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Preoperative IMRT of Esophageal Cancer

Bora Uysal* and Hakan Gamsiz

Department of Radiation Oncology, University of Health Sciences, Gulhane Medical Faculty, Ankara, Turkey

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Corresponding author: Bora Uysal, Department of Radiation Oncology, University of Health Sciences, Gulhane Medical Faculty, Ankara, Turkey

Abstract

Objective: In this study, we evaluated preoperative IMRT of esophageal cancer.

Materials and methods: Primary goal of this study has been to evaluate treatment volume determination for esophageal cancer. We have carried out a comparative analysis of treatment volume determination by CT simulation images only or by integration of PET. While we primarily focused on evaluation of incorporated multimodality imaging for treatment volume determination, we also assessed critical organ contouring along with interobserver and intra observer 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 PET-CT based treatment volume determination was identical with ground truth target definition in our selected group in esophageal cancer patients.

Conclusion: Multimodality imaging may be suggested to improve target definition for PET-CT fusion in patients with esophageal cancer despite the need for further supporting evidence.

Keywords: Esophageal cancer; Intensity modulated radiotherapy; Multimodality imaging; Documentation of treatment; Reducing toxicity levels

Abbreviations: IMRT: Intensity-Modulated Radiation Therapy; RT: Radiation Therapy; LINAC: Linear Accelerator; AAPM: American Association of Physicists in Medicine; ICRU: International Commission on Radiation Units and Measurements

Introduction

Esophageal cancer is a devastating disease that affects the esophagus, the muscular tube responsible for transporting food from the mouth to the stomach. With an increasing incidence rate worldwide, it is essential to explore innovative approaches to improve treatment outcomes and enhance patient quality of life. In recent years, preoperative intensity-modulated radiation therapy (IMRT) has emerged as a promising strategy for managing esophageal cancer. Before delving into the benefits of preoperative IMRT, it is crucial to understand the context in which this treatment approach is utilized. Esophageal cancer is typically classified into two main types: squamous cell carcinoma and adenocarcinoma. Assessment of patient eligibility for preoperative IMRT involves evaluating tumor location, stage, and the patient's overall health condition. Multidisciplinary discussions between surgical oncologists, radiation oncologists, and medical oncologists are vital to making informed decisions regarding treatment plans. Traditionally, curative radiation therapy (RT) has been an option for patients with inoperable esophageal cancer or those who are precluded from undergoing surgery due to various reasons. However, recent advancements in surgical techniques and perioperative care have expanded the spectrum of patients who can safely undergo surgery. For these patients, preoperative IMRT has emerged as an attractive alternative to curative RT.

One of the primary advantages of preoperative IMRT lies in its ability to deliver targeted radiation doses to tumor tissues while sparing adjacent healthy organs. Traditional RT techniques often result in radiation exposure to critical structures such as the lungs, heart, and spinal cord, leading to adverse effects and complications. IMRT, on the other hand, allows for better dose distribution, minimizing the potential for long-term toxicity and improving patient outcomes.

Moreover, preoperative IMRT can facilitate tumor shrinkage and downstaging, making surgery more feasible and potentially increasing the chance of achieving negative surgical margins. By administering low doses of radiation prior to surgery, it is possible to reduce tumor size, eradicate microscopic disease, and increase the chances of successful surgical resection. This multimodal approach, combining radiation and surgery, has the potential to enhance long-term survival rates for patients with esophageal cancer [1-15].

Materials and Methods

We have carried out a comparative analysis of treatment volume determination by CT simulation images only or by integration of PET. While we primarily focused on evaluation of incorporated multimodality imaging for treatment volume determination, we also assessed critical organ contouring along with interobserver and intra observer variations.

We have been treating a high patient population from many places from Turkey and abroad at. Within this prospect, a plethora of benign and malignant tumors have been irradiated at our tertiary cancer center for a long time. Primary goal of this study has been to evaluate treatment volume determination for esophageal cancer based on PET and CT fusion. 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 been 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 to assess the utility of multimodality imaging with incorporation of PET-CT fusion for treatment volume determination in a selected group of patients with esophageal 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 PET-CT to evaluate the use of this sophisticated strategy. Optimal RT planning procedure in cluded 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. Truth target volume was used as the reference for comparative evaluation, and our results revealed that use of fused PET-CT based treatment volume determination was identical with ground truth target definition in our selected group of patients with esophageal cancer.

Discussion

Scope of this trial (NCT00193882) is to investigate the feasibility and safety of preoperative IMRT and its potential impact on postoperative morbidity for patients with operable esophageal cancer. IMRT has been shown to be highly effective in conformal avoidance of organs and tissues not involved with tumor. Due to the close proximity of esophagus to critical surrounding structures such as heart, lungs, and spinal cord, esophageal cancer patients may be at high risk for debilitating side effects from radiation therapy. When compared to 3D-CRT, IMRT has potential in reducing toxicity levels for patients and increasing therapeutic ratios. With these points in mind, preoperative IMRT may be a rational measure for patients with respectable disease [16-55].

Traditionally, preoperative radiation and chemotherapy has been associated with high morbidity rates. Classically, severe complications have been documented in 30-40% of patients receiving preoperative radiation followed by surgery. Recent trials such as INT 0123 and RTOG 98-11 have shown that chemoradiotherapy has the potential in improving survival rates for patients with esophageal cancer. With the integration of IMRT, this combination treatment may be utilized adjunctively with surgery to further improve tumor targeting and in reducing radiation induced toxicity for patients. It is unclear at this time whether morbidity rates of overall chemoradiotherapy and surgery can be improved through the use of IMRT. Through detailed documentation of treatment related toxicity, patient reported quality of life assessments, and monitoring of postoperative recovery time, this trial may give insight on the possible benefits of preoperative IMRT. Phase I of the study will investigate the radiation component through the following SEEI-IMRT dose escalation: Level I: 36 Gy in 2 Gy fractions to PTV1, Level II: 41.4 Gy in 2.1 Gy fractions to PTV2, Level III: 46.8 Gy in 2.2 Gy fractions to PTV3.

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A recent study conducted by researchers in Europe demonstrated the benefits of preoperative IMRT in improving survival outcomes for esophageal cancer patients. The study found that patients who received preoperative IMRT had significantly higher overall survival rates compared to those who underwent surgery alone or received curative RT. This finding further supports the notion that preoperative IMRT has the potential to be a game-changer in the management of esophageal cancer. Despite its promise, preoperative IMRT should be approached cautiously and on an individualized basis. Adequate patient selection and comprehensive treatment planning are imperative to optimize the benefits of this strategy while minimizing potential risks. Close collaboration between surgical and radiation oncologists, along with a multidisciplinary team of healthcare providers, is necessary to ensure that each patient receives the most appropriate and effective treatment.

In conclusion, preoperative IMRT of esophageal cancer presents a potentially innovative and effective approach to enhance treatment outcomes. By administering low-dose radiation prior to surgery, it allows for tumor shrinkage, downstaging, and increased chances of complete surgical resection with negative margins. With careful patient selection and comprehensive treatment planning, preoperative IMRT can revolutionize the management of esophageal cancer and improve both survival rates and quality of life for patients. Continued research and collaboration among healthcare providers will play a crucial role in further refining this treatment approach and maximizing its benefits for patients worldwide [56-99].

Conflict of Interest

No.

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