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Unintended irradiation of internal mammary chain – Is that enough?☆

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ABSTRACT

Aim: To evaluate the unintentional coverage of the internal mammary chain (IMC) with tangential fields irradiation to the breast, and its relation with the type of surgery employed.
Background: The dose distribution in regions adjacent to the treatment targets (mammary gland or chest wall), with incidental irradiation of the IMC, could translate into clinical benefit, due to the proximity of these regions.
Materials and methods: One hundred and twelve consecutive conformal radiotherapy plans were correlating the average dose to the IMC with the type of surgery employed, the extent of disease and the irradiation techniques.
Results: The mean doses to IMC after modified radical mastectomy (MRM), modified radical mastectomy with immediate reconstruction (MRM + R), and breast conservative surgery (BCS) were 30.34 Gy, 30.26 Gy, and 18.67 Gy, respectively. Significant differences were identified between patients who underwent MRM or MRM + R over BCS ($p = 0.01$ and 0.003, respectively), but not between MRM and MRM + R ($p = 0.88$). Mean doses to IMC were greater in patients with T3–T4 tumors when compared with more initial stages (≤T2) ($p = 0.0096$). The lymph node involvement also correlated with higher average doses to IMC (node positive: 26.1 Gy × node negative: 17.8 Gy, $p = 0.0017$).
Conclusions: The moderate dose level to the IMC in the unintentional irradiation scenario seems to be insufficient to treat the subclinical disease, although it could have an impact in patients undergoing mastectomy.

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1. Background

The internal mammary chain (IMC) is an important route of lymphatic drainage of the breast gland, especially from the medial quadrants, constituting a probable route of tumoral dissemination.[1,2] Radiotherapy can control or eliminate cancer cells in this region, classically through the intentional inclusion of the IMC in the treatment fields.[3]

However, irradiation of the IMC is still a matter of much debate,[3,4] because even with a high incidence of pathological involvement of this nodal region,[5] there are low rates of recurrence at this region even when not irradiated.[6] While the results of most prospective randomized trials that assess the benefits of IMC irradiation have not yet been published (NCT00005957, NCT00002851), therapeutic decisions are guided by one prospective study,[7] some retrospective series evaluating both oncological outcomes and clinical toxicity,[6,8,9] or even dosimetric studies.[10] The controversy regarding its potential benefit leads to differences in the profile of the IMC irradiation indication in different geographical regions worldwide,[11,12] with arguments both for and against intentional inclusion of IMC in the irradiation fields.[13]

A rationale for the exclusion of IMC from the irradiation fields is related to the dose distribution in regions adjacent to the treatment targets (mammary gland or chest wall), with incidental irradiation of the IMC, which could translate into clinical benefit, due to the proximity of these regions.[14,15]

This study aims to estimate the degree of unintended irradiation of the IMC and the profile of patients receiving greater spatial and dosimetric IMC coverage, correlating with the type of surgery employed, the extent of disease and the irradiation technique, in a series of conformal radiotherapy (3D-CRT) plans for breast cancer.

2. Materials and methods

In the period of January–September 2013, 120 consecutive patients underwent adjuvant radiotherapy for breast malignancy in the department of radiation oncology. Among these, 112 had their CT simulation (CT-sim) selected for dosimetric evaluation. Eight were excluded from the study for the following reasons: hypofractionation (5 patients), bilateral chest wall irradiation (1 patient), and re-irradiation for chest wall recurrence (2 patients). Among these, the majority was treated with breast conservative surgery without prosthesis (BCS) and had Tis, T1 or T2 pathological stage (Table 1). Three other patients with previously esthetic mammary prosthesis had conservative surgery (BCS + P). Twenty-six percent of the cases were treated with modified radical mastectomy, with or without immediate reconstruction (MRM and MRM + R, respectively).

All CT-sims were performed with venous contrast and 5 mm thick sections. The patients were immobilized with the use of own personal devices, Vac-fix™ (Par Scientific A/S [Odense, Denmark]).

The prescription doses are 45 Gy and 50.4 Gy to the breast and chest wall, respectively, delivered over 5 weeks, with tangential fields (two opposite parallel with up to two sub-fields). The dose of 45 Gy was used to the supraclavicular fossa (SCF) region, over 5 weeks, according to N stage, with a single anterior field (or combined anterior and posterior fields). The boost to the tumor cavity, when indicated, was performed with two tangential fields with dose of 10 Gy, in 1 week.

Table 1 – Patients and treatment characteristics.

	n	%
Stage		
Tis	13	11.6
T1	56	50
T2	29	25.9
T3	4	3.6
T4	8	7.1
Tx	2	1.8
N0	67	59.8
N1	29	25.9
N2	8	7.1
N3	7	6.2
Nx	1	1
Surgery		
BCS[a]	83	74.1
MRM[b]	15	13.4
MRM + R[c]	14	12.5
Radiotherapy		
Breast	12	10.7
Breast + boost	64	57.1
Breast + SCF[d]	1	1
Chest Wall	6	5.4
Reconstruction	8	7
Breast + boost + SCF[d]	6	5.4
Chest Wall + SCF[d]	9	8
Reconstruction + SCF[d]	6	5.4

[a] BCS: breast conserving surgery.
[b] MRM: modified radical mastectomy.
[c] MRM + R: modified radical mastectomy plus immediate reconstruction
[d] SCF: supraclavicular fossa.

The clinical target volume (CTV) of the breast and SCF was delineated based on the Radiation Therapy Oncology Group (RTOG) consensus guideline (online at: http://www.rtog.org/CoreLab/ContouringAtlases/BreastCancerAtlas.aspx). The planning target volume (PTV) margin was 5 mm to the CTV. The contouring of the IMC was performed by the same physician in all cases and followed the topography of the internal thoracic vessels and included the extension from the first to third intercostal space ipsilateral to the affected breast, due to the increased probability of secondary involvement in this location.[1] An evaluation volume was also created, to consider the chest wall movement (PTV IMC), and consisted of an expansion of 5 mm from IMC (Fig. 1). All cases were planned using the Eclipse™ v8.6.23 system (Varian [Palo Alto, USA]) for a linear accelerator with energy of 6 MV photons and multi-leaf collimator.

It is expected that the small target (IMC) changes the position inside the PTV IMC during the respiratory movements, being exposed to regions of different dose levels during the treatment time. For this reason, the coverage of IMC was assessed as of the mean doses (D_{mean}) and dose ranges (D_{max}–D_{min}) in PTV IMC (represented in boxplot chart). Most of the irradiated volume with the isodose of reference (IR) is located in the breast or chest wall. Thus, it is not possible to apply the concept of Conformity Index,[16] since the IR