Treatment of Extensive Scalp Lesions using VMAT (RapidArc®)

A. Aitken[1], G.P Beyer[2], S. Smith[1], D. Ritchie[3]

1. Radiotherapy Physics, NHS Greater Glasgow and Clyde.
2. Physics Services International Ltd, Cork , Ireland.
3. Department of Clinical Oncology, Beatson West of Scotland Cancer Centre, Glasgow.

Introduction

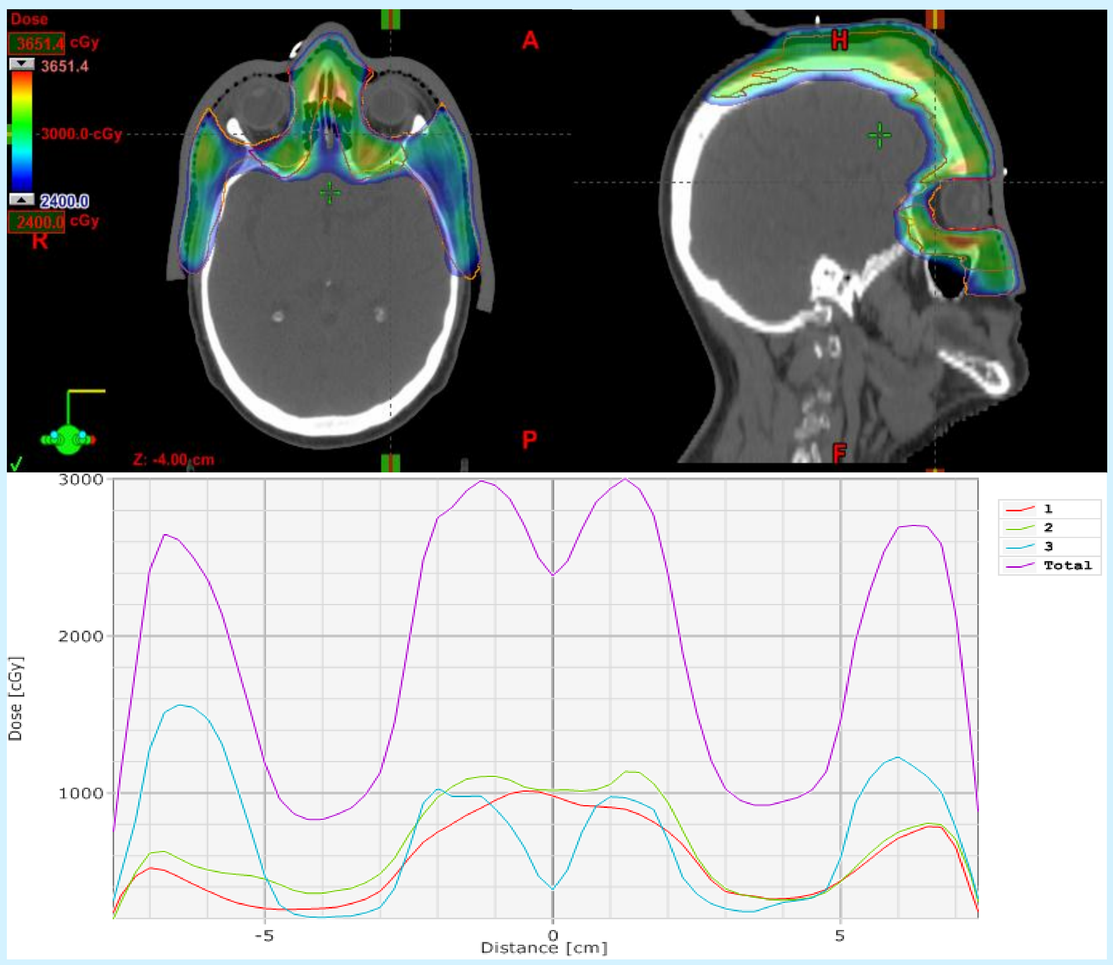
The use of Volumetric Modulated Arc Therapy (VMAT) for the treatment of a variety of Head and Neck Lesions has become the established technique of choice in a number of Radiotherapy centres around the world. However, the potential advantages offered by using this modality to treat extensive superficial and locally invasive disease of the scalp is less well documented. The technique classically employed to deliver this type of treatment often utilises multiple matched electron fields which are positioned to try to adequately cover the extent of the disease. This approach can often be limited by organ at risk (OAR) toxicity and yield large dose gradients throughout the planning target volume (PTV) which compromise dose coverage as well as being extremely time consuming to plan and labour intensive to treat.

In this series, 5 patients with extensive disease of the scalp (1 x malignant melanoma, 1 x non-hodgkins lymphoma, 1 x squamous cell carcinoma and 2 x B cell lymphoma) were planned and treated using VMAT via the RapidArc® treatment solution. In each case, optimised treatment plans were produced utilising multiple arcs to achieve the required disease coverage. Highly conformal dose sculpting was used to maximise sparing of normal tissue and any OAR's where necessary.

Methods

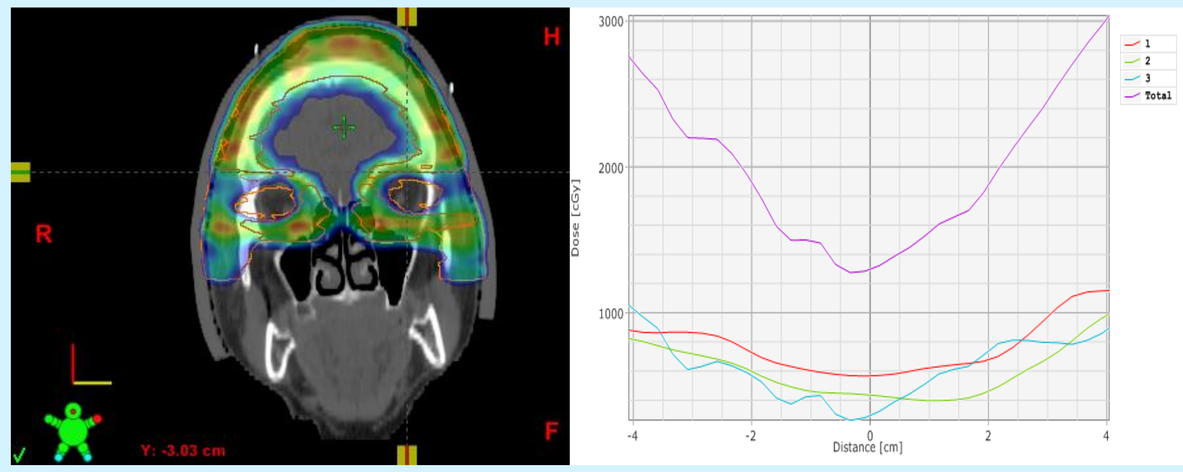
In all cases, a beam direction immobilisation shell (BDS) with three point fixation was constructed which encapsulated a customised bolus helmet for each patient which was formed from a thermo-setting build up material (Aquaplast RT™). The use of bolus material to ensure sufficient surface dose delivery is customary for this treatment site[1]. Planning CT scans (0.25cm spacing) were undertaken with the bolus helmet in situ and radio-opaque markers were attached to the BDS to enable localisation of a 3D CT reference point within the acquired image data set.
The planning CT image data set was imported to the Eclipse (V10.0.39) Treatment Planning System and the required target volumes and OAR structures were delineated by the treating physician. Treatment plans were then optimised and calculated (using AAA 10.0.28) for delivery using 6MV photons via a Truebeam linear accelerator with a standard 120 leaf multi-leaf collimator (MLC). The primary planning objective was to achieve clinically acceptable dose coverage to the specified target volumes with the 95% isodose line. However, attention to dose sparing particularly within the defined optical structures was also of clinical concern.
In 3 of the 5 cases, secondary PTV's considered as being at lower risk but still requiring treatment were also delineated. These were prescribed lower doses than the primary target but were geometrically complex and in one particular B cell lymphoma case included orbital involvement. **Figure 1** below demonstrates the highly irregular target geometry which can be encountered for this type of disease. The central (red) target volume was defined as the primary PTV (30Gy prescription in 15 fraction) with the larger (orange) contour defining the lower risk target volume (24Gy prescription).

Fig.1



The 24Gy dose colourwash is displayed on the axial and sagittal views with an attached dose profile curve at the posterior edge of the orbits as defined on the axial slice by the hatched horizontal level indicator. Despite the use of three arcs (2 axial and 1 sagittal) in this particular case, significant brain sparing was still achievable. This is demonstrated in **Figure 2**, again showing the 24Gy isodose colourwash along with a left to right horizontal dose profile demonstrating dose fall off within the brain. This was realised by manipulating the dose distribution via the inclusion of additional planning volumes within the optimiser.

Fig.2



Results

A summary of the prescription, fractionation and dose volume histogram (DVH) information for the primary PTV in each of the cases involved is given in **table 1** below. In addition, the monitor units (MU) per fraction are shown along with the QA gamma analysis (3%,3mm) data for the clinical treatment plans which were all verified using a Sun Nuclear Arc Check system prior to delivery.

Table 1

Parameter	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Total Px Dose (cGy)	5500	3800	6500	2800	3000
No. of Fractions	20	20	30	12	15
Volume of PTV (cc)	344.1	148.3	192.4	732	465.8
$V_{95\%}$(cc)	341.7	145.3	173.4	712.2	458.3
$V_{107\%}$(cc)	2.1	1.3	8.3	309.7	242.2
$D_{5\%}$(cGy)	5802.1	3965.4	6932.9	3157.8	3466.8
$D_{95\%}$(cGy)	5317.2	3665.1	6105	2740.2	2941
D_{mean}(cGy)	5562.3	3826.4	6472.1	2968.9	3213.7
MU per fx	659	347	820	921	570
QA Gamma Analysis (%)	98.5	99.2	99.4	98.8	97.8

The V_{95} and V_{107} are defined as the volume of PTV receiving at least 95% or 107% of the prescribed dose respectively. The D_5 and D_{95} are defined as the dose to 5% or 95% of the PTV volume respectively. It can be seen from the tabulated data that for the two lowest prescribed doses, (Patients 4 and 5) a large proportion of the target received 107% of the prescribed dose with 5% of the primary PTV receiving 113% and 116% respectively. Due to the lower dose prescription, these localised areas of increased dose above 107% were deemed as being clinically acceptable at the review stage, as dose heterogeneity was not considered to be a primary concern for either of these cases provided that the required target and OAR dose requirements were achieved.
The use of VMAT delivery could yield a higher dose to the brain due to dose bathing effects, but for several of the cases studied, the use of more classical techniques such as multiple electron field therapy would not have provided adequate coverage of the target volumes. In all cases, the mean brain dose was deemed to be clinically acceptable when compared to the benefits in terms of target dose coverage and dose manipulation capability when using a VMAT delivery technique.

Conclusions

Although extensive scalp irradiations are still relatively rare, they can nevertheless be complex to plan and treat. The availability of a fast and effective treatment solution which can be used over a variety of target geometries for this site was investigated. The use of RapidArc® at the Beatson West of Scotland Cancer Centre provided an effective treatment solution for all 5 cases reported. The VMAT technique was particularly effective for the cases involving more than one PTV structure with multiple prescriptions and several OAR's in close proximity to the target areas. The dose coverage and conformity which was achieved for this patient group could not have been realised using other more traditional treatment techniques such as multiple matched electron fields.
The availability of this delivery modality for the treatment of extensive scalp lesions now gives a viable treatment solution which clinicians can consider for suitable patients, many of which may not have previously been considered as potential candidates for radiotherapy.

References

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