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A dosimetric comparison of conventional wedge fields versus 'forward-planned' IMRT for tangential breast radiotherapy.

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Purpose

The Royal College of Radiologists recently stated[1, 2] there is evidence in breast cancer that forward-planned tangential IMRT can be used to reduce the toxicity seen in conventional wedged breast radiotherapy. They referenced the clinical trial carried out by the Royal Marsden Hospital[3], published in 2007, which found a significant association of late adverse effects with the presence of regions receiving doses ≥ 105% of the prescribed dose.

Following these recommendations CancerPartnersUK treats all breast patients where the maximum dose in the conventional wedged technique equals or exceeds 105%, with forward-planned IMRT. This study evaluates the reduction in the 'clinical maximum' dose (2cc) achieved using forward-planned IMRT and investigates whether there is any correlation between the patient 'separation' and magnitude of the reduction in maximum dose.

Method

A total of 50 breast and mastectomy patients were planned with both the conventional wedged field technique and forward-planned IMRT using Philips Pinnacle3 TPS. The forward-planned IMRT was created using field in field segments, 'control points', to shield regions of high dose within the open tangential field. A maximum of four control points were used per field, i.e. the open tangential field with an additional three smaller segments. The shielding of each control point was created by viewing the 3D dose distribution in the beams eye view window and shaping the multi-leaf collimator to shield out the relevant high dose region (Figure 1). This process was repeated until the lowest clinical maximum dose was achieved without decreasing 95% coverage or until four control points was reached. The plan was normalised to the modal dose in the irradiated area. The same modal dose normalisation was then applied to the conventional wedged plan to ensure a fair comparison (Figures 2 & 3). The clinical maximum dose and the separation from medial beam edge to lateral beam edge on the isocentre slice for each plan was recorded.

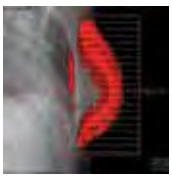

Figure 1: Formation of a control point by shielding the 3D dose cloud in the beams eye view

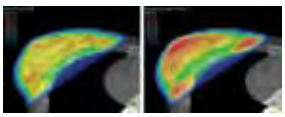

Figure 2: Axial isodose comparison between forward-planned IMRT & conventional wedge technique, green representing 95%, yellow 100%, orange 102% and red 107%

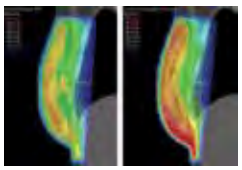

Figure 3: Sagittal isodose comparison between forward-planned IMRT & conventional wedge technique, green representing 95%, yellow 100%, orange 102% and red 107%

Results

Considerable reductions in the clinical maximum were recorded in the IMRT plans for the majority of patients (Figure 4). The average clinical maximum for the IMRT plans was 104% compared to 108% for the conventional wedged technique. Performing a paired-t test yielded a p-value of <0.001 indicating that this reduction is statistically significant (Table 1). In 3 patients the use of IMRT could not achieve a clinical maximum of ≤105% however the maximum was less than that of the corresponding conventional wedged plan. Figure 5 compares the reduction in clinical maximum achieved versus patient separation and demonstrates there is no obvious correlation between the two, as indicated by the resultant correlation coefficient of -0.03.

	Reduction in Clinical Maximum	Clinical Maximum	
		Conventional	IMRT
Mean	5%	108%	104%
Standard deviation	0.03	0.03	0.01
P-value	P = < 0.001		

Table 1

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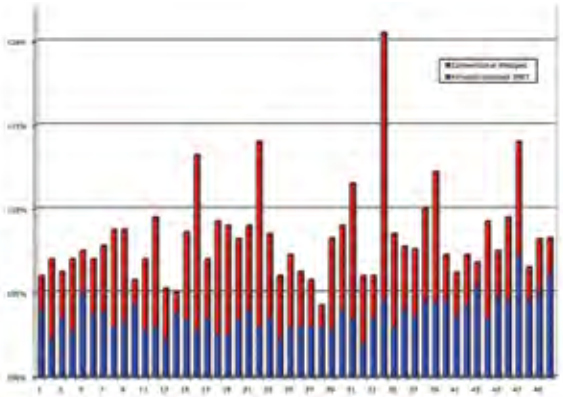

Figure 4: Graphically representation of the clinical maximum achieved using forward-planned IMRT compared to the corresponding conventional wedged plan

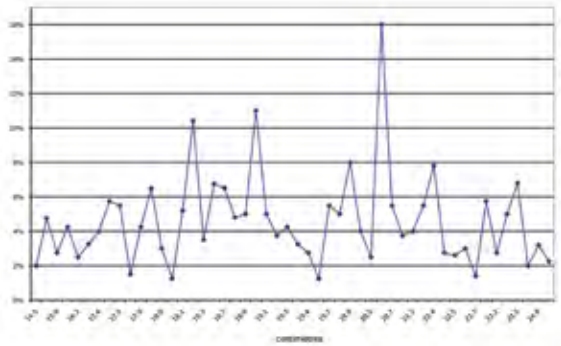

Figure 5: Comparison of the reduction in the clinical maximum achieved versus patient separation

Conclusion

For the majority of patients in this study the use of intensity modulation in the planning of their radiotherapy treatment significantly reduced the maximum radiation dose in their treatment plans. As there was no clear correlation between patient separation and the reduction of the clinical maximum, it would seem that patient separation should not be relied on to pre-select suitable candidates for IMRT. Forward-planned IMRT has been shown to be beneficial to a wide range of patient shapes and sizes.

References

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[2]A Review of the Clinical Evidence for Intensity-modulated Radiotherapy. J. Staffurth on behalf of the Radiotherapy Development Board, Clinical Oncology 22 (2010) 643-657.

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