An alternative option to classical breast irradiation under certain clinical circumstances

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Purpose

The typical parallel opposed tangential fields are the common technique to treat the breast cancer but when the clinical conditions require the treatment of internal mammary lymph nodes or when the cervico-dorsal spine are targeted, a challenge is presented in the planning. The objective of this poster is to propose an alternative technique to the typical tangential fields in the advanced breast cancer planning with 3D conformal radiotherapy technique (3D-CRT), able to do a good coverage of target volume, maintaining the doses of organs at risk in acceptable levels.

Patients and Methods

PATIENTS

Two patients with advanced breast cancer and metastatic bone disease (MBD) and twelve patients with internal mammary lymph nodes targeted or with excess tolerance dose at lung and heart, in typical tangential fields planning, were treated with adjuvant postoperative radiotherapy using a 3D-CRT with the alternative technique described ahead. In this study we illustrate and analyse one patient as an example, where this option was applied.

All patients underwent CT-scanning following their breast surgery. The images were obtained with the patients lying supine position on inclined breast board with both arms abducted above their heads. The scans included the entire lung and extended approximately from the mid-clavicle to the upper abdomen.

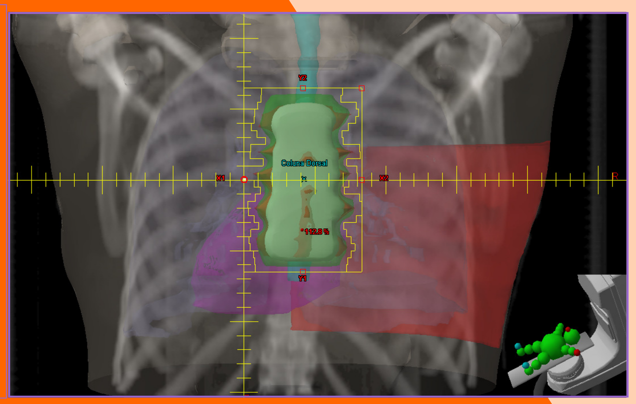

Fig. 1– Cervical-dorsal posterior field.

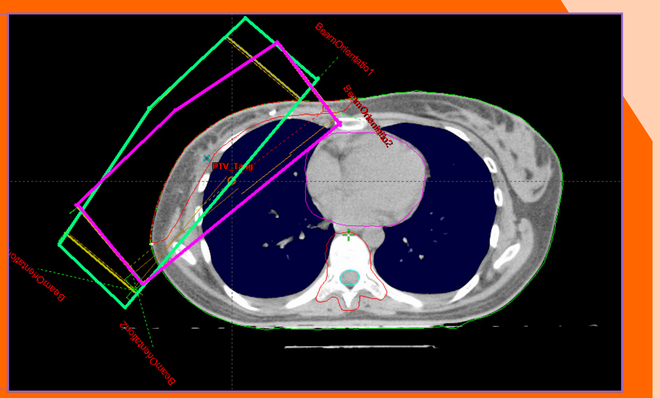

Fig. 2– Two beam orientations of two tangential fields.

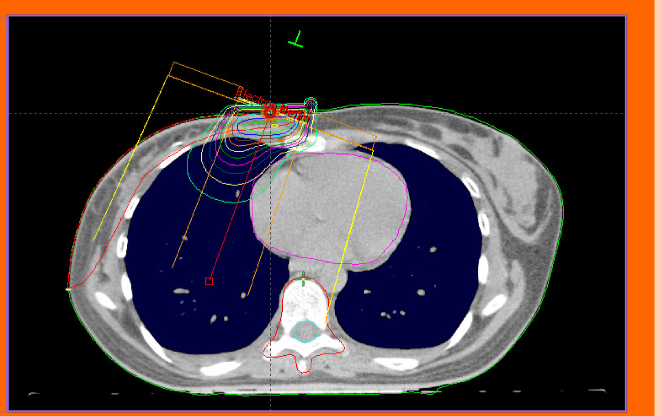

Fig. 3– Electron beam in parasternal area.

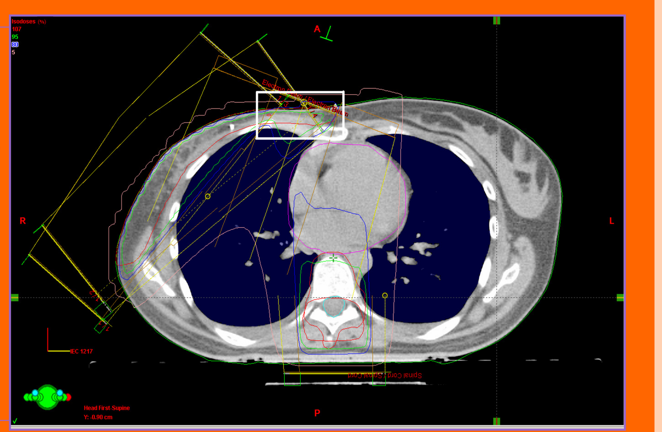

Fig. 4– Optimization dose in parasternal region.

TREATMENT PLANNING

The alternative technique (AT) when simultaneous irradiation of the cervico-dorsal spine is required with the treatment of breast cancer (or thoracic wall) consists in a cervical-dorsal posterior field (fig. 1) two orientations of parallel opposed tangential beams (one of them without irradiating parasternal area—fig.2) and a electron field to the parasternal region (fig. 3).

The tangential fields are composed with two beam orientations, one of them encompassing all breast or thoracic wall delineated. The gantry angles and isocentre are optimized manually to minimize the beam divergence along the dorsal beam edge. In the other beam orientation, the medial field aperture is defined by the divergence of the cervical-dorsal posterior field, and doesn't include the parasternal region. In this beam orientation the heart and/or lung volume include is the minimal as possible. In each of beam orientations the sum penumbras method is applied.

Multileaf collimators (MLCs) are manually shaped and beam weights (and thus, wedge angles) are optimized.

The electron field is added in the parasternal region. The lateral field aperture is defined by the divergence of cervico-dorsal posterior field and medial field aperture by the midline. This field has an inclination of 20º to overcome an underdosage at the junction of the fields.

The isocentre of cervico-dorsal posterior field is placed to minimize the divergence to the contra-lateral lung and MLC is automatically shaped.

With this setup, the parasternal region will have an overlap dose, but that is optimized to achieve a homogeneous dose distribution (fig. 4). An optimization of dose proportion of electron field, of the two tangential beam orientations and with the low doses from the cervico-dorsal posterior field can achieve a homogenous plan (target volume between 95%-110%). In the white box (parasternal region), in one specific case, tangential fields contribute with 20% of the dose to that region, the posterior cervico-dorsal contributes with 60% and the electron field with 20%.

In the same way, this alternative technique is applied when lung and/or heart dose tolerance is exceeded, mainly when internal mammary lymph nodes are targeted. Here the optimization of dose proportion is do it without the low doses from the cervico-dorsal posterior field.

PRESCRIPTION

All plans to treat the breast cancer (or thoracic wall) use the tangential fields with 6 MV photons beams and the 100% isodose surface is prescribed to received a total dose of 50Gy in 25 daily equal fractions over 5 weeks (2Gy/day). The prescribed dose of electron beam is dependent of the dose in parasternal area from the tangencial fields, and is weighted to cover the target volume with at least the 95% isodose of total dose of 50Gy. The electron energy is chosen between 6 and 9MeV.

The dose prescription of simultaneous irradiation of the metastatic bone disease is 2Gy/day normalized to give 100%, at ICRU reference point, with a total dose for palliation of 40Gy.

EVALUATING AND ANALYSIS

This technique was evaluated analyzing target volume coverage and dose in normal tissues (using dose volume histogram), and comparing it with the typical tangential fields technique and with conformal irradiation of cervico-dorsal (TT) vertebras delineated.

Results and Discussion

One of the most challenging radiotherapy cases are when two different volumes are targeted in the same planar region and when different total dose or dose/fraction is prescribed . For this, ICRU report 50 recommends that the both PTVs receives between 95 and 107% of the prescribed dose and that the adequacy of the treatment plan`s dose distribution depends on the PTV coverage (as defined by isodoses surfaces encompassing the target), the conformality of treatment and the target dose homogeneity. With two different target volumes (with different dose prescribed), these recommendations should be take into account while the treatment is simultaneous.

The dose-volume histograms and the axial views corresponding to a particularly difficult patient, and the DVH analysis is ahead do it.

Fig. 4 – HDV corresponding to to the typical plan (tangential plan and conformal plan for the cervico-dorsal irradiation) and for the alternative technique.

TARGET DOSE COVERAGE

In the typical plan, the PTV Breast DVH shows the overlap region (red triangle – fig.4) caused by low doses from the cervico-dorsal irradiation. The hot-spots in the PTV breast are 20%. In the alternative technique, the dose is properly modulated to avoid these overdose regions.

With the alternative technique, the doses within the PTV not vary more than 20%.

ORGANS AT RISK SPARING

In both lungs, for typical technique there are high doses comparing to alternative technique (fig. 4). The low doses from the conformal cervico-dorsal irradiation are responsible for this. In the alternative technique to improve a better lung sparing, a single cervico-dorsal posterior field was used. In the heart DVH the typical technique can improve a good heart sparing, but with increasing the low doses in the lungs.

The reason for a unique posterior cervico-dorsal field was to minimize the possible overlap regions, and with this, an improved the homogeneity of the PTV breast is achieved.

This alternative technique without the irradiation of the dorsal spine (metastatic bone disease), can offer a good heart and lung sparing comparing to a fixed tangential geometry (typical technique). In some cases, with the fixed tangential fields the MHD (maximum heart distance) and lung doses can be high. With two tangential beam orientations and an electron beam in parasternal region the heart and lung sparing can improves, and it's possible a optimization of dose proportion of this two plans to achieve the clinical requirements.

CLINICAL GUIDELINES

The criteria for an acceptable plan are a matter of clinical judgement and, therefore, subject to change in the planning process. At our institution, an adequate dose distribution for breast treatment is defined as: (1) average mean dose at the lungs <15Gy and at the heart, mean dose <10Gy and maximum <50Gy, with maximum MHD of 2cm; (2) >70% (include skin in PTV) of the relative target volume receives a does between 47,5Gy and 55Gy and (3) tumour bed receives a minimal dose of 95% prescribed. When other target volumes are introduced (for example, in this case with simultaneous metastatic bone disease), this definition can be adjusted.

To achieve these recommendations, in our department a step-by-step procedure is applied in the execution of breast plans:

1. Generate a typical plan, with one beam orientation and evaluate the dose distribution (particularly heart and lung overdosage and breast underdosage). If the dose distribution is acceptable then keep the plan;
2. If unacceptable (as expected for left-sided breast cancer patients with large MHD and high lung doses), generate a multiple beam tangential beam orientations;
3. If unacceptable generate this alternative plan, with two tangential beam orientations and an electron antero-medial field.

Conclusion

When the typical tangential fields are clinically unsatisfactory, leading to a potential toxicity of treatment, or when conformal cervico-dorsal irradiation is required, and the risk of overlapping regions are possible, this typical technique offer a limited benefit.

This alternative technique purposed enables to an adequate dose modulation in agreement with ICRU guidelines.

This alternative technique without the irradiation of the dorsal spine (metastatic bone disease), can offer a good heart and lung sparing, when with the fixed tangential geometry (typical technique) an adequate dose distribution isn't achieved.

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