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Research Article

Feasibility of Treating Superficial Complex Targets using Advanced Radiation Therapy Planning

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Abstract
Aim: *Superficial targets are those which either is on skin surface or within 1-2cm of skin surface. If the target is widespread and situated in conjunction with vital normal structures, it is complicated to treat. Here we discuss three situations, were we used megavoltage photons to treat scalp, face and combined scalp and face lesions.*
Materials and Methods: *One case is a verrucous carcinoma of scalp after excision of the tumours treated with radical radiation. He had good response with radiation and is on regular follow up. Next one is peripheral T cell lymphoma of the face which was resistant to chemotherapy. He also had excellent response to radiation and good palliation of symptoms, but due to the biology of the disease, he developed widespread disease. And a rare angiosarcoma of face and scalp, which was inoperable, and underwent PET-CT based planning for his lesion. He had satisfactory regression of the lesions.*
Results: *Good target coverage with acceptable normal tissue constraints was achieved in all the three cases and there was a good clinical regression of the tumours. Thus with modern planning techniques, complex targets can be treated adequately.*
Conclusion: *With improved technology complex superficial targets can be treated adequately with high energy photon beams.*
Keywords: *Dosimetry; superficial PTV; IMRT; VMAT.*

Introduction

Dosimetric uncertainty of the surface becomes major issue while treating superficial region such as face. Inadequate dosage to the PTV along with increasing dosage to the OAR is common while using conventional and electron beam radiotherapy. Newer modalities like IMRT, VMAT overcomes these hurdles and provide dramatic response when used for treating superficial complex targets like face, scalp by sparing OAR provide homogenous dose distribution throughout the lesion.

Methods and Materials

Case1

65yrs old male came with c/o pain and swelling over the face and scalp examination revealed well defined hyperpigmented woody hard non-tender

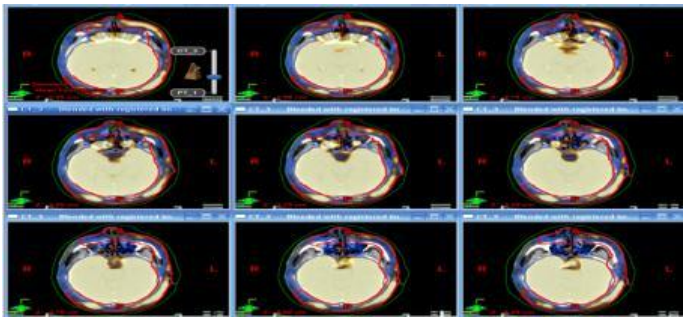
swelling involving left eyelid and encircling the orbit. There was swelling of both eyelids present and erythematous plaque over both postauricular area. Peau-de-orange appearance of the skin over the forehead was present.

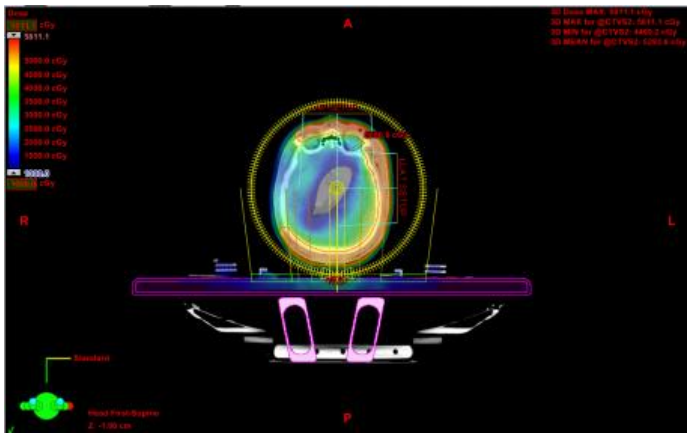
Histopathological examination and the immunohistochemistry were suggestive of angiosarcoma. Spiral CT shows swelling in the left eyelid which is more extensive over the left side extending into temporal and pre-maxillary region, mild soft tissue swelling in the right periorbital region. As per the descriptions cutaneous angiosarcoma is a rare but a highly aggressive malignancy that affect commonly the elderly males. The lesion commonly presented as ill defined lesion resembling bruise unexplained facial oedema is present.

Angiosarcoma is a biologically aggressive tumour and it has high chance for metastatic potential to lung lymphnodes and brain. PET-CT shows abnormal increased tracer uptake noted in the irregular diffuse thickening in the left eyelid involving ipsilateral periorbital and pericranial subcutaneous regions (SUV 4.0) and irregular lobulated soft density lesion in the pericranial occipital region (SUV 9.2) .Neck nodes level IIA (SUV 2.8), both level III (SUV 2.5) left level VA,VB (SUV 2.1) and level IV- supraclavicular (SUV 2.9) region.

Because of the aggressiveness of the lesion treatment options are found to be limited. Radical excision of the lesion is found to be the common modality of the treatment. Since the lesion is found to be extensive surgery was not possible and radiotherapy was planned. Aquaplast mould was done, wax bolus was prepared to match irregular facial contour. Mould was prepared along with bolus so that dosimetry will be even.

Thermo luminescent dosimeters (TLD) were used to verify the accuracy of the techniques. The required thickness of bolus was investigated, and an anthropomorphic phantom was also used to examine the effects of air gaps between the wax bolus used for the IMRT technique and the patient's scalp.





PET-CT based plan was done. Target volume contouring was done based on standardized uptake value. Other organs at risk such as eye, optic nerve, optic chiasma, brain, spinal cord were also contoured. Volumetric modulated arc therapy was planned. Dose verification was done using

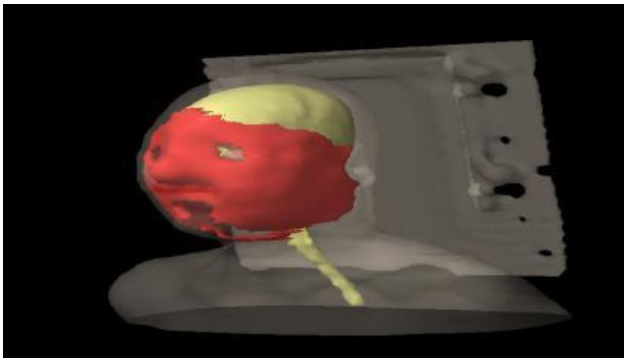
phantom and then treatment was executed. He was treated from Monday to Friday with a daily dose of 180 cGy. Total dose was 5040 cGy. Satisfactory regression of the lesion and palliation of pain was achieved. Pawlik and colleagues,[6] in their series of 29 patients with angiosarcoma of the scalp, demonstrated that the addition of RT to surgical excision significantly improved both local control and overall survival.

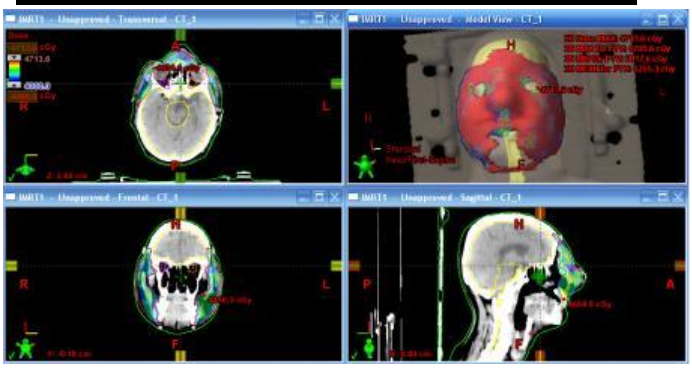
Mark and colleagues[7] also found, in a cohort that included 28 patients with angiosarcoma of the face and scalp, that surgery plus RT was associated with better local control and disease-free survival compared to patients treated with surgery alone or RT alone to the primary site of disease. Specifically, two series from Japan, one by Sasaki and colleagues[9] and one by Ohguri and colleagues,[8] did not show a prognostic significance to surgery plus RT compared to RT alone in series that included 24 patients and 20 patients, respectively with AFS.

Case 2

71 yrs male was diagnosed as a case of peripheral T cell lymphoma Stage IV (aggressive). He presented with a 6*5cm nasal swelling reddish and mild erythema present along with right sided preauricular node and another swelling on right side 0.5cm below the eyebrow. Right sided node at the level of angle of mandible present right sided level III nodes present.

Histopathological exam and the immunohistochemistry were suggestive of peripheral T cell lymphoma with aggressive histology. Spiral CT PNS/neck showed soft tissue swelling in the nose towards proximal aspect of the left side of the nose. The lesion slightly indented over the extraconal space of left orbit abutting the eyeball, another nodule of size 14mm was seen over left cheek. Bilateral level II and level III cervical lymphnodes present. Since the lesion is resistant to chemotherapy palliative radiation was considered as a treatment option.





Aquaplast mould was done. Target volume contoured based on CT plan. Other organs at risk like brain, spinal cord, optic nerve both right and left, optic chiasma were contoured along with the lesion. Intensity modulated radiation therapy was planned. Dose verification was done using phantom and then treatment was executed. RT to a total dose of 50Gy as per International Lymphoma Oncology group[10] was given to the lesion. Patient developed good response to radiation but developed widespread disease due to the biology of the disease.

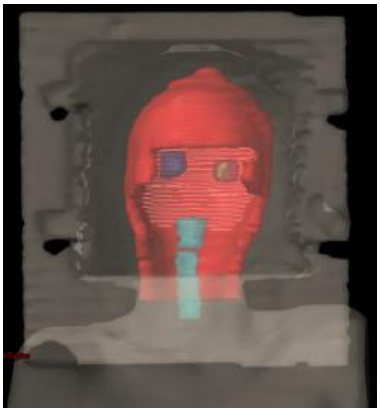
Case 3

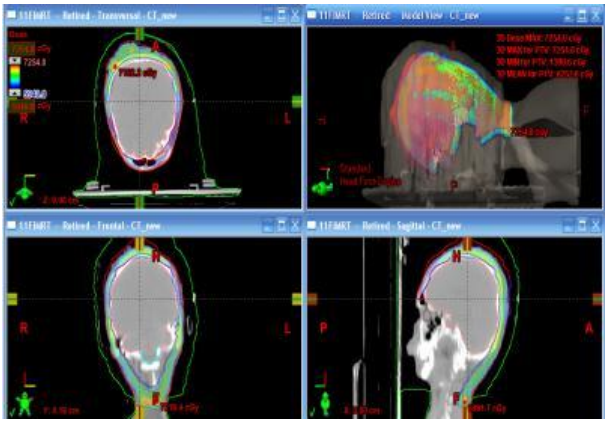
38yrs old male presented with multiple verrucous lesion over the entire scalp with 3 verrucous growth in right parietal, occipital, left parietal regions treated with wide local excision and split skin grafting elsewhere.

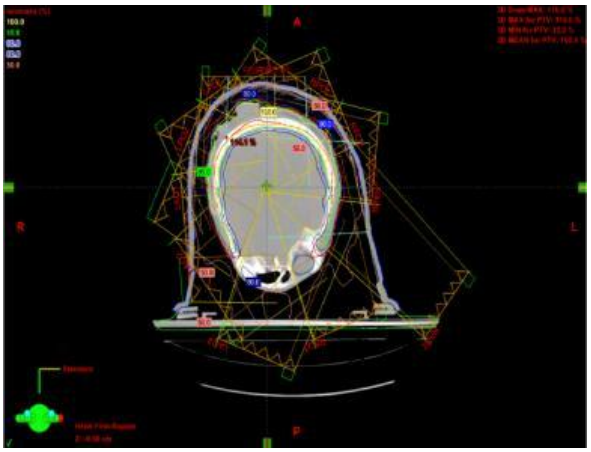

Prior to Surgery


After Surgery

The treatment available for the patient is a)Photon -Electron 3DCRT . b) Helmet mould -based HDR and c) LINAC -based segmental IMRT. The Photon-Electron technique has the longest history and spares the optical structures, but involves troublesome field matching and dose heterogeneity. The HDR technique is the most conformal and simple to deliver, but is limited to target dose in homogeneity. IMRT technique offers the best target coverage and the most homogenous and conformal dose distribution with only a moderate increase in dose to the optical structures but within a clinically acceptable level. So he was treated with 6MV X raybeam therapy to the whole scalp using IMRT technique.





Custom made bolus and immobilisation device was done. CT for RT planning was done using 3 mm cuts. IMRT planning was done. After QA plan was executed. Excellent regression of the scalp lesion was achieved. He is on regular follow up now with no evidence of recurrence

Discussion

Analysis of IMRT/VMAT technique that has been used in these three cases made clear that adequate dosage to the PTV had been achieved.

Homogeneity Index

Case 1

Planned 50Gy received 52Gy

D2:55Gy

D95:47Gy

D98:45Gy

Case 2

Planned 50Gy received 47Gy

D2:44Gy

D95:40Gy

D98:39Gy

Case 3

Planned 60Gy received 62 Gy

D2:62Gy

D95:57Gy

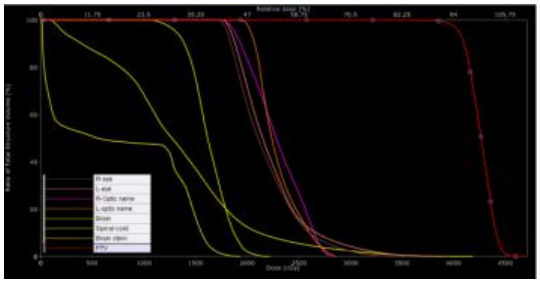
D98:54Gy

Homogeneity index shows excellent uniformity in dosage throughout the tumour. This is understood by the fact that further critical organ sparing was excellent even with extensive leisions on proximity to critical organs this was evidenced by DVH.

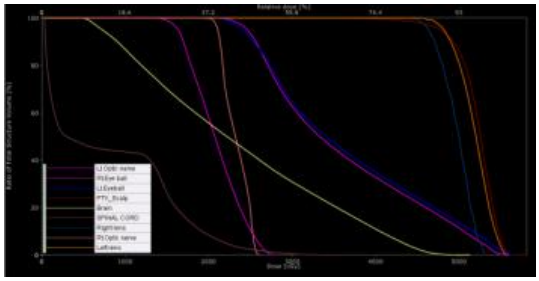
	Max Dose (Gy)	Case 1 (cGy)	Case 2 (cGy)	Case 3 (cGy)
Optic Nerve Lt	55	2289	2288	2300
Optic Nerve Rt	55	2283	2288	2400
Brain	<50	2345	2288	2400
Spinal Cord	46	821	747	3700

Dose Volume Histogram

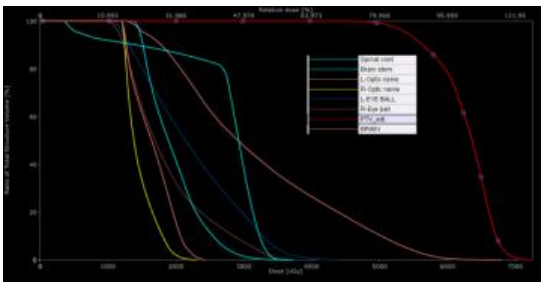
Case 1



Case 2



Case 3



Conclusion

IMRT and VMAT offers best target coverage and most homogenous confirmed dosage distribution as evidenced above with very minimal dosage to the critical organs such as brain, spinal cord, optic nerve thereby sparing organ at risk. Neither static nor arcing electron techniques were able to provide a reliable coverage of the planning target volume (PTV), owing to obliquity of the fields in relation to the scalp. IMRT technique considerably improved PTV dose uniformity .Photon IMRT provides a feasible alternative to electron techniques for treatment of large scalp lesions, resulting in improved homogeneity of dose to the PTV but with a moderate increase in dose to the brain.

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