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# An Original Article for Assessment of Multimodality Imaging Based Precise Radiation Therapy (Rt) in the Management of Recurrent Pancreatic Cancers

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**Abstract**

**Objective:** Department of Radiation Oncology, Gulhane Medical Faculty, University of Health Sciences serves as a tertiary cancer center and referral institution for management of a plethora of malignancies. The aim of this study is to assess the use of multimodality imaging based radiation therapy (RT) for recurent pancreatic cancers.

**Materials and Methods:** In this study, patents referred for radiotherapeutic management of recurrent pancreatic cancer were assessed in terms of multimodality imaging based RT. We investigated whether multimodality imaging improves target, critical organ, and treatment volume definition along with interobserver and intraobserver variations. We planned a comparative analysis regarding critical organ and RT target definitions based on Computed Tomography (CT) simulation images only or by integration of Magnetic Resonance Imaging (MRI) in the RT planning process.

**Results:** In this original research article, patients referred for radiotherapeutic management of recurrent pancreatic cancer at our tertiary referral institution were assessed for target and critical organ definition by use of multimodality imaging. Target and critical organ definition by either CT-only imaging or by CT-MR registration based imaging has been assessed comparatively. As the primary endpoint of our study, we have identified that ground truth target volume was identical with the CT-MR registration based imaging for radiotherapeutic management of patients with recurrent pancreatic cancer.

**Conclusion:** Our study indicates improved target and critical organ definition through the use of multimodality imaging for radiotherapeutic management of recurrent pancreatic cancers. Admittedly, future studies are needed to shed light on this critical issue.

**Keywords:** Recurrent pancreatic cancer; Radiation therapy (RT); Magnetic resonance imaging (MRI)

## Introduction

Pancreatic cancer is a leading cause of cancer related morbidity and mortality universally [1-5]. While the incidence is not as frequent as most common cancers such as lung cancer, breast cancer, prostate cancer, and colorectal cancers; a considerable proportion of patients afflicted with pancreatic cancer succumb to their disease usually within a relatively shorter timeframe. Prognosis is typically grim. Surgical resection is the principle modality of treatment, however, complete surgical resection may not be feasible for majority of patients due to invasion of vital structures [6-8]. Multidisciplinary management with surgery, radiation therapy (RT), and systemic treatment may be considered to improve the therapeutic ratio for patients suffering from pancreatic cancers. The role of RT with different techniques and sequencing has been addressed in the literature [9-17]. Adverse effects of irradiation and additional burden on the patients comprise a major concern for radiotherapeutic management. Within this context, improving the toxicity profile of radiation delivery should be regarded as an indispensable aspect of contemporary radiotherapeutic management in the millenium era.

Optimal target definition is a very critical step for RT, and several studies have underscored the importance of accuracy

and precision in contouring [9-17]. There may be differences in delineation, and this critical part of RT process may unfortunately lead to treatment failures or excessive toxicity in some patients. The most common practice in a considerable proportion of of RT centers includes the utilization of Computed Tomography (CT) for radiation treatment simulation and planning. CT is a viable tool for dose calculation and treatment purposes, however, use of CT as the only imaging modality for RT planning may lead to inadequate definition of treatment volumes. From this standpoint, utilization of multimodality imaging may aid in optimal target and critical organ definition for radiotherapeutic management of pancreatic cancers [23-25]. Herein, we assess the use of multimodality imaging based RT for recurent pancreatic cancers.

## Materials and methods

Department of Radiation Oncology, Gulhane Medical Faculty, University of Health Sciences serves as a tertiary cancer center and referral institution for management of a plethora of malignancies. In this study, patents referred for radiotherapeutic management of recurrent pancreatic cancer were assessed in terms of multimodality imaging based RT. We investigated whether multimodality imaging improves target, critical organ, and treatment volume definition along with interobserver and intraobserver variations. We planned a comparative analysis regarding critical organ and RT target definitions based on CT simulation images only or by integration of Magnetic Resonance Imaging (MRI) in the RT planning process. For the purpose of comparative analysis and to be utilized for actual treatment, a ground truth target volume has been determined for each patient by board certified radiation oncologists after meticulous evaluation, colleague peer review, and consensus. The individualized decision making procedure for treatment with RT has involved multidisciplinary input from relevant disciplines of surgical oncology and medical oncology. Patient, disease, and treatment characteristics including age, symptomatology, previous therapies, lesion size, localization and association with normal tissues, contemplated outcomes of suggested therapies, patient preferences and logistical issues were considered to achieve optimal patient selection for precise RT.

We used Synergy (Elekta, UK) linear accelerator (LINAC) to administer precise RT. Included patients individually underwent CT simulation at the available CT simulator (GE Lightspeed RT, GE Healthcare, Chalfont St. Giles, UK) for acquisition of high quality RT planning images. After the CT simulation procedure, acquired RT planning images were sent to the delineation workstation (SimMD, GE, UK) by the network. Structure sets including the target volumes and critical organs were outlined. Target volume and critical organ definition was performed by either the CT simulation images only or by registered CT and MR images. For the purpose of this study, we carried out a comparative analysis for assessment of target and critical organ definition by CT only and with incorporation of CT-MR registration based imaging to investigate the impact of multimodality imaging.

## Results

In this original research article, patients referred for radiotherapeutic management of recurrent pancreatic cancer at our tertiary referral institution were assessed for target and critical organ definition by use of multimodality imaging. Target and critical organ definition by either CT-only imaging or by CT-MR registration based imaging has been assessed comparatively. Evaluated tumor-related parameters were lesion size, location and association with normal tissues. Moreover, symptomatology, performance status, patient age, logistical issues, lesion location and association with other critical structures were also considered. Reports by American Association of Physicists in Medicine (AAPM) and International Commission on Radiation Units and Measurements (ICRU) were considered in state of the art RT planning. Through the detailed consideration of contemporary guidelines and clinical experience, our radiation physicists took role in generation of RT plans with consideration of critical organ dose constraints. Electron density, tissue heterogeneity, CT number and HU values in CT images have also been considered by radiation physicists for precision in RT planning. Most important objective in RT planning was achievement of optimal target volume coverage without jeopardizing critical organ dose constraints. Determination of ground truth target volume has been carried out by the board certified radiation oncologists after thorough evaluation, rigorous colleague peer review, and consensus. Ground truth target volume has been utilized for actual treatment and for comparison purposes. We made use of Image Guided Radiotherapy (IGRT) techniques including the kilovoltage cone beam CT and electronic digital portal imaging. RT delivery was achieved by use of Synergy (Elekta, UK) LINAC. As the primary endpoint of our study, we have identified that ground truth target volume was identical with the CT-MR registration based imaging for radiotherapeutic management of patients with recurrent pancreatic cancer.

## Discussion

Currently, pancreatic cancer remains to be a major cause of cancer related morbidity and mortality on a global scale [1-5]. The incidence of pancreatic cancer is lower than many common malignancies including lung cancer, breast cancer, prostate cancer, and colorectal cancers, nevertheless, a considerable proportion of pancreatic cancer patients typically succumb to their disease within a relatively shorter timeframe. From this perspective, the prognosis may be considered as poor with a relentless disease course in many afflicted patients. Surgery offers a viable local treatment modality to improve therapeutic outcomes, however, complete surgical removal of pancreatic cancers may not be achieved for majority of the patients in view of intimate association of the tumor with critical structures [6-8]. Efforts have been focused on multidisciplinary management with surgical resection, RT, and systemic treatment to achieve the best possible treatment results. The role of RT in the neoadjuvant, adjuvant, and intraoperative setting by utilization


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of different techniques and sequencing has been addressed in the literature [9-17]. Nevertheless, adverse irradiation effects and the additional burden on the patients currently comprise a critical concern for RT. In view of this fact, any improvement in the toxicity profile of RT should be considered as an important aspect of sophisticated RT strategies in the millenium era. Clearly, optimization of target definition composes a very critical step for successfull RT applications, and the importance of accuracy and precision in delineation has been emphasized by experts [9-17].

Contouring practice may show diversities between different centers, and this very important component of the RT procedure may potentially result in treatment failures or adverse irradiation effects in some patients. Use of CT for RT simulation and planning is very frequent among cancer treatment facilities. CT serves as a viable technique for dose calculation and treatment purposes, however, utilization of CT as the sole imaging modality for RT planning may not be adequate for optimal definition of target volumes and critical organs. With this in mind, use of multimodality imaging may judiciously assist in optimal target and critical organ definition for radiotherapeutic management of pancreatic cancers [23-25]. As a matter of fact, adverse effects of RT should be vigilantly considered to get rid of undesired consequences. Exploittaion of innovatory IGRT techniques, adaptive RT (ART) approaches, and improved target and critical organ definition may be considered among the several aspects of sophisticated RT strategies to achieve an improved therapeutic ratio. Target definition composes an indispensable component of the RT process, and indeed, incorporation of multimodality imaging techniques and image fusion methods has been shown to result in improved target definition for a variety of tumors. As yet, there has been a growing body of data supporting the utility of multimodality imaging for improved target definition [26-61].

In the meantime, CT simulation remains to be a useful tool for RT planning for pancreatic cancers. CT may remain to serve as a viable imaging modality, however, integration and combined utilization of other imaging modalities such as MRI may lead to improved target definition. In the current study, we have assessed RT target and critical organ delineation for recurrent pancreatic cancers by use of multimodality imaging and revealed that target and critical organ definition might be improved by use of multimodality imaging. Taking this into account, the current study may have clinical implications and offer additional data in support of improved target and critical organ determination through the incorporation of multimodality imaging in the target and critical organ definition process.

Several advances have been achieved in the field of radiation oncology in recent years with the introduction of stereotactic radiotherapy, molecular imaging methods, automatic segmentation techniques, intensity modulated radiotherapy (IMRT), IGRT, and ART [62-100]. By use of these state of the art approaches and strategies, accuracy and precision in target definition has been a more critical part of current management. In this regard, we consider that this original research article could possess pertinent clinical implications for routinization of multimodality imaging for improved target and critical organ determination of recurrent pancreatic cancers.

## Conclusion

In conclusion, this study indicates improved target and critical organ definition through the use of multimodality imaging for radiotherapeutic management of recurrent pancreatic cancers. Admittedly, future studies are needed to shed light on this critical issue.

## Conflict of Interest

There are no conflicts of interest and no acknowledgements.

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