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An international, multicenter planning study on regional nodal irradiation in breast cancer



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Introduction

The inter-institutional variability in planning objectives and constraints are expected to be very large in regional nodal irradiation (RNI) since no international guidelines are available specific for breast cancer (BCa) treatment planning.

The aim of this international study was to assess the decision making process as well as the planning of RNI in experienced European BCa centers.

Material and Methods

The planning part of the study focused on a left-sided "total" RNI scenario (Level I - IV + internal mammary chain-(IMC)), including the breast.

Two datasets were chosen:

- a dataset of a regular (R_pt) patient (BMI:24.5; breast vol.:680cm³) and
- an adipose (A_pt) patient (BMI:31; breast vol.:1260cm³).

All regions of interest (ROIs) - CTVs, PTVs and OARs were centrally contoured.

- The CTV was generated according to the ESTRO contouring guideline in free breathing (FB) and deep inspiration breath hold (DIBH); PTV=CTV_breast+1cm and CTV_RNI+0.6cm, respectively.
- The organs at risk (OAR) were: the heart, the left anterior descending artery (LAD), the lungs, the brachial plexus, the esophagus, the humeral head and the thyroid gland.

All participants received the same DICOM datasets with the recommendation to perform the treatment planning for 40.05/2.67Gy with the in-house technique, PTV and OAR constraints.

The final plan and dose files, were sent back as DICOM files. We analyzed for each CTV the D99%, D98%, D95%, D50%, D1% and V95%; for the OAR the D1%, Dmean, V20Gy, V30Gy, V40Gy and the absolute V95% of normal tissue outside the PTV.

We report average±standard deviation and/or median (range).

Results

The techniques used were: tomotherapy, 3D-conformal, volumetric modulated radiotherapy, hybrid techniques (Fig.1).

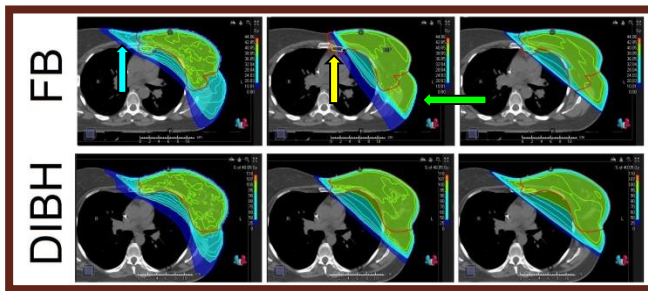


Figure 1. Exemplary dose color wash (0-110% of 40.05 Gy) of three planning approaches depicting the inter-institutional differences in the dose to the contralateral breast (light blue), the dose to the CTV_IMC (in yellow) and the V95% (in green) outside the PTV

Differences in the coverage A_pt vs. R_pt of the CTV_breast (higher D2%/D1% for A_pt; p=0.031) and CTV_IMC (lower D50% for A_pt; p=0.014) were significant.

There was a statistically (p=0.037) significant larger V95% outside the PTV in the A_pt vs. the R_pt (324.48cm²±211 vs. 251.78cm²±144).

Overall, there were statistically significant better D99%, D98%, D95%, D50% CTV_IMC values in the DIBH plans compared to the FB plans. Nonetheless this led to significantly (p=0.021/p=0.008) higher (by 5cm²±7.11cm²/ 11cm²±12.6cm²) V40Gy/V30Gy to the contralateral breast in DIBH compared to FB.

The CTV_IMC V95% for the A_pt was in DIBH/FB: 88.1%(62.6%-100%)/62.8%(6.9%-99.9%) and for R_pt: 78.6%(62.3%-100%)/91%(45.7%-99.9%), respectively. (Fig. 2).

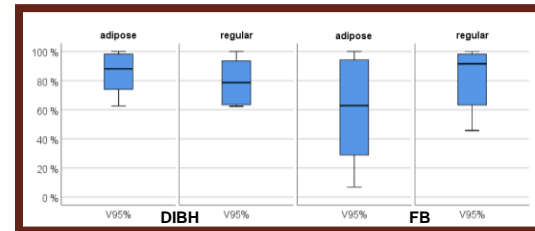


Figure 2. CTV_IMC and heart doses

There was a small significant difference in the Dmean heart dose between the two patients: R_pt (4.04Gy±1.09Gy) vs. A_pt patient (5.19Gy±2.4Gy).

Due to the treatment planning approach with an optimization of heart doses in the FB plans (at a cost of a lower CTV_IMC coverage), there was no statistically significant difference in the Dmean heart between the DIBH and FB plans.

Discussion/Conclusion

RNI remains a challenge in breast cancer treatment.

Our analysis quantifies for the first time the existing international inter-institutional variability in the treatment planning approach and the treatment decision.

Two departments considered the A_pt especially challenging and the achieved dose clinically not acceptable. Both recommended proton therapy.

The heart was the ROI with the most reproducible dose between institutions. This might be due to the increased international interest in heart doses after the Darby et al. publication.