adequate coverage of treatment volumes with optimal sparing of critical structures were prioritized in RT planning. Definition of ground truth target volume has been accomplished by board certified radiation oncologists following comprehensive evaluation, collaboration, colleague peer review and ultimate consensus to be utilized for actual treatment and for comparative analysis. Synergy (Elekta, UK) LINAC has been utilized for irradiation. Treatment volume definition by CT-only imaging and by CT-MR fusion based imaging has been evaluated with comparative assessment. As the result, ground truth target volume has been found to be identical with treatment volume determination by CT-MR fusion based imaging.

**Conclusion:** Inclusion of MRI in RT planning procedure may be considered for improving the therapeutic ratio through optimization of target and treatment volume definition for precise and accurate reirradiation despite the need for further supporting evidence.

**Keywords:** nasopharyngeal carcinoma, reirradiation, recurrence, magnetic resonance imaging (MRI)

## 1. INTRODUCTION

Nasopharyngeal carcinoma is a frequent head and neck neoplasm which is endemic in Southern China [1-3]. Patients with nasopharyngeal carcinoma may benefit from multidisciplinary management including systemic agents and radiation therapy (RT). Since the role of surgery is typically limited for nasopharyngeal carcinoma treatment, RT constitutes an integral part of multimodality management. In the context of RT, there has been substantial progress in cancer management over the years with introduction of contemporary irradiation strategies, adaptive RT approaches, automatic segmentation techniques, molecular imaging methods, stereotactic irradiation, along with modernized treatment delivery techniques such as Image Guided

Radiation Therapy (IGRT), Intensity Modulated Radiation Therapy (IMRT), Adaptive Radiation Therapy (ART), Breathing Adapted Radiation Therapy (BART) [4-41]. While the improvements in radiation oncology are encouraging, the toxicity profile of radiation delivery remains to be a concern for patients receiving RT for nasopharyngeal carcinoma. In the setting of locally recurrent disease, it is more critical to consider adverse effects of reirradiation to avoid severe complications which may deteriorate quality of life and functionality.

RT planning for nasopharyngeal carcinoma is typically based on computed tomography (CT) simulation of the patients in treatment position. While CT is essential for dose calculations and RT planning, additional data from

multimodality imaging may assist in accurate target definition. In this original research article, we assess treatment volume determination for irradiation of recurrent nasopharyngeal carcinoma with multimodality imaging.

## **2. MATERIALS AND METHODS**

Determination of treatment volume by multimodality imaging with incorporation of magnetic resonance imaging (MRI) or by CT-simulation images only has been assessed with comparative evaluation in patients receiving irradiation for recurrent nasopharyngeal carcinoma. Ground truth target volume serving as the reference for actual treatment and comparison purposes has been comprehensively determined by the board certified radiation oncologists following thorough evaluation, collaboration, colleague peer review, and ultimate consensus. Detailed assessment has been performed individually with consideration of lesion size, localization, symptomatology, patient preferences, and expected outcomes of irradiation. CT-simulator (GE Lightspeed RT, GE Healthcare, Chalfont St. Giles, UK) has been utilized for radiation treatment simulation for RT planning at our tertiary cancer center. Planning CT images were acquired and transferred to the contouring workstation (SimMD, GE, UK) for outlining of treatment volumes and surrounding critical structures. Either CT-simulation images only or fused CT and MR images have been considered for treatment volume determination for RT. Treatment volume definition with CT only and with incorporation of CT-MR fusion has been comparatively assessed. Synergy (Elekta, UK) linear accelerator (LINAC) has been used for treatment delivery and IGRT techniques were routinely incorporated in radiotherapeutic management.

## **3. RESULTS**

Contemporary RT planning systems at our department have been utilized for precise radiation treatment planning. Adequate coverage of treatment volumes with optimal sparing of critical structures were prioritized in RT planning. Definition of ground truth target volume has been accomplished by board certified radiation oncologists following comprehensive evaluation, collaboration, colleague peer review and ultimate consensus to be utilized for actual treatment and for comparative analysis. Synergy (Elekta, UK) LINAC has been utilized for irradiation. Treatment volume definition by

CT-only imaging and by CT-MR fusion based imaging has been evaluated with comparative assessment. As the result, ground truth target volume has been found to be identical with treatment volume determination by CT-MR fusion based imaging.

## **4. DISCUSSION**

Nasopharyngeal carcinoma constitutes an important health concern as a frequent head and neck neoplasm particularly in Southern China. Affected patients may suffer from a plethora of symptoms since this critical region of the human body and its neighborhood may be associated with several functions including digestion, swallowing, hearing, speaking, and other important functions. Surgical resection has a limited role in management of nasopharyngeal carcinoma. Thus, RT and systemic agents are primarily used as therapies. RT has a major role in treatment, and encouraging treatment outcomes may be achieved with multidisciplinary management. However, patients may suffer from recurrent disease which is typically more difficult to manage. Main challenge in management of recurrent nasopharyngeal carcinoma is due to high delivered doses in the primary disease setting, and the need for limiting the reirradiation dose for avoidance of adverse radiation effects. Excessive exposure of critical structures at reirradiation may result in substantial morbidity which may be considered as a significant burden on the patients. Nevertheless, irradiation has been utilized for management of recurrent nasopharyngeal carcinoma [42-44].

Precise target and treatment volume definition is a critical component of reirradiation for recurrent nasopharyngeal carcinoma. While the typical RT planning process includes utilization of CT-simulation, multimodality imaging may add to the precision and accuracy of target definition. In the literature, several studies have addressed the utility of multimodality imaging for improved treatment volume determination [45-67]. Contemporary techniques including radiosurgical applications under rigid stereotactic immobilization and image guidance may improve radiotherapeutic management, however, target definition becomes more critical in the context of stereotactic irradiation since higher dose of radiation is typically delivered in a single or a few fractions. Defining larger than actual target volumes may lead to excessive critical organ exposure and resultant

morbidity. On the other hand, determination of smaller than actual target volumes may result in inadequate coverage of treatment volumes and subsequent failure of therapy. Within this context, optimization of target definition is a critical aspect of recurrent nasopharyngeal carcinoma management. Our study supporting the role of

multimodality imaging for target definition of recurrent nasopharyngeal carcinoma may add to the existing literature.

In conclusion, inclusion of MRI in RT planning procedure may be considered for improving the therapeutic ratio through optimization of target and treatment volume definition for precise and accurate reirradiation despite the need for further supporting evidence.

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