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Evaluatıon of Target Volume Determınatıon for Irradıatıon of Pılocytıc Astrocytomas: An Orıgınal Artıcle

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Abstract

Background: *Pilocytic astrocytomas are the most frequent gliomas in children. Radiation therapy (RT) may have a role in management of pilocytic astrocytomas either as an adjunctive, salvage or primary treatment in selected patients. Nevertheless, toxicity profile of considered treatments are an important concern for management of pilocytic astrocytomas. Determination of target volumes for irradiation of pilocytic astrocytomas constitutes a critical part of radiotherapeutic management and has been poorly addressed in the literature. In this context, we evaluate incorporation of multimodality imaging with magnetic resonance imaging (MRI) into target volume determination for irradiation of pilocytic astrocytomas in this original research article.*

Materials and Methods: *RT treatment volume determination based on multimodality imaging with incorporation of MRI or by use of computed tomography (CT)-simulation images only has been comparatively assessed for patients with pilocytic astrocytoma in our study.*

Results and Conclusion: *Radiation treatment planning has been performed by the available treatment planning system at our department. Optimal target coverage with minimization of normal tissue exposure has been prioritized. Synergy (Elekta, UK) LINAC has been utilized for treatment delivery. Irradiation treatment volume definition by CT-only imaging and by CT-MR fusion based imaging was comparatively evaluated in this study. Ground truth target volume determined by the board-certified radiation oncologists after thorough assessment, collaboration, colleague peer review and ultimate consensus has been found to be identical to target definition by use of CT-MR fusion based imaging. In conclusion, treatment volume definition constitutes a critical part of irradiation for pilocytic astrocytomas. Incorporation of MRI into the treatment volume determination procedure for improved radiation treatment planning for pilocytic astrocytomas may be considered to achieve optimal outcomes despite the need for further supporting evidence.*

Keywords: *Pilocytic Astrocytoma, Irradiation, Magnetic Resonance Imaging (MRI)*

1. INTRODUCTION

Pilocytic astrocytomas are the most frequent gliomas in children. Radiation therapy (RT) may have a role in management of pilocytic astrocytomas either as an adjunctive, salvage or primary treatment in selected patients. Nevertheless, toxicity profile of considered treatments are an important concern for management of pilocytic astrocytomas. Since children comprise a considerable proportion of the patients, long term adverse effects should be taken into account in decision making for treatment. Pilocytic astrocytomas typically follow an excellent prognosis which renders quality of life an endpoint of utmost importance. Depending on the location of lesion and its association with critical surrounding structures, a variety of adverse effects may occur due to irradiation. In this context, omission or deferral of RT may be considered on an individualized basis for patients with pilocytic astrocytoma. Nevertheless, irradiation in the forms of conventionally fractionated RT (CFRT) or radiosurgery as Stereotactic Radiosurgery (SRS), Hypofractionated Stereotactic Radiotherapy (HFSRT), and Stereotactic Body Radiotherapy (SBRT) may be judiciously used for optimal management of several central nervous system (CNS) disorders as well as a variety of other tumors throughout the human body with promising results [1, 38]. Determination of target volumes for irradiation

of pilocytic astrocytomas constitutes a critical part of radiotherapeutic management and has been poorly addressed in the literature. In this context, we evaluate incorporation of multimodality imaging with magnetic resonance imaging (MRI) into target volume determination for irradiation of pilocytic astrocytomas in this original research article.

2. MATERIALS AND METHODS

RT treatment volume determination based on multimodality imaging with incorporation of MRI or by use of computed tomography (CT)-simulation images only has been comparatively assessed for patients with pilocytic astrocytoma in our study. Ground truth target volume to be used as the reference for actual treatment and comparison purposes was determined by the board-certified radiation oncologists after thorough evaluation, colleague peer review, collaboration, and ultimate consensus. Comprehensive assessment was performed considering the lesion size, location, patient symptomatology and preferences along with expected outcomes of treatment individually. Treatment simulation for RT planning has been performed at the CT-simulator (GE Lightspeed RT, GE Healthcare, Chalfont St. Giles, UK) available in our institution. Planning CT images were acquires and then sent to the contouring workstation (SimMD, GE, UK) for delineation of treatment volumes and organs at risk. Either CT-simulation images only or fused CT and MR images have been used for treatment volume determination for irradiation. Treatment volume definition with CT only and by incorporation of CT-MR fusion has been comparatively assessed. Determination of ground truth target volume has been performed by the board-certified radiation oncologists after thorough evaluation, collaboration, colleague peer review and ultimate consensus to be used for actual treatment as well as for comparison purposes. Treatment delivery has ben performed by Synergy (Elekta, UK) linear accelerator (LINAC) available at our tertiary cancer center.

3. RESULTS

Radiation treatment planning has been performed by the available treatment planning system at our department. Optimal target coverage with minimization of normal tissue exposure has been prioritized. Synergy (Elekta, UK) LINAC has been utilized for treatment delivery. Irradiation treatment volume definition by CT-only imaging and by CT-MR fusion based imaging was comparatively evaluated in this study. Ground truth target volume determined by the board-certified radiation oncologists after thorough assessment, collaboration, colleague peer review and ultimate consensus has been found to be identical to target definition by use of CT-MR fusion based imaging.

4. DISCUSSION

Pilocytic astrocytomas comprise the most common gliomas in children. These tumors are typically low grade tumors following an indolent disease course. Irradiation can be used for management of pilocytic astrocytomas as an adjunct therapy or in the setting of recurrences. There has been considerable growth in irradiation capacity of several cancer centers for a plethora of benign and malign conditions. Also, important advances have been introduced in the discipline of radiation oncology including adaptive irradiation strategies and state of the art treatment delivery techniques such as incorporation of molecular imaging, automatic segmentation procedures, Image Guided Radiation Therapy (IGRT), Adaptive Radiation Therapy (ART), Intensity Modulated Radiation Therapy (IMRT), Breathing Adapted Radiation Therapy (BART), and stereotactic irradiation with SRS, HFSRT, and SBRT [38, 49].

Determination of irradiation target volumes constitutes a critical part of radiotherapeutic management of pilocytic astrocytomas. Avoiding geopraphical misses and untowards radiation induced toxicity are pertinent goals of irradiation in the millennium era. Determination of larger target volumes may lead to severe toxicity associated with RT, nevertheless, definition of smaller than actual target volumes may result in geopraphical misses and subsequent disease progression. Addition of multimodality imaging may be utilized for improving the accuracy of treatment volume localization, and combined use of fused CT and MR images may aid in optimizing target volume definition for RT. There is scant data in the literature addressing the utility of multimodality imaging for radiation treatment planning of pilocytic astrocytomas. In this context, this study may add to the existing literature.

5. CONCLUSION

In conclusion, treatment volume definition constitutes a critical part of irradiation for pilocytic astrocytomas. Incorporation of MRI

into the treatment volume determination procedure for improved radiation treatment planning for pilocytic astrocytomas may be considered to achieve optimal outcomes despite the need for further supporting evidence.

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