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Multimodality Imaging Based Target Definition of Cervical Lymph Nodes in Precise Limited Field Radiation Therapy (Lfrt) for Nodular Lymphocyte Predominant Hodgkin Lymphoma (Nlphl)

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Abstract

Objective: *Nodular lymphocyte predominant hodgkin lymphoma (NLPHL) constitutesa distinct and typically indolent subtype of hodgkin lymphoma with favorable therapeutic outcomes. Radiation therapy (RT) plays a major role in management of NLPHL. Irradiation of limited target volumes is an area of active investigation to limit radiation induced toxicities. Nevertheless, accuracy and precision in target definition is of utmost importance in the context of limited field RT (LFRT). Herein, we assess multimodality imaging based target definition of cervical lymph nodes in precise LFRT for NLPHL.*

Materials and Methods: *Incorporation of integrated positron emission tomography (PET)- computed tomography (CT) imaging for target volume determination of NLPHL was evaluated.*

Results: *Determination of ground truth target volume was performed by board-certified radiation oncologists after meticulous assessment, thorough consideration, collaboration, colleague peer review, and ultimate consensus for actual treatment and for compison purposes. RT delivery was performed by Synergy (Elekta, UK) LINAC with kilovoltage cone beam CT and electronic portal imaging verification capability. Target volume definition by CT-only imaging and by incorporated PET-CT images was assessed with comparative analysis. Ground truth target volume was found to be identical with target volume definition by incorporated PET-CT images.*

Conclusion: *Multimodality imaging based target volume definition should be considered for radiotherapeutic management of NLPHL with LFRT. Further studies are needed to shed light on this issue.*

Keywords: *nodular lymphocyte predominant hodgkin lymphoma (NLPHL), limited fieldradiation therapy (LFRT), positron emission tomography (PET)*

1. Introduction

Hodgkin lymphoma is a rare subtype of B cell lymphoma [1]. Nodular lymphocyte predominant hodgkin lymphoma (NLPHL) constitutes a distinct and typically indolent subtype of hodgkin lymphoma with favorable therapeutic outcomes [2-5]. Radiation therapy (RT) plays a major role in management of NLPHL. However, active surveillance has even been considered as an initial management strategy for selected patients given the typically indolent disease course and concerns regarding treatment induced toxicities [6]. In the context of RT, several studies have addressed use of different approaches for improving the toxicity profile of irradiation such as dose deescalation and limited field RT (LFRT) [7-12]. Irradiation of limited treatment volumes may serve as a viable method in the context of reduced adverse effects, however, this strategy should be utilized carefully with accurate and precise target definition to avoid any geographical misses which may lead to treatment failure. RT planning for NLPHL is typically based on computed tomography (CT) simulation at treatment position. Incorporation of additional imaging modalities offer great potential for improved target definition. Herein, we assess multimodality imaging based target definition of cervical lymph nodes in precise LFRT for NLPHL.

2. Materials and Methods

Incorporation of integrated positron emission tomography (PET)-CT imaging for target

volume determination of NLPHL was evaluated. Either CT-simulation images only or incorporated PET-CT images were utilized for target definition in patients receiving LFRT directed at the cervical lymph nodes for NLPHL management. Ground truth target volume which served as the reference for actual treatment and comparison purposes was meticulously determined by the board-certified radiation oncologists after comprehensive evaluation, collaboration, colleague peer review, and ultimate consensus. Thorough patient evaluation was performed considering lesion sizes, localization, association with critical structures, symptomatology, patient preferences, and contemplated outcomes of treatment. CT-simulator (GE Lightspeed RT, GE Healthcare, Chalfont St. Giles, UK) was used for treatment simulation and RT planning. Planning CT images were acquired and then sent to the contouring workstation (SimMD, GE, UK) via the network for delineation of target volumes and nearby critical structures. Target definition based on CT only and incorporated PET-CT images was evaluated with comparative analysis. RT was delivered by Synergy (Elekta, UK) linear accelerator (LINAC) with routine iutilization of Image Guided Radiation Therapy (IGRT) techniques by use of daily kilovoltage cone beam CT and electronic portal imaging.

3. RESULTS

RT treatment plans were generated by the precise RT planning systems at our tertiaryreferral institution. Prioritization was given for adequate encompassing of the target volume whilst protecting nearby critical structures as much as possible. Determination of ground truth target volume was performed by board-certified radiation oncologists after meticulous assessment, thorough consideration, collaboration, colleague peer review, and ultimate consensus for actual treatment and for compison purposes. RT delivery was performed by Synergy (Elekta, UK) LINAC with kilovoltage cone beam CT and electronic portal imaging verification capability. Target volume definition by CT-only imaging and by incorporated PET-CT images was assessed with comparative analysis. Ground truth target volume was found to be identical with target volume definition by incorporated PET-CT images.

4. DISCUSSION

NLPHL is a distinct subtype of hodgkin lymphoma with a favorable prognosis in majority of affected patients [2-5]. Active surveillance was even considered for selected patients with NLPHL with respect to indolent disease course and concerns about adverse effects of treatment [6]. Given the favorable prognosis with excellent survival of patients, improving the toxicity profile of therapy is an indispensable component of current treatment strategies. In the context of RT, there has been a trend towards irradiating limited target volumes to improve the therapeutic ratio. Cervical lymph node irradiation may be associated with radiation induced adverse effects since this region includes critical structures. LFRT may serve as a viable alternative to extended field radiotherapeutic approaches with reduced exposure of nearby critical structures. Irradiation of limited target volumes is an area of active investigation to limit radiation induced toxicities. Nevertheless, accuracy and precision in target definition is of utmost importance in the context of LFRT. In the era of artificial intelligence based applications, it is now possible to expedite several processes during the typical RT workflow such as image segmentation, image registration and reconstruction, treatment planning and verification. While RT planning is usually based on CT-simulation, incorporation of additional imaging data may significantly improve definition of target volumes for irradiation of NLPHL. Within this context, several studies have assessed multimodality imaging based target definition [13-32]. Our results support the use of multimodality imaging based target definition for radiotherapeutic management of NLPHL in the setting of LFRT, and our study may add to the growing body of evidence in the literature.

Recent years have witnessed substantial progress in radiation oncology discipline with introduction of adaptive RT approaches and state of the art treatment delivery techniques with incorporation of Image Guided Radiation Therapy (IGRT), Adaptive Radiation Therapy (ART), Breathing Adapted Radiation Therapy (BART), Intensity Modulated Radiation Therapy (IMRT), automatic segmentation techniques, molecular imaging methods, and stereotactic irradiation strategies [33-68]. In the context of RT for NLPHL, studies have addressed irradiation of limited treatment volumes to improve the toxicity profile of radiation delivery [7-12]. This strategy may result in reduced normal tissue exposure and radiation induced toxicity, however, vigilance is

required to avoid geographic misses. Accuracy and precision in definition of target volume is a more critical aspect of radiotherapeutic management in the setting of LFRT for NLPHL.

In conclusion, multimodality imaging based target volume definition should be considered for radiotherapeutic management of NLPHL with LFRT. Further studies are needed to shed light on this issue.

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