



Plastic surgery for breast conservation therapy: How to define the volume of the tumor bed for the boost?

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Abstract

Purpose: To describe the procedure of definition of the boost volume using pre- and post-operative computed tomography (CT) and surgical clips in the tumor bed after oncoplastic surgical procedure.

Patients and methods: Thirty-one consecutive breast cancer patients who underwent simple lumpectomy or oncoplastic surgery were studied. All of them underwent pre- and post-operative CT scan in treatment position to evaluate the planning target volume (PTV) boost volume and define the primary tumor (gross tumor volume (GTV)) and tumor bed zones (CTV), with an overall margin of 5 mm in lateral and 10 mm in craniocaudal directions, corresponding to localization and setup uncertainties.

Results: Thirteen patients underwent simple lumpectomy and 18 oncoplastic surgery. The volumetric analysis showed that the intersection between GTV and CTV clips was significantly higher in patients with three and more clips (28.4% vs 3.14%; $p < 0.001$). In the case of patients with oncoplastic surgery, more than three clips were needed to define the tumor bed volume with accuracy. The number of clips was directly related to the exact definition of the boost volume.

Conclusions: The use of more than three clips allows better definition of the PTV boost volume after oncoplastic surgical procedure.

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Keywords: breast cancer; Oncoplastic surgery; Boost; tumor bed; clips; pre- and post-operative CT scan; images registration

Introduction

Breast-conserving therapy consists of conservative surgery to remove the primary tumor, followed by radiotherapy. The importance of preventing local recurrence has been highlighted in a meta-analysis by the Early Breast Cancer Trialists' Collaborative Group that examined the effect of radiotherapy and extent of surgery on clinical outcomes using individual patient data from 42 000 women in 78 randomized trials found that the absolute reduction in the 5-year rate of locoregional recurrence was proportional to the reduction in 15-year breast cancer mortality with a 4:1 ratio.^{1,2} The benefit of boost to the tumor bed in conservative breast cancer treatment has been supported

by two randomized studies.^{3,4} Although the use of boost irradiation is recommended, neither a standard technique nor the definition of the tumor bed volume has been clearly established.⁵ A good cosmetic result is a very important reason for the breast-conserving approach to early-stage breast cancer. Oncoplastic breast surgery is a fast-expanding and developing field consisting in the contribution of plastic surgery to surgery for breast cancer. This involves resection of the tumor and remodelling the breast using a breast reduction technique (V-mammoplasty outer, V-mammoplasty inner, superior pedicle mammoplasty inverted T and round block mammoplasty).

However, it results in new challenges to deliver of breast radiotherapy, especially for the boost. Boost irradiation is associated with a worsened cosmesis.⁶ The tumor bed volume needs to be more clearly defined in order to decrease the risk of recurrence and complications. The definition of tumor bed could be more difficult to define after

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oncoplastic breast surgery, because of very large mammary gland translation, rotation or excision. We have previously described our multidisciplinary approach to localize the tumor bed boost using pre-operative and post-operative CT, both in the treatment position, image registration, and clips in the lumpectomy region.^{7,8} No studies have evaluated the tumor bed after oncoplastic surgical treatment using pre-operative and post-operative CT. The aim of this study was to evaluate the correlation between primary tumor and tumor bed after oncoplastic surgery.

Patients and methods

This pilot study was conducted at Institut Curie by the department of radiation oncology, with the collaboration of the departments of surgery and radiology, with approval by the Board of the Institut Curie Breast Cancer Study Group. From 2008 to 2011, 31 consecutive breast cancer patients who underwent simple lumpectomy or oncoplastic surgery with placement of one or more clips in the surgical cavity have been studied. We used a previously published procedure in eight steps to localize the tumor bed boost after lumpectomy or oncoplastic surgery, as following: Step 1 – patient's selection; Step 2 – CT in treatment position before the surgery; Step 3 – breast-conserving surgery with orientation of the surgical specimen and measurements and placement of clips; Step 4 – post-op CT scan in treatment position 4–5 wks after surgery; Step 5 – pre- and post-operative image registration; Step 6 – delineation of the tumour (GTV) on the pre-op. CT scan and delineation of the clips and definition of PTV on the post-surgical CT; Step 7 – 3D treatment volumes definition after pre- and post-operative CT scan in treatment position; Step 8 – dosimetric work (simplified IMRT).^{7,8}

Pre-operative CT scan in RT treatment position with contrast

The pre-surgery CT scan was performed 1 week before surgery. For all patients, an intravenous bolus contrast injection of 100–120 mL (contrast agent concentration of 350 mg/mL of iodine) was injected with a venous cannula placed in the contralateral antecubital fossae of the affected breast. We started the CT acquisition 90–120 s after injection. They were in the supine treatment position, the angle of breast board (typically 15° or 20°) is chosen to obtain a horizontal thorax. The ipsilateral arm is at 90° from the patient axis. The RT technicians aligned the patient on the breast board and placed markers on the clinical medial line of the patient. The breast board index parameters were recorded.

Surgery

All patients underwent breast-conserving therapy, simple lumpectomy or oncoplastic surgery depending on the

breast volume and tumor size. Whatever the technique used, we realized a complete excision of the primary tumor, from the subcutaneous plane down to the pectoralis fascia. Four oncoplastic techniques were performed during this study: V-mammoplasty outer for outer quadrant pole lesion, V-mammoplasty inner for lower inner quadrant pole lesion, superior pedicle mammoplasty inverted T for lower pole lesion and round block mammoplasty for upper pole lesion because they required larger resections.⁹

V-mammoplasty involves excising a pyramidal section of gland, with apex at the border of the areola. The section is removed en bloc, including the skin attached to the gland down to the pectoralis fascia. The nipple areola complex is recentralized on a deepithelialized superior lateral pedicle.

Superior pedicle mammoplasty inverted T, this procedure begins with deepithelialization of the area surrounding the nipple areola complex. The inframammary incision is then completed, followed by wide undermining of the breast tissue off the pectoralis fascia. The tumor is removed en bloc with a large margin of normal breast tissue and overlying skin as determined by the pre-operative drawings.

Round block mammoplasty starts by making two concentric periareolar incisions, followed by deepithelialization of the intervening skin. Wide excision of the tumor and surrounding tissue is performed from the subcutaneous plane down to the pectoralis fascia.

During the surgery, 1–5 titanium surgical clips were placed in the tumor bed cavity: one deep clip attached to the pectoralis major and 2–5 clips placed in the lumpectomy cavity before breast remodeling.

Post-operative CT scan in RT treatment position with contrast

The post-operative CT scan was performed 4–5 weeks after surgery or in case of chemotherapy treatment; the second CT scan was realized 3–4 weeks after the chemotherapy. This CT scan was performed in the treatment position determined during the first CT scan.

Image registration

The two sets of images (pre and post-operative CT) were registered on our treatment-planning system (TPS) (Eclipse; Varian Medical Systems, Palo Alto, CA) for each patient, using rigid image fusion automatic software. This fusion was verified by a radiation oncologist and a radiologist.

Volume

Three volumes were contoured (Fig. 1) by the radiation oncologist in collaboration with the radiologist: primary tumor (GTV, gross tumor volume), a region including all clips (CTV clips, clinical target volume clips) with additional 0.5 cm margins and the planning target volume

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