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 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
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 importance 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 may result in consequential treatment failure. Within this context, there remains to be an apparent requirement for optimized target 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.

References

1. Eckardt AM, Lemond J, Rana M, Gelrich NC (2013) Orbital lymphoma: diagnostic approach and treatment outcome. World J Surg Oncol 11: 73. Link: https://bit.ly/3sEbcuj
2. Niwa M, Ishikura S, Tatekawa K, Takama N, Miyakawa A, et al. (2020) Radiotherapy alone for stage IE ocular adnexal mucosa-associated lymphoid tissue lymphomas: long-term results. Radiat Oncol 15: 25. Link: https://bit.ly/3jv7EHi
3. König L, Stade R, Rieber J, Debus J, Herfarth K (2016) Radiotherapy of indolent orbital lymphomas: Two radiation concepts. Strahlenther Onkol 192: 414-421. Link: https://bit.ly/3Hl6r3
4. Zhou P, Ng AK, Silver B, Li S, Hua L, et al. (2005) Radiation therapy for orbital lymphoma. Int J Radiat Oncol Biol Phys 63: 866-871. Link: https://bit.ly/3ergW8h
5. Kharod SM, Herman MP, Morris CG, Lightsey J, Mendenhall WM, et al. (2018) Radiotherapy in the Management of Orbital Lymphoma: A Single Institution’s Experience Over 4 Decades. Am J Clin Oncol 41: 100-106. Link: https://bit.ly/3guhjBx

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Multimodality management of cavernous sinus meningiomas with less extensive surgery followed by subsequent irradiation: Implications for an improved toxicity profile. J Surg Surgical Res 6: 056-061. Link: https://bit.ly/3toKvi

22. Beyzadeoglu M, Sager O, Dincoglan F, Demiral S, Uysal B, et al. (2020) Single Fraction Stereotactic Radiosurgery (SRS) versus Fractionated Stereotactic Radiotherapy (FSRT) for Vestibular Schwannoma (VS). J Surg Surgical Res 6: 062-066. Link: https://bit.ly/3qVHo5

23. Dincoglan F, Beyzadeoglu M, Sager O, Demiral S, Uysal B, et al. (2020) A Concise Review of Irradiation for Temporal Bone Chemodectomas (TBC). Arch Otolaryngol Head 6: 016-020. Link: https://bit.ly/3cvmTw

24. Dincoglan F, Sager O, Uysal B, Demiral S, Gamsiz H, et al. (2019) Evaluation of hypofractionated stereotactic radiotherapy (HFSRT) for the resection cavity after surgical resection of brain metastases: A single center experience. Indian J Cancer 56: 202-206. Link: https://bit.ly/3lE0eVM

25. Dincoglan F, Sager O, Demiral S, Gamsiz H, Uysal B, et al. (2019) Fractionated stereotactic radiosurgery for locally recurrent brain metastases after failed stereotactic radiosurgery. Indian J Cancer 56: 151-156. Link: https://bit.ly/3kGgss

26. Demiral S, Dincoglan F, Sager O, Uysal B, Gamsiz H, et al. (2018) Contemporary Management of Meningiomas with Radiosurgery. Int J Radiol Imaging Technol 80: 187-190. Link: https://bit.ly/3rJWiRw

27. Dincoglan F, Sager O, Demiral S, Uysal B, Gamsiz H, et al. (2017) Radiosurgery for recurrent glioblastoma: A review article. Neurul Disord Therap 1: 1-5. Link: https://bit.ly/3OJZTQ

28. Demiral S, Dincoglan F, Sager O, Gamsiz H, Uysal B, et al. (2016) Hypofractionated stereotactic radiotherapy (HFSRT) for who grade I anterior clinoid meningiomas (ACM). Jpn J Radiol 34: 730-737. Link: https://bit.ly/30FfBk

29. Gamsiz H, Beyzadeoglu M, Sager O, Demiral S, Dincoglan F, et al. (2015) Evaluation of stereotactic body radiation therapy in the management of adrenal metastases from non-small cell lung cancer. Tumori 99: 101-103. Link: https://bit.ly/3lBpNa

30. Sager O, Dincoglan F, Beyza Link: deoglu M (2015) Stereotactic radiosurgery of glomus jugulare tumors: Current concepts, recent advances and future perspectives. CNS Oncol 4: 105-114. Link: https://bit.ly/3ih1FjT

31. Dincoglan F, Beyzadeoglu M, Sager O, Demiral S, Gamsiz H, et al. (2015) Management of patients with recurrent glioblastoma using hypofractionated stereotactic radiotherapy. Tumori 101: 179-184. Link: https://bit.ly/3dD4BN

32. Demiral S, Beyzadeoglu M, Sager O, Dincoglan F, Gamsiz H, et al. (2014) Evaluation of linear accelerator (linac)-based stereotactic radiosurgery (srs) for the treatment of cranioopharyngiomas. UHOD - Uluslararası Hematoloji-Onkoloji Dergisi 24: 123-129. Link: https://bit.ly/3vr4Dq

33. Gamsiz H, Beyzadeoglu M, Sager O, Dincoglan F, Demiral S, et al. (2014) Management of pulmonary oligometastases by stereotactic body radiotherapy. Tumori 100: 179-183. Link: https://bit.ly/2Q7UCDH

34. Demiral S, Beyzadeoglu M, Sager O, Dincoglan F, Gamsiz H, et al. (2014) Evaluation of linear accelerator (linac)-based stereotactic radiosurgery (srs) for the treatment of cranioopharyngiomas. UHOD - Uluslararası Hematoloji-Onkoloji Dergisi 24: 123-129. Link: https://bit.ly/3vr4Dq

35. Dincoglan F, Sager O, Gamsiz H, Uysal B, Demiral S, et al. (2014) Management of patients with ≥ 4 brain metastases using stereotactic radiotherapy boost after whole brain irradiation. Tumori 100: 302-306. Link: https://bit.ly/3rh6CN

36. Sager O, Beyzadeoglu M, Dincoglan F, Gamsiz H, Demiral S, et al. (2014) Evaluation of linear accelerator-based stereotactic radiotherapy in the management of glomus jugulare tumors. Tumori 100: 184-188. Link: https://bit.ly/38f16eL

Citation: Demira S, Dincoglan F, Sager O, Beyzadeoglu M (2021) Treatment volume definition for irradiation of primary lymphoma of the orbit: Utility of multimodality imaging. J Surg Surgical Res 7(1): 057-061. DOI: https://dx.doi.org/10.17352/2455-2968.000138
37. Sager O, Beyzadeoglu M, Dincoglan F, Uysal B, Gamsiz H, et al. (2014) Evaluation of linear accelerator (LINAC)-based stereotactic radiosurgery (SRS) for cerebral cavernous malformations: A 15-year single-center experience. Ann Saudi Med 34: 54-58. Link: https://bit.ly/3ePpBM

38. Sager O, Beyzadeoglu M, Dincoglan F, Demiral S, Uysal B, et al. (2013) Management of vestibular schwannomas with linear accelerator-based stereotactic radiosurgery: a single center experience. Tumori 99: 617-622. Link: https://bit.ly/3bMgoAF

39. Dincoglan F, Beyzadeoglu M, Sager O, Uysal B, Demiral S, et al. (2013) Evaluation of linear accelerator-based stereotactic radiosurgery in the management of meningiomas: A single center experience. J Buon 18: 717-722. Link: https://bit.ly/3ltoRa

40. Demiral S, Beyzadeoglu M, Uysal B, Oysul K, Kahya YE, et al. (2013) Evaluation of stereotactic body radiotherapy (SBRT) boost in the management of endometrial cancer. Neoplasma 60: 322-327. Link: https://bit.ly/2ORe4D

41. Dincoglan F, Sager O, Gamsiz H, Uysal B, Demiral S, et al. (2012) Stereotactic radiosurgery for intracranial tumors: A single center experience. Guzhan Med J 54: 190-198. Link: https://bit.ly/3cYmv1J

42. Dincoglan F, Beyzadeoglu M, Sager O, Oysul K, Sirin S et al. (2012) Image-guided positioning in intracranial non-invasive stereotactic radiosurgery for the treatment of brain metastasis. Tumori 98: 630-635. Link: http://bit.ly/2B0lO2A

43. Sirin S, Oysul K, Surenkok S, Sager O, Dincoglan F, et al. (2011) Linear accelerator-based stereotactic radiosurgery in recurrent glioblastoma: A single center experience. Vojnosanit Pregl 68: 961-966. Link: http://bit.ly/3hqFBGb

44. Demiral S, Sager O, Dincoglan F, Uysal B, Gamsiz H, et al. (2018) Evaluation of Target Volume Determination for Single Session Stereotactic Radiosurgery (SRS) of Brain Metastases. Canc Therapy Oncol Int J 12: 555848. Link: https://bit.ly/2MXRS1K

45. Sager O, Dincoglan F, Demiral S, Gamsiz H, Uysal B, et al. (2019) Utility of Magnetic Resonance Imaging (Imaging) in Target Volume Definition for Radiosurgery of Acoustic Neuromas. Int J Cancer Clin Res 6: 119. Link: https://bit.ly/3bMh3j

46. Sager O, Dincoglan F, Demiral S, Beyzadeoglu M (2019) Evaluation of Radiosurgery Target Volume Determination for Meningiomas Based on Computed Tomography (CT) And Magnetic Resonance Imaging (MRI). Cancer Sci Res Open Access 5: 1-4. Link: https://bit.ly/3vPihkw

47. Dincoglan F, Sager O, Demiral S, Beyzadeoglu M (2019) Multimodality Imaging for Radiosurgical Management of Arteriovenous Malformations. Asian Journal of Pharmacy, Nursing and Medical Sciences 7: 7-12. Link: https://bit.ly/3cwnFMX

48. Beyzadeoglu M, Sager O, Dincoglan F, Demiral S (2019) Evaluation of Target Definition for Stereotactic Reirradiation of Recurrent Glioblastoma. Arch Can Res 7: 3. Link: https://bit.ly/20pxr90

49. Sager O, Dincoglan F, Demiral S, Beyzadeoglu M (2019) Evaluation of the Impact of Magnetic Resonance Imaging (MRI) on Gross Tumor Volume (GTV) Definition for Radiation Treatment Planning (RTP) of Inoperable High Grade Gliomas (HGGs). Concepts in Magnetic Resonance Part A 2019: 4282754. Link: https://bit.ly/3qY77Nn

50. Demiral S, Sager O, Dincoglan F, Beyzadeoglu M (2019) Assessment of target definition based on Multimodality imaging for radiosurgical Management of glomus jugulare tumors (GJTs). Canc Therapy Oncol Int J 15: 555909. Link: https://bit.ly/3vP4hB2

51. Demiral S, Sager O, Dincoglan F, Beyzadeoglu M (2019) Assessment of Computed Tomography (CT) And Magnetic Resonance Imaging (MRI) Based Radiosurgery Treatment Planning for Pituitary adenomas. Canc Therapy Oncol Int J 13: 555857. Link: https://bit.ly/3qKvFPR

52. Dincoglan F, Sager O, Demiral S, Beyzadeoglu M (2019) Incorporation of Multimodality Imaging in Radiosurgery Planning for Craniohypoglossalomas: An Original Article. SAJ Cancer Sci 6: 103. Link: https://bit.ly/2NFkiPL

53. Sager O, Dincoglan F, Demiral S, Beyzadeoglu M (2020) Evaluation of Target Volume Determination for Irradiation of Pilocytic Astrocytomas: An Original Article. ARC Journal of Cancer Science 6: 1-5. Link: https://bit.ly/3Rd5yG

54. Demiral S, Beyzadeoglu M, Dincoglan F, Sager O (2020) Evaluation of Radiosurgery Target Volume Definition for Tectal Gliomas with Incorporation of Magnetic Resonance Imaging (MRI): An Original Article. Biomedical Journal of Scientific & Technical Research (BJSTR) 27: 20543-20547. Link: https://bit.ly/3bNKfG0

55. Beyzadeoglu M, Dincoglan F, Demiral S, Sager O (2020) Target Volume Determination for Precise Radiation Therapy (RT) of Central Neurocytoma: An Original Article. International Journal of Research Studies in Medical and Health Sciences 5: 29-34.

56. Sager O, Dincoglan F, Demiral S, Beyzadeoglu M (2020) Radiosurgery Treatment Volume Determination for Brain Lymphomas with and without Incorporation of Multimodality Imaging. Journal of Medical Pharmaceutical and Allied Sciences 9: 2398-2404. Link: https://bit.ly/3eyrkn0

57. Demiral S, Beyzadeoglu M, Dincoglan F, Sager O (2020) Assessment of Target Volume Definition for Radiosurgery of Atypical Meningiomas with Multimodality Imaging. Journal of Hematology and Oncology Research 3: 14-21. Link: https://bit.ly/3eUEz7Y

58. Beyzadeoglu M, Dincoglan F, Sager O, Demiral S (2020) Determination of Radiosurgery Treatment Volume for Intracranial Germ Cell Tumors (GCTs). Asian Journal of Pharmacy, Nursing and Medical Sciences 8: 18-23. Link: https://bit.ly/3toePNzn

59. Sager O, Demiral S, Dincoglan F, Beyzadeoglu M (2020) Target Volume Determination for Stereotactic Radiosurgery (SRS) Of Cerebral Cavernous Malformations (CCMs). Canc Therapy Oncol Int J 15: 555917. Link: https://bit.ly/3dxe6v

60. Dincoglan F, Demiral S, Sager O, Beyzadeoglu M (2020) Utility of Multimodality Imaging Based Target Volume Definition for Radiosurgery of Trigeminal Neuralgia: An Original Article. Biomed J Sci Tech Res 26: 19728-19732. Link: https://bit.ly/2OXXAja

61. Dincoglan F, Beyzadeoglu M, Demiral S, Sager O (2020) Assessment of Treatment Volume Definition for Irradiation of Spinal Ependymomas: an Original Article. ARC Journal of Cancer Science 6: 1-6. Link: https://bit.ly/2Q3Bl2E

62. Sager O, Demiral S, Beyzadeoglu M (2020) Evaluation of Treatment Volume Determination for Irradiation of chordoma: an Original Article. International Journal of Research Studies in Medical and Health Sciences 5: 3-8. Link: https://bit.ly/3rB6lKE

63. Sager O, Dincoglan F, Demiral S, Beyzadeoglu M (2020) Assessment of Target Volume Definition for Irradiation of Hemangiopericytomas: An Original Article. Canc Ther Oncol Int J 17. Link: https://bit.ly/3bMqub

64. Sager O, Dincoglan F, Demiral S, Beyzadeoglu M (2021) Treatment Volume Determination for Irradiation of Recurrent Nasopharyngeal Carcinoma with Multimodality Imaging: An Original Article. ARC Journal of Cancer Science 6: 18-23.

65. Demiral S, Dincoglan F, Sager O, Beyzadeoglu M (2021) Multimodality Imaging Based Target Definition of Cervical Lymph Nodes in Precise Limited Field Radiation Therapy (LFR) for Nodular Lymphocyte Predominant Hodgkin Lymphoma (Nlph). ARC Journal of Cancer Science 6: 06-11.

66. Dincoglan F, Sager O, Demiral S, Beyzadeoglu M (2021) Target Determination of orbital Embryonal Rhabdomyosarcoma (Rms) by Multimodality Imaging: An Original Article. ARC Journal of Cancer Science 6: 12-17.

Citation: Demira S, Dincoglan F, Sager O, Beyzadeoglu M (2021) Treatment volume definition for irradiation of primary lymphoma of the orbit: Utility of multimodality imaging. J Surg Surgical Res 7(1): 057-061. DOI: https://dx.doi.org/10.17352/2455-2968.000138
67. Demiral S, Sager O, Dincoglan F, Beyzadeoglu M (2021) Radiation Therapy (RT) Target Volume Definition for Peripheral Primitive Neuroectodermal Tumor (PPNET) by Use of Multimodality Imaging: An Original Article. Biomed J Sci Tech Res 34: 26970-26974.

68. Sager O, Demiral S, Dincoglan F, Beyzadeoglu M (2021) Multimodality Imaging Based Treatment Volume Definition for Reirradiation of Recurrent Small Cell Lung Cancer (SCLC). Arch Can Res 9: 1-5. Link: https://bit.ly/3avNtiz

69. Sager O, Demiral S, Dincoglan F, Beyzadeoglu M (2021) Assessment of posterior fossa target definition by multimodality imaging for patients with medulloblastoma. J Surg Res 7: 032-035. Link: https://bit.ly/3auMeAK

70. Sager O, Dincoglan F, Demiral S, Beyzadeoglu M (2021) Evaluation of Changes in Tumor Volume Following Upfront Chemotherapy for Locally Advanced Non Small Cell Lung Cancer (NSCLC). Glob J Cancer Ther 7: 31-34. Link: https://bit.ly/3elzsFD

71. Dincoglan F, Demiral S, Sager O, Beyzadeoglu M (2021) Evaluation of Target Definition for Management of Myoid Liposarcoma (MLS) with Neoadjuvant Radiation Therapy (RT). Biomed J Sci Tech Res 33: 26171-26174. Link: https://bit.ly/3n8ZqjH

72. Demiral S, Dincoglan F, Sager O, Beyzadeoglu M (2021) Assessment of Multimodality Imaging for Target Definition of Intracranial Chondrosarcomas. Canic Therapy Oncol Int J 18: 655981. Link: https://bit.ly/3gb6go

73. Dincoglan F, Sager O, Demiral S, Beyzadeoglu M (2021) Impact of Multimodality Imaging to Improve Radiation Therapy (RT) Target Volume Definition for Malignant Peripheral Nerve Sheath Tumor (MPNST). Biomed J Sci Tech Res 34: 26734-26738.

74. Sager O, Dincoglan F, Demiral S, Beyzadeoglu M (2021) Radiation Therapy (RT) target determination for irradiation of bone metastases with soft tissue component: Impact of multimodality imaging. J Surg Res 7: 042-046. Link: https://bit.ly/2QK17rQ