Dosimetric Comparison of Hypofractionation with Concomitant Boost versus Sequential Boost following Breast-Conserving Surgery in Early-Stage Breast Cancer Patients

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Introduction

Radiation therapy is a cornerstone of the treatment regimen for breast cancer. Since the introduction of breast conserving therapy,, defined as breast conserving surgery (BCS) followed by radiation therapy, various radiation doses have been studied. Moderate hypofractionation has become the clinical standard of care for adjuvant whole breast radiotherapy (RT). Dose escalation to the lumpectomy bed by way of a radiation boost improves local control with the absolute largest benefit found in younger patients [1].

There are multiple mechanisms of boost delivery used in clinical practice including sequentially or concomitantly. In a sequential boost (SB), the whole breast is irradiated followed by a cone down boost to the lumpectomy bed using either electrons for superficial cavities or photons for deeper cavities. In a concomitant boost (CB), the boost dose to the tumor bed is delivered simultaneously with the whole breast dose.

Citations

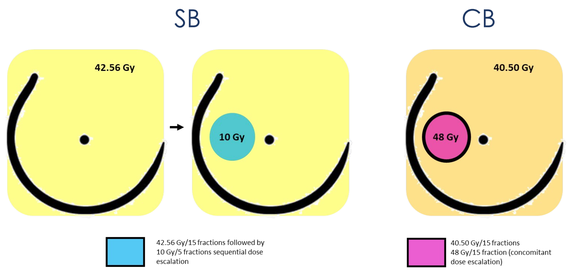
1. Bartelink H, Maingon P, Poortmans P, et al. Whole-breast irradiation with or without a boost for patients treated with breast-conserving surgery for early breast cancer: 20-year follow-up of a randomised phase 3 trial. Lancet Oncol. 2015;16(1):47-56. doi:10.1016/S1470-2045(14)71156-8
2. Petrova D, Smichovska S, Lazarevska E. Conformity Index and Homogeneity Index of the Postoperative Whole Breast Radiotherapy. Open Access Maced J Med Sci. 2017;5(6):736-739. doi:10.3889/oamjms.2017.161

Purpose

A basic dogma of radiation therapy is to deliver the maximum therapeutic dose to the target volume homogeneously with minimal involvement of the surrounding tissue. Dosimetric measures such as the conformity index (CI), homogeneity index (HI), and gradient index (GI) are effective tools in analyzing treatment plans during radiation therapy in patients with early-stage breast cancer [2].

The purpose of this study was to dosimetrically compare two hypofractionated RT breast boost techniques—CB and SB—using CI, GI, and HI in early-stage breast cancer patients who have undergone BCS. This study also aimed to evaluate the planning target volume (PTV) coverage and dose to the organs at risk (OARs) between the two techniques

Boost Techniques



Dosimetric Indices

Conformity index	**CI = V_{RI} / TV** **V_{RI}** = Volume of the reference isodose **TV** = Target volume
Homogeneity Index	**HI = D_{Max} / D_p** **D_{max} =** Maximum dose of the target volume **D_p =** Prescription dose
Gradient Index	**GI = $V_{50\%}$ / $V_{100\%}$** **$V_{50\%}$ =** Volume receiving half the prescription dose **$V_{100\%}$ =** Volume receiving the total prescription dose

Methods

25 patients with early-stage, node negative breast cancer who had undergone BCS and adjuvant RT at a single institution in the prone position from December 2021 to April 2022 were selected. A CB and SB plan were created for each patient. CI, HI, and GI were calculated based on a dose-volume histogram for both treatment plans and compared. PTV coverage and OAR (heart, lungs, and contralateral breast) dosimetric parameters were analyzed.

Results

Comparing CB and SB, CI was significantly better with CB (p<.0001). GI was also better with CB compared to SB (p=0.0002). There was no significant difference in HI between CB and SB (p=0.71). Regardless of boost technique, lumpectomy beds located in the inner quadrants had a worse CI than those located in the outer quadrants (p=0.055). A small lumpectomy bed size (≤50cm^3) was more likely to have a higher CI with CB than SB (OR=3.75, 95%C.I. 0.52-28.7, p=0.18). There was no significant difference between CB and SB in PTV coverage or adherence to OAR constraints.

Discussion

CB demonstrated a better conformity and gradient index when compared to SB. The dosimetric advantage of CB appeared to be greater when lumpectomy bed size was smaller and located in an outer quadrant. Only a few studies have evaluated the association between treatment parameters like target location or volume on dosimetric indices. The association between CI, lumpectomy bed size, and location is a relatively novel finding. Both CB and SB plans delivered acceptable PTV coverage and adherence to OAR constraints.

CB is a safe alternative to SB and can be implemented in clinical routine with the advantage of shortening patient treatment time.