Cancer Therapy & Oncology
International Journal
ISSN: 2473-554X

Juniper Publishers
key to the Researchers

Research Article
Volume 24 Issue 5 - August 2023
DOI: 10.19080/CTOIJ.2023.23.556148

Cancer Ther Oncol Int J

Reappraisal of Treatment Volume Determination for Parametrial Boosting in Patients with Locally Advanced Cervical Cancer

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Submission: July 15, 2023 **Published:** August 14, 2023

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Abstract

Objective: In this study, we evaluated treatment volume determination for parametrial boosting in patients with locally advanced cervical cancer.

Materials and methods: Primary goal of this study has been to evaluate treatment volume determination for parametrial boosting based on CT only or fused CT-MRI in patients with locally advanced cervical cancer. We have carried out a comparative analysis of treatment volume determination by CT simulation images only or by integration of MRI. While we primarily focused on evaluation of incorporated multimodality imaging for treatment volüme determination, we also assessed critical organ contouring along with interobserver and intraobserver variations. Ground truth target volume has been utilized for comparative analysis, and it was determined by board certified radiation oncologists after detailed evaluation of all imaging and relevant data with thorough colleague peer review and consensus.

Results: Ground truth target volume was used as the reference for comparative evaluation, and our results revealed that use of fused CT-MRI based treatment volume determination was identical with ground truth target definition in our selected group of patients with locally advanced cervical cancer.

Conclusion: Multimodality imaging may be suggested to improve target definition for parametrial boosting in patients with locally advanced cervical cancer despite the need for further supporting evidence.

Keywords: Parametrial boosting, locally advanced cervical cancer; Radiation therapy (RT); Magnetic Resonance Imaging (MRI)

Introduction

Cervical cancers constitute a considerable public health concern with critical incidence among women worldwide, and many women suffer from morbidity and mortality due to cervical cancer globally [1-7]. Surgery, radiation therapy (RT), and chemotherapy may be used alone or in combination for optimal management of cervical cancer [2-7]. Several forms of irradiation in the forms of external beam radiation therapy and brachytherapy may be utilized, and techniques may include sequential or simultaneous parametrial boost according to patient, disease, and treatment characteristics. Parametrial boosting comprises a critical component of radiotherapeutic management for selected patients with cervical cancer. While the use of high effective doses may clearly contribute to improved local control outcomes, adverse effects of irradiation should also be considered to maintain patient's quality of life. In the millenium era, there have been several advances in technology which improved the delivery of irradiation. Molecular imaging methods, automatic segmentation techniques, Image Guided RT (IGRT), Intensity Modulated RT (IMRT), stereotactic RT, and adaptive RT (ART) have been introduced for facilitating optimal radiotherapeutic management of patients [8-49]. Admittedly, best therapeutic results could be obtained through close collaboration among related disciplines for cancer management.

Tumor boards bring together surgical oncologists, radiation oncologists, medical oncologists, imaging and other relevant specialists to discuss about patient, tumor, and treatment characteristics to find out the management strategy for individualized optimal management. From the standpoint of radiation oncology, optimal target volume determination and normal tissue sparing are among the critical considerations for

optimal radiotherapeutic management. While definition of larger target volumes may results in excessive radiation induced toxicity, determination of smaller treatment volumes may eventually lead to treatment failure. Within this context, efforts to improve target definition may translate into improved radiotherapeutic results from the perspectives of local control and toxicity. For the time being, Computed Tomography (CT) simulation constitutes the commonly practiced method for acquisition of radiation treatment planning images, however, inclusion of other imaging modalities such as Magnetic Resonance Imaging (MRI) may potentially add to the accuracy of target definition which has been addressed by other studies [50-99]. In this study, we evaluated treatment volume determination for parametrial boosting in patients with locally advanced cervical cancer.

Materials and Methods

For several decades, we have been treating a high patient population from many places from Turkey and abroad at Department of Radiation Oncology at Gulhane Medical Faculty, University of Health Sciences. Within this prospect, a plethora of benign and malignant tumors have been irradiated at our tertiary cancer center for a long time period. Primary goal of this study has been to evaluate treatment volume determination for parametrial boosting based on CT only or fused CT-MRI in patients with locally advanced cervical cancer. We have carried out a comparative analysis of treatment volume determination by CT simulation images only or by integration of MRI. While we primarily focused on evaluation of incorporated multimodality imaging for treatment volüme determination, we also assessed critical organ contouring along with interobserver and intraobserver variations. Ground truth target volume has been utilized for comparative analysis, and it was determined by board certified radiation oncologists after detailed evaluation of all imaging and relevant data with thorough colleague peer review and consensus. Decision making procedure for individualized patient management has involved multidisciplinary input from experts on surgical oncology, radiation oncology, medical oncology. Patient, disease, and treatment related factors were all considered. Patient age, previous treatments, symptomatology, lesion size, performance status, lesion localization and association with normal tissues, contemplated outcomes of alternative treatment alternatives, patient preferences and logistical issues have also been taken into account.

A Linear Accelerator (LINAC) furnished with sophisticated IGRT techniques has beeen utilized for RT. Following robust patient immobilization, planning CT images were obtained at CT simulator for radiation treatment planning. Then, acquired RT planning images have been transferred to the delineation workstation via the network. Treatment volumes and normal tissues have been outlined on these images and structure sets have been generated. Either CT simulation images only or fused CT-MR images have been used for assessment and comparative data analysis.

Results

We designated this original research article in an attempt to assess the utility of multimodality imaging with incorporation of MRI for treatment volume determination for parametrial boosting in a selected group of patients with locally advanced cervical cancer. Irradiation of patients was performed at our Radiation Oncology Department of Gulhane Medical Faculty at University of Health Sciences, Ankara. Before irradiation, patients were individually evaluated by multidisciplinary collaboration of surgical oncology, medical oncology and radiation oncology disciplines. Briefly, we executed a comparative analysis based on either CT only imaging or by fused CT-MRI to evaluate the use of this sophisticated strategy. Optimal RT planning procedure included consideration of lesion sizes, localization and association with nearby critical structures. Radiation physicists were included in RT planning process with consideration of reports by American Association of Physicists in Medicine (AAPM) and International Commission on Radiation Units and Measurements (ICRU). Precise RT planning process included consideration of electron density, tissue heterogeneity, CT number and HU values in CT images. Primary objective of RT planning has been to achieve optimal coverage of treatment volumes along with minimized exposure of surrounding critical structures. Ground truth target volume was used as the reference for comparative evaluation, and our results revealed that use of fused CT-MRI based treatment volume determination was identical with ground truth target definition in our selected group of patients with locally advanced cervical cancer.

Discussion

Cervical cancers are among the most important public health concerns with their critical incidence among women worldwide, and many women suffer from morbidity and mortality due to cervical cancer globally [1-7]. Surgery, radiation therapy (RT), and chemotherapy might be utilized alone or in combination for optimal management of cervical cancers [2-7]. Many forms of irradiation as external beam radiation therapy and brachytherapy might be used, and techniques may include sequential or simultaneous parametrial boost with regard to patient, disease, and treatment characteristics. Parametrial boosting constitutes a critical component of radiotherapeutic management for selected patients with cervical cancer. While the use of high effective doses may clearly contribute to improved local control outcomes, adverse effects of irradiation should also be considered to maintain patient's quality of life. In the millenium era, several advances in technology have occurred which improved the delivery of irradiation. Molecular imaging methods, automatic segmentation techniques, Image Guided RT (IGRT), Intensity Modulated RT (IMRT), stereotactic RT, and adaptive RT (ART) have been

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introduced for facilitating optimal radiotherapeutic management of patients [8-49]. As a matter of fact, best therapeutic results might be acquired by close collaboration of related disciplines for cancer management.

Tumor boards bring together surgical oncologists, radiation oncologists, medical oncologists, imaging and other relevant specialists to discuss about patient, tumor, and treatment characteristics to find out the management strategy for individualized optimal management. From the standpoint of radiation oncology, optimal treatment volume determination and critical organ sparing are among the critical considerations for optimal radiotherapeutic management. While definition of larger target volumes may results in excessive radiation induced toxicity, determination of smaller treatment volumes may eventually lead to treatment failure. Within this context, efforts to improve target definition may translate into improved radiotherapeutic results from the perspectives of local control and toxicity. Several other studies have also addressed the utility of multimodality imaging for improved target definition [50-99]. In this study, we have assessed treatment volume determination for parametrial boosting in patients with locally advanced cervical cancer and found out that multimodality imaging improves this critical procedure of target definition. Multimodality imaging may be suggested to improve target definition for parametrial boosting in patients with locally advanced cervical cancer despite the need for further supporting evidence.

Conflict of Interest and Acknowledgement

There are no conflicts of interest and no acknowledgement.

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How to cite this article: Selcuk D, Ferrat D, Omer S, Murat B. Reappraisal of Treatment Volume Determination for Parametrial Boosting in Patients with Locally Advanced Cervical Cancer. Canc Therapy & Oncol Int J. 2023; 24(5): 556148. DOI: 10.19080/CTOIJ.2024.23.556148

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DOI: 10.19080/CTOIJ.2024.23.556148

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