



Reappraisal of Computed Tomography (CT) And Magnetic Resonance Imaging (MRI) Based Target Definition for Radiotherapeutic Management of Recurrent Anal Squamous Cell Carcinoma (ASCC): An Original Article



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Abstract

Objective: Anal squamous cell carcinoma (ASCC) is a very common histological subtype of anal cancers. Intensity Modulated Radiation Therapy (IMRT) with dose painting serves as the current standard radiotherapeutic approach for management of ASCC. Optimal delineation of critical organs and target volumes comprise an indispensable component of successful IMRT for ASCC. In this study, we evaluate Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) based target definition for radiotherapeutic management of recurrent ASCC.

Materials and methods: Our Department of Radiation Oncology at Gulhane Medical Faculty, University of Health Sciences serves as a tertiary cancer center and referral institution for management of a plethora of malignancies for many years. For the purpose of current study, we have included patients who have been referred for RT of recurrent ASCC. Our aim was to investigate whether multimodality imaging contributed to target, critical organ, interobserver and intraobserver variations, and treatment volume determination for patients planned to undergo radiotherapeutic management for ASCC.

Results: Ground truth target volume has been found to be identical with fused CT-MRI based target definition for radiotherapeutic management of ASCC as the main outcome of this original research article.

Conclusion: We have assessed CT and MRI based target definition for radiotherapeutic management of recurrent ASCC and found that multimodality imaging improves target definition in this study. Clearly, there is need for future studies.

Keyword: Anal squamous cell carcinoma (ASCC); Radiation therapy (RT); Magnetic resonance Imaging (MRI)

Introduction

Although anal cancers comprise a relatively smaller proportion of all cancers diagnosed worldwide, the incidence appears to demonstrate an increasing trend which may partly be attributed to potentially rising prevalence of risk factors such as viral infections including Human Papilloma Virus (HPV) and Human Immunodeficiency Virus (HIV) [1-5]. Anal squamous cell carcinoma (ASCC) is a very common histological subtype of anal cancers. Although relatively rare among other more frequent cancers, affected patients with ASCC may suffer from a variety of symptoms which may profoundly deteriorate their quality of life.

Discharge of mucus, bleeding, pain, itching, and incontinence may be considered among the several symptoms of ASCC.

Currently, multimodality management is the treatment of choice for ASCC [6-11]. In terms of radiotherapeutic management, Intensity Modulated Radiation Therapy (IMRT) with dose painting has resulted in satisfactory outcomes as the current standard [12-14]. Nevertheless, quality of life after treatment of anal cancers presents a critical concern [15-17]. To improve the therapeutic ratio, a critical balance between therapeutic efficacy and toxicity is warranted. Clearly, recent radiotherapeutic approaches such

as IMRT has allowed for improved critical organ sparing with reduced normal tissue exposure due to steep dose gradients around the target volumes. Nevertheless, the implementation of sophisticated treatment methods such as IMRT needs critical requirements and optimization. Optimal delineation of critical organs and target volumes comprise an indispensable component of successful IMRT for ASCC. Multimodality imaging has been suggested as a viable strategy for improved target definition for a plethora of indications [18-53]. In this study, we evaluate Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) based target definition for radiotherapeutic management of recurrent ASCC.

Materials and Methods

Our Department of Radiation Oncology at Gulhane Medical Faculty, University of Health Sciences serves as a tertiary cancer center and referral institution for management of a plethora of malignancies for many years. For the purpose of current study, we have included patients who have been referred for RT of recurrent ASCC. Our aim was to investigate whether multimodality imaging contributed to target, critical organ, interobserver and intraobserver variations, and treatment volume determination for patients planned to undergo radiotherapeutic management for ASCC. In this context, we have executed a comparative analysis for determination of critical organ and RT target volumes based on CT simulation images only or by incorporation of MRI in the sophisticated procedure of RT planning. A ground truth target volume to serve for comparative analysis and for actual treatment was outlined individually for every patient by multiobserver input from board certified radiation oncologists.

The delineation process was run by thorough evaluation, colleague peer review, and consensus to achieve optimal results. Also, the decision making step for using RT for patient management was judiciously performed by multidisciplinary detailed assessment of involved cancer treatment disciplines including surgery, medical oncology, and radiation oncology. We took into account individual patient, disease, and treatment characteristics with consideration of age, symptomatology, administered prior treatments, lesion size, localization and association with critical structures, expected results of suggested treatments, patient preferences and logistical issues for choosing wisely to achieve the optimal therapeutic ratio.

Synergy (Elekta, UK) linear accelerator (LINAC) has been utilized for delivery of accurate and precise RT. CT simulation has been individually performed for acquiring high quality RT planning images at CT simulator (GE Lightspeed RT, GE Healthcare, Chalfont St. Giles, UK). Following the CT simulation process, the acquired RT planning images have been transferred to the contouring workstation (SimMD, GE, UK) by use of the network for generation of the structure sets including target volumes and critical organs. To assess the endpoint of the study,

target volume and critical organ delineation has been performed by using either the CT simulation images only or by fused CT and MR images. Consequently, a comparative analysis has been executed to evaluate target and critical organ definition by either CT only and with integration of fused CT-MR based imaging to find out the impact of multimodality imaging for improved definition of volumes.

Results

Patients receiving RT for recurrent ASCC at Department of Radiation Oncology, Gulhane Medical Faculty, University of Health Sciences have been evaluated for target volume and critical organ determination by incorporation of multimodality imaging in this original research study. A comparative analysis has been conducted to assess treatment volume and critical organ definition by use of either CT only imaging or by fused CT-MRI based RT planning. Most relevant tumor related parameters included the lesion sizes, localization and association with surrounding critical structures. Additionally, we took account the patient symptomatology, individual performance status, age, logistical issues, lesion localization and association with other normal tissues. A critical aspect of RT planning was thorough consideration of the reports by American Association of Physicists in Medicine (AAPM) and International Commission on Radiation Units and Measurements (ICRU) to improve the results. Generation of RT plans by expert radiation physicists has involved strict adherence to recent guidelines in combination with years of available clinical experience. For accuracy and precision in the RT planning process, relevant parameters including electron density, tissue heterogeneity, CT number and HU values in CT images were considered.

A critical goal in RT planning has been providing optimal treatment volume coverage without jeopardizing normal tissue dose limitations. There has been meticulous assessment, rigorous colleague peer review, and consensus for definition of the ground truth target volumes by the board certified radiation oncologists. Ground truth target volumes have served as the references for comparison purposes and have also been used for actual treatment. We have also exploited the advantage of Image Guided Radiation Therapy (IGRT) techniques such as the kilovoltage cone beam CT and electronic digital portal imaging for improved setup accuracy and precision. Administration of RT has been performed by the Synergy (Elekta, UK) LINAC available at our tertiary referral institution. Ground truth target volume has been found to be identical with fused CT-MRI based target definition for radiotherapeutic management of ASCC as the main outcome of this original research article.

Discussion

ASCC is the principal histological subtype of anal cancers. While the incidence and prevalence is relatively lower than most frequent cancers, an increasing trend in frequency of anal cancers

is of potential concern which may partly be ascribed to the rising prevalence of risk factors including viral infections such as HPV and HIV [1-5]. Afflicted patients with ASCC may present with a plethora of symptoms which could significantly deteriorate their quality of life. Bleeding, mucus discharge, itching, pain, and incontinence may be considered among symptoms of patients with ASCC.

Current practice for management of ASCC supports multimodality management with respect to patient, tumor, and treatment characteristics [6-11]. For radiotherapeutic management, dose painting IMRT has been widely accepted given the satisfactory outcomes at long term [12-14]. However, quality of life issues remain to be a concern after therapeutic management of anal cancers [15-17]. A critical balance between therapeutic efficacy and toxicity is warranted to improve the therapeutic ratio. Admittedly, contemporary radiotherapeutic strategies including IMRT, IGRT, stereotactic RT, molecular imaging methods, automatic segmentation techniques, and adaptive RT have contributed to improved critical organ sparing with reduced normal tissue exposure with steeper dose gradients around the target volumes [54-92]. However, the use of complex therapeutic strategies such as IMRT warrants critical requirements and optimization. Optimal delineation of critical organs and target volumes comprise an indispensable component of successful IMRT for ASCC.

Currently, CT for RT simulation and planning is the common practice in a plethora of cancer treatment centers globally. CT clearly serves as a viable technique for dose calculation and treatment purposes, nevertheless, using CT as the only imaging modality for RT planning may not be adequate for optimal definition of target volumes and critical organs at some circumstances. Taking this into account, incorporation of multimodality imaging may critically aid in optimal target and critical organ determination for radiotherapeutic management of anal cancers [93,94]. At this standpoint, we believe that our study may add to the accumulating data on the utility of multimodality imaging for improved RT target definition of anal cancers.

Conclusion

In conclusion, we have assessed CT and MRI based target definition for radiotherapeutic management of recurrent ASCC and found that multimodality imaging improves target definition in this study. Clearly, there is need for future studies.

Conflict of Interest

There are no conflicts of interest and no acknowledgements.

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