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Assessment of Target Volume Definition for Contemporary Radiotherapeutic Management of Retroperitoneal Sarcoma: An Original Article

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Keywords: Retroperitoneal Sarcoma; Radiation Therapy (RT); Magnetic Resonance Imaging (MRI)

Abbreviations: CT: Computed Tomography; LINAC: Linear Accelerator; IGRT: Image Guided RT; AAPM: American Association of Physicists in Medicine; ICRU: International Commission on Radiation Units and Measurements

ABSTRACT

Objective: Surgery has been the principal mode of management for retroperitoneal sarcomas, however, complete surgical removal may not be achievable particularly in the setting of large tumor sizes and involvement of nearby critical structures. In an attempt to improve therapeutic outcomes, the use of radiation therapy (RT) has been addressed. Target definition has gained more importance and relevance with the availability of contemporary RT strategies. Herein, we evaluate multimodality imaging based RT target definition for radiotherapeutic management of retroperitoneal sarcomas.

Materials and Methods: In this study, we aimed to investigate if multimodality imaging contributes to target volume definition, interobserver and intraobserver variations for patients treated for retroperitoneal sarcoma. Within this context, an evaluation with comparative analysis has been performed to shed light on this important aspect of radiotherapeutic management. We performed a comparative assessment of RT target volume definition by integration of Magnetic Resonance Imaging (MRI) or by Computed Tomography (CT) simulation images only.

Results: Modern treatment equipment has been used for irradiation. Synergy (Elekta, UK) Linear Accelerator (LINAC) was utilized, and we made use of contemporary Image Guided RT (IGRT) strategies such as kilovoltage cone beam CT and electronic digital portal imaging for optimal setup verification. As the primary outcome of this study, the ground truth target volume was observed to be identical with CT-MR fusion based imaging for precise RT of retroperitoneal sarcoma.

Conclusion: This study indicates improvement in treatment volume determination for precise RT of retroperitoneal sarcoma by integration of MRI in RT target definition process albeit with the requirement for further supporting evidence.

Introduction

Soft tissue sarcomas are relatively rare and comprise a heterogeneous group of malignancies. While the most common localization for soft tissue sarcomas includes the limbs, a considerable proportion occur in the retroperitoneum. Soft tissue sarcomas include a variety of histologic subtypes such as liposarcomas, undifferentiated-unclassified tumors, and leiomyosarcomas. Among the group of soft tissue sarcomas, retroperitoneal sarcomas deserve utmost attention since they represent a heterogeneous and relatively rare group of tumors originating from mesenchymal cells with considerably high rates of local recurrence and mortality. Surgery has been the principal mode of management for retroperitoneal sarcomas, however, complete surgical removal may not be achievable particularly in the setting of large tumor sizes and involvement of nearby critical structures. In an attempt to improve therapeutic outcomes, the use of radiation therapy (RT) has been addressed [1-7]. Surgical resection with negative margins may be challenging to achieve in some circumstances and neoadjuvant or adjuvant therapeutic strategies may be considered. RT may be utilized as a local treatment option, however, adverse radiation effects should be considered [1-7]. Critical advances in the millennium era for improved RT outcomes include sophisticated technologies along with state of the art irradiation techniques [8-46]. Accuracy and precision in target volume definition may be considered as a more important aspect of state of the art radiotherapeutic strategies to comply with these contemporary improvements. An overwhelming majority of RT centers currently make use of Computed Tomography (CT) simulation for radiotherapeutic management of retroperitoneal sarcomas. Clearly, CT remains to be a viable imaging modality for this purpose, however, incorporation of other imaging modalities such as Magnetic Resonance Imaging (MRI) may lead to improved target definition. Herein, we evaluate multimodality imaging based RT target definition for radiotherapeutic management of retroperitoneal sarcomas.

Materials and Methods

Herein, we had the purpose of investigating whether any improvement may be achieved through the incorporation of multimodality imaging in the target volume definition process for radiotherapeutic management of retroperitoneal sarcoma. To achieve this goal, a thorough appraisal has been utilized to shed light on this important aspect. We have carried out thorough comparative investigation of RT target volume definition. To be utilized for actual treatment and comparison purposes, a ground truth target volume was outlined individually by board certified radiation oncologists. Patients who have been allocated to RT for retroperitoneal sarcoma were included, and decision making for RT has been performed on a multidisciplinary basis. At the outset, alternative treatment strategies and protocols have been thoroughly discussed. Synergy (Elekta, UK) linear accelerator (LINAC) has been utilized for treatment delivery. Selected patients underwent CT-simulation at the CT-simulator. After the CT-simulation process has been completed, acquired images have been transferred to the contouring workstation. Outlining of structure sets including treatment volumes and critical structures comprised an important aspect of RT planning. Treatment volume determination has been performed by either the CT-simulation images only or by fused CT and MR images. A comparative analysis has been performed for evaluation of treatment volume determination by CT only and with incorporation of CT-MR fusion based imaging.

Results

Patients with retroperitoneal sarcoma referred to Department of Radiation Oncology, Gulhane Medical Faculty, University of Health Sciences were assessed for treatment volume definition by either CT-only imaging or by CT-MR fusion based imaging in this original research article. Lesion size, localization and association with critical structures, and disease extent were among the considered tumor associated characteristics. Also, we individually took into account the patient ages, symptoms, and performance status before radiotherapeutic management of retroperitoneal sarcoma. The reports by American Association of Physicists in Medicine (AAPM) and International Commission on Radiation Units and Measurements (ICRU) have also been considered for improved treatment planning. Radiation physicists played a significant role in generation of optimal RT plans by taking into account the recent informatory guidelines and clinical experience. Considered parameters in RT planning included the critical organ dose limitations, tissue heterogeneity, electron density, CT number and HU values in CT images. Primary aim of treatment planning was to achieve optimal treatment volume coverage while respecting the preset critical organ dose limitations. Modern treatment equipment has been used for irradiation, and we made use of contemporary image guidance strategies such as kilovoltage cone beam CT and electronic digital portal imaging for optimal setup verification. As the primary outcome of this study, the ground truth target volume was observed to be identical with CT-MR fusion based imaging for precise RT of retroperitoneal sarcoma.

Discussion

Although relatively rare, retroperitoneal sarcomas comprise a heterogeneous group of tumors originating from the mesenchymal cells. They may be typically associated with high rates of local recurrence and resultant mortality. While the main therapeutic option includes surgical resection to achieve optimal treatment results, complete removal of the tumor may not be achieved in some patients particularly when the tumor is large and in intimate association with surrounding critical structures. Within this context, RT may be considered in selected patients as another local therapeutic approach [1-7]. The primary objective of irradiation is eradication of as many tumor cells as possible without damage to normal tissues. However, achieving an optimal therapeutic ratio by RT may be hampered by critical organ dose constraints and the desired ablative doses of irradiation may sometimes not be administered due to the risk of excessive radiation induced toxicity. Several contemporary RT techniques and strategies have been developed recently to improve the toxicity profile of

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radiation delivery. Nevertheless, target definition has gained more importance and relevance with the availability of contemporary RT strategies. In this context, target definition for optimal RT planning is an indispensable component of sophisticated RT approaches. Meanwhile, CT-simulation is the most frequently used procedure for RT planning in a plethora of cancer centers. Cross sectional imaging with thin CT slices has clearly improved target and critical organ definition for radiotherapeutic management, however, incorporation of additional imaging with MRI may further refine this critical procedure. Fusion of CT-simulation and MR images may allow for exploiting the advantage of multimodality imaging. Indeed, the addition of MRI to CT images has been demonstrated to improve RT planning for a variety of cancers [47-80]. At this standpoint, we cordially believe that this study may add to the accumulating data on this subject and may have pertinent clinical implications for utilization of multimodality imaging for optimal RT of retroperitoneal sarcoma. We conclude that our study indicates improvement in treatment volume determination for precise RT of retroperitoneal sarcoma by integration of MRI in RT target definition process albeit with the requirement for further supporting evidence.

Conflicts of Interest

There are no conflicts of interest and no acknowledgements.

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