Background

Intensity modulated radiotherapy is the most promising approach to conformal therapy of complex shaped targets. At the DKFZ in Heidelberg, two different IMRT techniques have been introduced: The use of compensators and multi-leaf modulation. Both methods are applied routinely in conformal stereotactically guided treatments of head and neck tumors and paraspinal lesions since autumn 1997. In a comparative study, we have investigated the delivery of IMRT and evaluated the advantages and disadvantages of both methods.

Materials and methods

Patients with head and neck tumors and paraspinal tumors are treated under stereotactic fixation and positioning conditions. Target volumes and organs at risk are outlined on registered CT- and MR-images. Dose planning is performed with the 3D treatment planning program VOXELPLAN in conjunction with the inverse treatment planning program KONRAD. Coplanar as well as non coplanar treatment techniques consisting of 5-7 static irregular shaped and mostly equally spaced IMRT beams were applied. Beside the iterative optimization of dose distributions, KONRAD is able to consider the method of IMRT delivery (compensators or different kinds of multi-leaf collimators). When compensators are being used, it is possible to specify the resolution with which the compensators will be milled. The planning system generates the control file and transfers it to the computer controlled milling machine.

When ML-intensity modulation is used, it is possible to predefine the leaf thickness, the number of intensity levels to be applied and the minimal gap between opposing leaves. In the segmentation procedure the step and shoot technique is realized. The segmentation algorithm is optimized to suppress tongue and groove as well as match-line effects. The leaf settings which are necessary to produce the different field segments are transferred to the LANTIS control system of the Siemens PRIMUS LINAC.

The verification of dose distributions was performed by film dosimetry using a special 3D head phantom. An extensive evaluation included the single IMRT beams as well as the final superimposed 3D dose distributions.

The evaluation of 3D dose distribution was performed on the basis of dose volume histograms and TCP/NTCP calculations.

Results

For selected patients treated with IMRT since Nov. 1997 , inverse treatment planning was performed and IMRT delivery was planned for both methods, compensators as well as multi-leaf intensity modulation. The theoretical evaluation of the dose distributions showed, that in most cases compensator plans and ML intensity modulated plans did not differ significantly. However, we also found cases, where the compensator plans were superior to the ML plans. This was due to the complexity of the shape of the PTV and the finer resolution which can be achieved by compensators. Furthermore, the practical evaluation of the measured dose distributions showed that compensator plans could in all cases be verified with an error less than 5%, while the verification of ML-plans was much more critical, especially in those cases where field segments with a width of less than 1 cm were involved. If such small field segments can not be avoided, this might also be an indication for compensator application.

Educational objectives

1.Understand the principles of IMRT delivery with compensators and ML intensity modulation,
2. the advantages and disadvantages of compensator and ML intensity modulation,
3. the medical indications for the application of compensators in IMRT