

Evaluation of Treatment Volume Determination for Irradiation of chordoma: an Original Article

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ABSTRACT

Objective: Chordomas are relatively rare tumors arising from the remnants of the notochord. These locally aggressive tumors may cause destruction of bone and extension into adjacent soft issues. Radiation therapy (*RT*) may be used as a treatment modality for management of chordomas. Chordomas are considered as radio resistant tumors, and high doses may be required to achieve durable local control rates with irradiation. In this context, treatment volume definition is a critical component of safe and effective radio therapeutic management.

Materials and Methods: Meticulous assessment has been performed on an individual basis for consideration of lesion size, location, symptomatology, patient preferences, and predicted outcomes of management. Treatment volume determination by use of multimodality imaging within corporation of MRI or by computed tomography (CT)-simulation images only was comparatively assessed for patients irradiated for chordoma in our study.

Results: Optimal target coverage and sparing of normal tissues was prioritized in radiation treatment planning. In our study, ground truth target volume has been found to be identical with treatment volume determination based on CT-MR fusion based imaging.

Conclusion: Toxicity profile of radiation delivery is an important aspect of radio therapeutic management given the typically critical location of chordomas in intricate association with vital neurovascular structures. Precision and accuracy in treatment volume definition is a critical component of irradiation for chordoma. Incorporation of MRI in treatment volume determination procedure can be considered for improving the optimization of target volume definition for precise radiation delivery despite the need for further supporting evidence.

Keywords: chordoma, radiation therapy (RT), magnetic resonance imaging (MRI), irradiation

INTRODUCTION

Chordomas are relatively rare tumors arising from the remnants of primitive embryonal cells also referred to as the notochord [1-3]. Most frequent locations for chordoma include the skull base and sacrum. A slow growth pattern with an indolent disease course is common, however, these locally aggressive tumors may cause destruction of bone and extension into adjacent soft tissues [4,5]. Affected patients may suffer from several symptoms depending on lesion location. Surgery is a main therapeutic modality for management of chordomas, however, complete surgical resection may not be feasible for tumors in the vicinity of critical neurovascular structures, and local recurrences may represent a considerable concern [5-7]. In this context, radiation therapy (RT) may be used as a treatment modality to address residual disease or recurrences, and also as the primary mode of management in selected patients [7-10]. Irradiation by use of conventionally fractionated RT (CFRT) or radio surgery as Stereotactic Radio surgery (SRS), Fractionated Stereotactic Radiation Therapy (FSRT), and Stereotactic Body Radiation Therapy (SBRT) or Stereotactic Ablative Body Radiotherapy (SABR) may serve as a viable therapeutic option with promising results for management of various central nervous system (CNS) disorders and for many other benign and malignant tumors throughout the human body [11-32]. As for chordomas, the role of irradiation has been addressed in several studies [7-10]. Chordomas are considered as radio resistant tumors, and high doses may be required to achieve durable local control rates with irradiation [33].Toxicity profile of radiation delivery is an important aspect of radio therapeutic management given the typically critical location of chordomas in intricate association with vital neurovascular structures. In this context, treatment volume definition is a critical component of safe and effective radio therapeutic management. In this study, we evaluated incorporation of multimodality imaging for treatment volume determination for irradiation of chordomas.

MATERIALS AND METHODS

Treatment volume determination by use of multimodality imaging with incorporation of MRI or by computed tomography (CT)simulation images only was comparatively assessed for patients irradiated for chordoma in our study. Ground truth target volume used as reference for actual treatment and comparison purposes has been determined by board-certified radiation oncologists after thorough evaluation, colleague peer review, collaboration, and ultimate consensus. Meticulous assessment has been performed on an individual basis for consideration of lesion size, location. symptomatology, patient preferences, and predicted outcomes of management. CTsimulator (GE Lights peed RT, GE Healthcare, Chalfont St. Giles, UK) has been utilized for radiation treatment simulation for RT planning at our department. Planning CT images have been acquired and then transferred to the contouring workstation (Sim MD, GE, UK) for treatment delineation of volumes and surrounding critical organs. Either CTsimulation 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 assessed comparatively. Definition of the ground truth target volume has been performed by board-certified radiation oncologists after thorough evaluation. collaboration, colleague peer review and ultimate consensus to be utilized for actual treatment as well as for comparative analysis. Synergy (Elekta, UK) linear accelerator (LINAC) has been used for treatment delivery with routine utilization of Image Guided Radiation Therapy (IGRT) techniques.

RESULTS

Radiation treatment planning has been performed by use of the available treatment planning systems at our tertiary cancer center. Optimal target coverage and sparing of normal tissues was prioritized in radiation treatment planning. Synergy (Elekta, UK) LINAC has been utilized for RT administration. Irradiation treatment volume definition by CT-only imaging and by CT-MR fusion based imaging has been comparatively evaluated. In our study, ground truth target volume defined by boardcertified radiation oncologists after thorough assessment. collaboration, colleague peer review, and ultimate consensus has been found identical with treatment volume to be determination based on CT-MR fusion based imaging.

DISCUSSION

Chordomas are relatively rare but locally aggressive tumors with predilection for local recurrence. RT with conventional fractionation or radio surgery has been utilized for improving local control rates and for definitive management in selected cases. Recent years have witnessed considerable achievements in the discipline of radiation oncology with introduction of adaptive RT approaches and state of the art treatment delivery techniques incorporation automatic including of segmentation techniques, molecular imaging methods, Adaptive Radiation Therapy (ART), Image Guided Radiation Therapy (IGRT), Intensity Modulated Radiation Therapy (IMRT). Breathing Adapted Radiation Therapy (BART), and stereotactic irradiation with SRS, FSRT, and SABR [34-44]. Sophisticated technologies including radio surgery may facilitate focused irradiation with robust immobilization and offer improvements in precision and accuracy of radiation treatments, nevertheless, treatment volume determination becomes more important given the high doses of radiation in a single or a few fractions. Accuracy in treatment volume determination is an integral part of successful chordoma irradiation. Defining larger than actual treatment volumes may significantly increase exposure of adjacent normal tissues which may result in excessive radiation induced toxicity. On the other hand, inadequate encompassing of the target volume may lead to treatment failure. At this point, there is an obvious need for improved target volume determination and localizaton. IGRT techniques may offer improved target localization, and combined use of registered CT and MR images may assist in optimization of treatment volume definition for precise RT delivery. Multimodality imaging for irradiation treatment volume determination has been assessed in

several studies [45-63]. Our study may add to the literature with regard to addressing of multimodality imaging for treatment volume determination for chordoma irradiation.

In conclusion, precision and accuracy in treatment volume definition is a critical component of irradiation for chordoma. Incorporation of MRI in treatment volume determination procedure can be considered for improving the optimization of target volume definition for precise radiation delivery despite the need for further supporting evidence.

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