Helical Tomotherapy® is a safe and feasible technique for total scalp irradiation

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Abstract

Angiosarcoma of the scalp is a rare aggressive tumor that affects elderly patients. Chemoradiation is the treatment of choice for multicentric and extensive disease. The shape of the scalp represents a dosimetric challenge in terms of achieving a homogeneous concave dose distribution with coverage of the entire target volume and an acceptable organs-at-risk sparing. We report a case of an 81-year-old man with a multifocal angiosarcoma of the scalp treated with Helical TomoTherapy® (Accuray Inc., Sunnyvale, CA, USA) intensity modulated radiotherapy. This technique allows precise and daily verifiable coverage of the target keeping the dose to the organs at risk within the constraints.

Introduction

Angiosarcoma is a rare malignant tumor of the soft tissues, arising from endothelial cells. It can occur in any part of the body, most frequently in the head and neck region, especially the scalp in elderly patients.[1] Prognosis of angiosarcomas of the scalp is very poor given its high propensity to metastasize, with 5-year survival rates of 10-30% and a median overall survival of about 15 months.

Radiotherapy represents a valuable treatment option as radical surgery is rarely feasible due to local spread and multicentric nature of this cancer type. Scalp irradiation is recommended after surgical excision or as primary treatment, usually in conjunction with chemotherapy, depending on the extent of disease. Several retrospective analyses have shown the ability of radiotherapy in prolonging progression-free and overall survival.[2-4]

Irradiation of the scalp is challenging in terms of obtaining a homogeneous dose distribution due to the concave shape and extensive size of the target. We present our experience using image guided radiotherapy/intensity modulated radiotherapy (IGRT/IMRT) delivered with Helical Tomotherapy® (HT; Accuray Incorporated, Sunnyvale, CA) to treat a patient with recurrent angiosarcoma of the scalp.

Case Report

An 81-year-old man presented with recurrent angiosarcoma in the form of multicentric hemorrhagic lesions throughout the scalp, mostly located on the right temple and nape. Some nodules were painful when examined and subject to spontaneous bleeding. A year earlier, the patient had undergone surgical resection of a skin lesion in the right parietal region, positive at pathologic examination for angiosarcoma. A total body CT-scan was performed for staging assessment, suggesting involvement of cervical lymph nodes and liver metastases. Given the advanced stage of disease, the patient was considered eligible for palliative irradiation of the scalp followed by chemotherapy. We decided to deliver a total dose of 30 Gy in 10 fractions to the whole scalp, using HT IGRT/IMRT. The planning CT scan was obtained with a 2.5-mm slice thickness and the patient in supine position wearing a head-neck-shoulder mask. The treatment plan was created with the Pinnacle Phillips Treatment Planning System, delineating brain, brainstem, and optical structures as organs at risk (OARs), and the whole scalp as planning target volume (PTV). The plan was optimized to achieve an adequate target coverage ensuring that delineated OARs, eyes, lenses, brain and optic chiasm, received maximum doses of 19.7 Gy, 1.73 Gy, 29.6 Gy, 22.9 Gy, and 20 Gy, respectively. A megavolt CT (MVCT) scan was performed prior to each fraction, in order to ensure optimal target coverage and setup accuracy. After eight fractions, clinical examination and MVCT showed substantial reduction in the size of the scalp lesions (Figure 1) and the patient reported considerable relief of initial symptoms. Given this rapid response and considering the patient's good compliance, we decided to extend the treatment by adding another 20 Gy delivered in 10 fractions. We performed a new planning CT-scan with the same immobilization systems and protocols used for the first one and re-planned the treatment. The maximum doses for the second part of the treatment were 17 Gy to the brain, 4.2 Gy to the eyes, 9 Gy to the optical nerves, 1.3 Gy to the lenses, and 13.6 Gy to the chiasm. The patient completed the radiotherapy course presenting a substantial reduction in the size of the lesions and no significant side effects. Twelve months after the end of radiotherapy, the patient was undergoing chemotherapy due to systemic progression of disease.

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Discussion and Conclusions

Scalp irradiation represents a dosimetric challenge because of the irregular shape of the target and the difficulty of obtaining a homogeneous dose distribution, while sparing the nearby critical structures. For many years, electron beam techniques were the first choice for treating this site, because of their superficial distribution and rapid fall-off. Though, dose homogeneity and cold-spot avoidance in the transition zone of adjacent fields was not always satisfactory. Akazawa *et al.* introduced the Lateral Photon Electron technique (LPE), consisting of parallel opposing lateral photon beams and complementary lateral electron fields, for a more adequate coverage of the scalp, using central blocks in order to protect structures like brain and eyes.[5] Nakamura et al. reported high-dose-ratio (HDR) BRT, using a mold surface applicator, as a valuable option to deliver an additional dose to under-dosage areas within extensive lesions treated with electron beam radiotherapy: treatment of a hemorrhagic lesion with HDR-BRT yielded partial

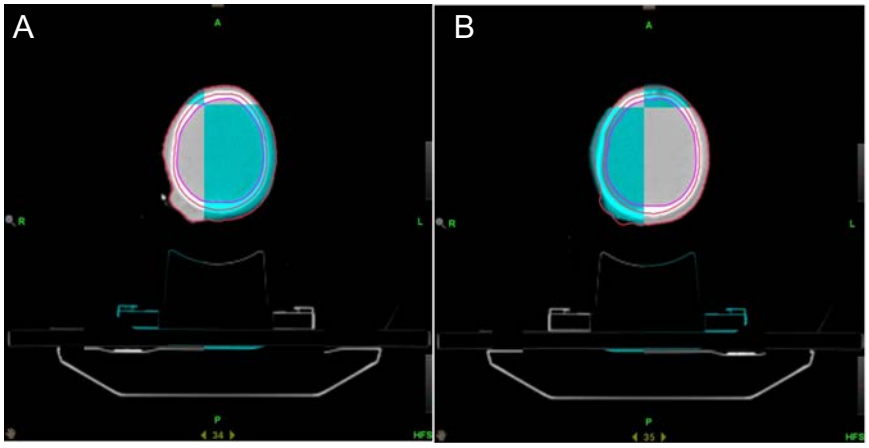

Figure 1. Megavoltage computed tomography transverse images of patient on day 1 (A) and day 8 (B), showing reduction in size of tumoral mass.

response, with disease progression after 2 years.[6] BRT was described as a feasible technique for angiosarcoma also by Wittych *et al*.[7] Several studies evaluated the role of IMRT/IGRT techniques to achieve a uniform coverage of the target and an acceptable OAR sparing. A dosimetric comparison between LPE, HT and Volumetric-Arc Modulated Therapy (VMAT) showed that HT allows the best target coverage and conformity with the most favorable OAR sparing especially for the brain and hypothalamus.[8] Orton et al. presented Linac-based IMRT and HT plans for scalp irradiation, showing that the latter technique can achieve a higher target equivalent uniform dose while reducing the brain volume receiving 30 Gy.[9] The superiority of HT is the result of its ability to deliver tangential beamlets to the scalp, preventing under- or over-dosage areas associated with field matching issues. Another advantage of HT is its increased safety in treatment delivery, because all target volumes are aligned and verified daily, prior to each fraction, based on MVCT scans. A safe and efficient use of HT was described by Katayama *et al*. in a case report of an angiosarcoma of the scalp, treated with 70Gy in 35 fractions to the primary site and 56 Gy to ipsilateral lymph nodes.[10] The authors reported optimal target coverage, with acceptable acute toxicity and resolution of the tumor nodules. HT has also been used for salvage total scalp irradiation after local recurrence of cutaneous mucinous adenocarcinoma in a patient previously treated with surgery and radiotherapy.[11]

Similar to previously reported cases, we show that HT is a valuable technique for scalp irradiation as it achieves a uniform coverage of the target and an adequate sparing of the critical structures.

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