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Research Article

Treatment volume definition for irradiation of primary lymphoma of the orbit: Utility of multimodality imaging

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Abstract

Objective: Irradiation may be utilized for management of orbital lymphomas with successful treatment results. However, adverse radiation effects may be considered as a concern particularly in the setting of higher delivered doses despite the excellent rates of tumor control in majority of irradiated patients. Multimodality imaging may serve as a contemporary approach for precise target definition in management of orbital lymphomas. Within this context, we assessed multimodality imaging based treatment volume definition for irradiation of primary lymphoma of the orbit in this original article.

Materials and methods: Treatment volume definition by multimodality imaging with incorporation of MRI or by computed tomography (CT)-simulation images only was evaluated with comparative analysis in a series of patients receiving irradiation for orbital lymphoma.

Results: Available treatment planning systems at our tertiary referral institution were used for precise radiation treatment planning. Prioritization was given for encompassing of the target volumes with optimal sparing of critical structures in radiation treatment planning. Synergy (Elekta, UK) LINAC was used in RT delivery. Treatment volume determination by CT-only imaging and by CT-MR fusion based imaging was assessed with comparative analysis. As a result, ground truth target volume was found to be identical with treatment volume definition with CT-MR fusion based imaging.

Conclusion: Accurate and precise target and treatment volume determination comprises an indispensable aspect of successful orbital lymphoma irradiation. Within this context, incorporation of MRI in target and treatment volume definition process may be strongly considered for improving the optimization of target and treatment volume determination for optimal irradiation. Clearly future studies are required to shed light on this issue.

Introduction

Although orbital lymphomas comprise a small proportion of of all lymphomas, primary lymphoma of the orbit occurring in the conjunctiva, lacrimal gland, eyelid and ocular musculature is a frequent orbital tumor accounting for approximately one half of all orbital malignancies [1]. Histology may mostly consist of mucosa associated lymphoid tissue (MALT) or diffuse large B cell non Hodgkin lymphoma. Vitrectomy, vitreal biopsy, or choroidal sampling may be utilized for establishing the diagnosis. Affected patients usually present with a painless orbital mass which is mostly located at the superior lateral quadrant in close vicinity of lacrimal gland. Pain, erythema, and swelling are relatively rare symptoms, however, exophthalmos, ptosis, diplopia, and ocular movement disturbances may occur. Impaired vision can also be a symptom despite relatively rare direct infiltration of optic apparatus.

Irradiation may be utilized for management of orbital lymphomas with successful treatment results [2-7]. However, adverse radiation effects may be considered as a concern particularly in the setting of higher delivered doses despite the excellent rates of tumor control in majority of irradiated patients [5-7]. Multimodality imaging may serve as a contemporary approach for precise target definition in management of orbital lymphomas. Within this context, we assessed multimodality

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imaging based treatment volume definition for irradiation of primary lymphoma of the orbit in this original article.

Materials and methods

Treatment volume definition by multimodality imaging with incorporation of MRI or by Computed Tomography (CT)-simulation images only was evaluated with comparative analysis in a series of patients receiving irradiation for orbital lymphoma. Ground truth target volume to serve as reference for actual treatment and comparison purposes was meticulously defined by board certified radiation oncologists after thorough assessment, collaboration, colleague peer review, and ultimate consensus. Thorough evaluation was performed for each individual patient taking into account lesion sizes, localization, symptoms, patient preferences, and contemplated outcomes of irradiation treatment. CT-simulator (GE Lightspeed RT, GE Healthcare, Chalfont St. Giles, UK) was used in radiation treatment simulation for treatment planning at our institution. Planning CT images were acquired and sent to the delineation workstation (SimMD, GE, UK) for outlining of treatment volumes and nearby critical structures. Either CT-simulation images only or fused CT and MR images were utilized for treatment volume definition for radiation treatment. Treatment volume determination with CT only and with incorporation of CT-MR fusion was evaluated with comparative analysis. Synergy (Elekta, UK) Linear Accelerator (LINAC) was utilized for treatment delivery with routine incorporation of Image Guided Radiation Therapy (IGRT) techniques.

Results

Available treatment planning systems at our tertiary referral institution were used for precise radiation treatment planning. Prioritization was given for encompassing of the target volumes with optimal sparing of critical structures in radiation treatment planning. Determination of ground truth target volume was performed by board-certified radiation oncologists after meticulous assessment, collaboration, colleague peer review and ultimate consensus to be used for actual treatment and for comparative evaluations. Synergy (Elekta, UK) LINAC was used in RT delivery. Treatment volume determination by CT-only imaging and by CT-MR fusion based imaging was assessed with comparative analysis. As a result, ground truth target volume was found to be identical with treatment volume definition with CT-MR fusion based imaging.

Discussion

Although the delivered irradiation doses for management of orbital lymphomas may be relatively lower, optimal sparing of surrounding normal tissues and critical structures is an indispensable component of contemporary radiotherapy applications in the millennium era. In this context, precise target and treatment volume definition comprises an integral part of current radiotherapy practice. There has been tremendous progress in recent years with substantial improvements radiation oncology discipline thanks to introduction of adaptive irradiation strategies along with modernized treatment delivery techniques such as incorporation of Image Guided Radiation Therapy (IGRT), Intensity Modulated Radiation Therapy (IMRT), Adaptive Radiation Therapy (ART), Breathing Adapted Radiation Therapy (BART), automatic segmentation techniques, molecular imaging methods and stereotactic irradiation [8-43]. In the context of orbital lymphoma irradiation, several studies have reported encouraging treatment outcomes [1-7]. However, precise target definition is a more critical aspect of successful irradiation with introduction of contemporary treatment techniques and modalities. While sophisticated technologies such as radiosurgery may allow for focused irradiation under robust immobilization and thus offer improved precision and accuracy, target definition gains utmost importantance considering the high doses of irradiation delivered in a single or a few fractions. Optimal target and treatment volume definition is a worthwhile component of irradiation for orbital lymphomas. Determination of larger than actual treatment volumes can substantially increase exposure of surrounding structures leading to untowards toxicity of irradiation. From another standpoint, definition of smaller than actual treatment volumes with inadequate encompassing of treatment volumes may result in consequential treatment failure. Within this context, there remains to be an apparent requirement for optimized treatment volume definition. IGRT techniques typically offer improvements in target localization, and utilization of matched CT and MR images can facilitate optimization of target determination for accurate irradiation. Indeed, several other studies have addressed multimodality imaging based treatment volume definition for a variety of indications [44-74]. This study can add to the growing body of evidence by addressing of multimodality imaging for target definition of orbital lymphomas.

Conclusion

Accurate and precise target and treatment volume determination comprises an indispensable aspect of successful orbital lymphoma irradiation. Within this context, incorporation of MRI in target and treatment volume definition process may be strongly considered for improving the optimization of target and treatment volume determination for optimal irradiation. Clearly future studies are required to shed light on this issue.

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