and the maximum total dose for all fractions to any point at 2 cm from PTV (D2cm) divided to Dpr.

Results

Depending on the volume of PTV, 5 groups are defined and the average results with standard deviation (SD) and maximum parameter values are presented in Table1.

Table 1

V_{PTV} (cc)	CI	SD	CI_{max}	NHI	SD	NHI_{max}	IDMHT (%)	$IDMHT_{max}$ (%)	$R_{50\%}$	SD	$R_{50\%\ max}$	$D_{2cm}/D_{pr.}$ (%)	$D_{2cm}/D_{pr.\ max}$ (%)
< 1	1,43	0,17	1,60	1,28	0,04	1,33	10,00%	14,69%	7,97	2,01	11,22	26,11%	38,57%
1 to 5	1,31	0,26	1,40	1,37	0,05	1,41	4,29%	5,28%	5,36	1,30	7,37	27,92%	32,86%
5 to 15	1,25	0,12	1,37	1,36	0,12	1,53	4,01%	9,60%	4,76	1,28	5,87	43,69%	50,00%
15 to 50	1,15	0,09	1,23	1,38	0,02	1,42	2,01%	4,69%	3,96	0,32	4,44	61,00%	57,43%
>50	1,16	0,07	1,20	1,29	0,14	1,40	1,06%	2,85%	3,51	0,12	3,65	61,42%	66,26%

The NHI shows a low sensitiveness to the PTV volume, and thus remains approximately within the same limits in all cases. The CI shows a clear dependence on the PTV volume and varies from 1.16 for volumes >50cc to 1.43 for volumes <1cc. Outside the PTV, the IDMHT does not show a clear dependency on volume, but it can be postulated that it should not exceed 10% for the PTV volumes >1cc.The gradient index outside the PTV decreases with increasing volume and on the basis of the results obtained, it is easy to calculate the radius of the shell to control the gradient outside the PTV for each particular case. The normalized maximum dose to any point at 2 cm from PTV increased with PTV volume from 26% for volume <1cc up to 61% and these result can also be used in prescribing subsequent stereotactic treatments.

Conclusion

Data base was obtained and evaluated, based on the worksheet with parameters describing the isodose distribution in stereotactic treatments. The created protocol is used to prescribe the dose in and out PTV of each new patient. This results to an increasing in optimization parameters, but it facilitates to save time and makes treatment planning evidence based.

EP-1930 Mixed beam radiotherapy for sternum and lung treatments

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Purpose or Objective

Current sternum and lung treatments using VMAT suffer from a large low dose bath delivered to the lungs, heart and other normal tissue. Combining photon and electron beams for mixed beam radiotherapy (MBRT) has the potential to reduce the dose delivered to normal tissue, because of the well-defined range of the electron beams without degrading the dose homogeneity in the target. This work presents an inverse treatment planning technique for MBRT and tests the given hypothesis by plan comparisons.

Material and Methods

An inverse treatment planning technique for photon MLC based step & shoot MBRT is developed including a novel hybrid column generation and simulated annealing direct aperture optimization (DAO) algorithm. The hybrid DAO starts with an empty aperture pool and iteratively adds photon and electron apertures using the column generation algorithm. After each aperture addition, all apertures in the pool undergo a quasi-Newton weight optimization followed by a simulated annealing based simultaneous shape and weight optimization and a second quasi-Newton weight optimization. Thus, the optimizer has full freedom about the number, shapes and weights of photon and electron apertures and simultaneously optimizes them. After optimization, the deliverable dose distribution of the apertures to be delivered with the photon MLC is calculated using Monte Carlo. MBRT plans with 50 apertures are generated for two sternum and a lung case with prescribed doses of 10, 30 and 50 Gy. Their deliverable dose distribution are compared to those of two arc VMAT plans in terms of planning target volume (PTV) dose homogeneity HI = V95% - V107%, mean dose to the lungs and the heart, D2% to the spinal cord and the low dose bath expressed as V10% of normal tissue.

Results

Averaged over all three cases, the PTV dose homogeneity is 3% higher, mean dose to the lungs 23% lower, mean dose to the heart 11% lower, D2% to the spinal cord 36% lower and V10% of normal tissue 31% lower for MBRT plans compared to VMAT plans. The electron contribution defined as the integral dose in the PTV summed over all electron apertures is 27%, 27% and 43% for the MBRT plans determined for the first and the second sternum and the lung case, respectively.

Conclusion

The MBRT plans outperformed the VMAT plans in all dosimetric aspects from PTV dose homogeneity, organs at risk sparing to the extension of the low dose bath. By utilizing electron apertures, the hybrid DAO is able to gain advantage over state-of-the-art photon only VMAT plans. This work was supported by Varian Medical Systems.

EP-1931 Suitability of dynamic trajectory mixed beam radiotherapy for head and neck and brain treatments

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Purpose or Objective

To demonstrate the clinical suitability of dynamic trajectory mixed beam radiotherapy (DT-MBRT) for head and neck as well as brain treatments.

Material and Methods

A mixed photon-electron treatment technique is developed with the aim to exploit all major degrees of freedom of a conventional linear accelerator, namely the different particle types, intensity- and energy modulations and dynamic gantry, couch and collimator rotations. This is achieved by using dynamic trajectories (DTs) photon and step & shoot modulated electron beams collimated both using the photon MLC. The treatment planning process consists of several steps. Firstly, the couch and collimator rotations associated to the gantry rotation of the DTs are determined by minimizing the overlaps of the organs and risk (OARs) with the planning target volume (PTV) and by minimizing the area between a conformal MLC opening and the PTV, respectively. Afterwards, photon apertures along the DTs and electron apertures are simultaneously optimized using a simulated annealing based direct aperture optimization. Finally, the deliverable dose distribution of the electron apertures is calculated and based on this, the photon DTs are re-optimized using a finer control point resolution. DT-MBRT plans with two photon DTs, differing only by a 90° collimator rotation, and 16 electron apertures are generated for two head and neck and a brain case with prescribed doses of 66, 40 and 60 Gy and compared to VMAT plans with 5, 3 and 2 arcs, respectively. The deliverable dose distributions of the plans are compared in terms of PTV dose homogeneity HI = V95% - V107%, mean dose to the parallel OARs, D2% to the serial OARs and the low dose bath expressed as V10% of normal tissue.