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Updated feasibility and reproducibility results of multi-institutional study of noninvasive breast tumor bed boost

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ABSTRACT

PURPOSE: To report updated feasibility and reproducibility results for high-dose-rate noninvasive breast brachytherapy (NIBB) for tumor bed boost with whole breast radiation therapy (WBRT) in the setting of expanded patient and treatment facility number.

METHODS AND MATERIALS: Fifteen independent community-based and academic centers reported 518 early-stage breast cancer patients from July 2007 to February 2015 on a privacy-encrypted online data registry. All patients' treatment included lumpectomy followed by combination of WBRT and NIBB. NIBB was completed with commercially available (AccuBoost, Billerica, MA) mammography-based system using high-dose-rate ^{192}Ir emissions along orthogonal axes. Harvard scale was used to grade cosmesis.

RESULTS: Total patient cohort had median followup of 12 months (1−75 months) with subset of 268 having available cosmesis. Greater than 2- and 3-year followup was 29% and 14%, respectively. Entire cohort had 97.4% excellent/good (E/G) breast cosmesis and freedom from recurrence of 97.6% at the final followup. WBRT timing with respect to NIBB delivery demonstrated no statistically significant difference in E/G cosmesis. Achieved E/G cosmesis rate was also not statistically significant (χ^2 p-value = 0.86) between academic and community institutions with 97.8% vs. 96.6%.

CONCLUSIONS: NIBB represents an alternative method for delivery of breast tumor cavity boost that has shown feasibility in a diverse group of both academic and community-based practices with reproducible early cosmesis and tumor control results. Recommendations are updated noting ideal timing of boost delivery likely to be before or early during WBRT given equal cosmesis and less documented treatment discomfort.

Keywords: High dose rate; Noninvasive breast brachytherapy; Breast boost

Introduction

Treatment options for early-stage invasive breast cancer and noninvasive ductal carcinoma *in situ* (DCIS) currently include mastectomy or breast-conserving surgery (BCS) followed by adjuvant radiation (1−4). In BCS for invasive breast cancer, survival benefit has association with

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reduction in in-breast recurrence as achieved by whole breast radiation therapy (WBRT) (5, 6). Tumor bed remains at highest risk for in-breast recurrence (7–9). To maximize in breast control, current practice is to deliver a tumor bed boost after WBRT as all studied subgroups of invasive ductal carcinoma demonstrated improvement. This boost is commonly extrapolated to other histologies such as invasive lobular carcinoma and DCIS (7–9).

Although breast tumor bed boost is considered standard for most patients, there is no standard delivery modality or setup technique. Tumor bed boost was designed historically based off clinical setup around visible external scar and delivered with electron-based treatment (8, 9). Other delivery modalities include invasive interstitial brachytherapy (8, 10), and recently, photon-based treatment delivery has been increasing (11). However, no modality will be effective if the target (i.e., tumor bed) is not identified correctly (12). Tumor bed identification is one of the greatest challenges in delivery of boost radiation therapy. Three-dimensional (3D) CT boost planning improves tumor cavity identification and allows optimization of tumor bed dosimetry coverage compared to clinically defining boost volume by placing a margin around the surgical scar (13, 14). Use of 3D-CT imaging has highlighted interobserver target contouring discrepancies suggesting additional improvements in target identification and physician delineation can be made (15, 16). Even with 3D planning, interfraction and intrafraction errors are not completely addressed by traditional delivery techniques (17–19). These errors are presented due to factors such as daily patient and breast setup variability, respiratory motion, and potential for tumor resection cavity volume changes over time (20–22).

Noninvasive breast brachytherapy (NIBB) is an alternative technique to deliver breast tumor bed boost that uniquely attempts to address the above challenges. NIBB incorporates pretreatment mammography-based imaging and reproducible breast compression (23–25). The initial feasibility, patient tolerance, and acute toxicity of NIBB in a small set of patients have been previously been reported by Hamid *et al.* (23). The current study provides longer median followup, larger patient number, and increased treatment site participation expanding evidence of technique feasibility and demonstrating reproducibility of NIBB in a diverse group of community and academic clinical practices.

Methods and materials

Patient population

Population consisted of 518 women with early-stage breast cancer between July 2007 and February 2015. All women completed BCS, WBRT, and tumor bed boost with NIBB. Additional patient characteristics are presented in Table 1. Patients were excluded from analysis if they had no followup data, not stated to have negative margins at time of treatment, or were not early stage (T1-T3N0-1 based on AJCC seventh edition) or noninvasive (Tis).

Treatment centers

All practices actively treating patients with NIBB as boost were contacted by e-mail, in person, and/or phone and invited to participate in online registry. Participating sites retrospectively logged patient, treatment, and outcome date in the online NIBB database. Fifteen independent community-based and academic centers volunteered to report retrospective data. Two centers were academic based, and 13 were community based. No financial incentive was provided for center or patient participation.

NIBB system and treatment

NIBB (AccuBoost, Billerica, MA) is a commercially available treatment device that uses mammography-based image-guided radiation therapy to deliver breast tumor

Table 1
Patient characteristics

Patient characteristics	Treated patients with cosmesis data (*n*)	%
Age, *n* (%)		
Mean age (y) ± std (range)	60.3 ± 10.7 (19–87)	
>50	224	83.6
<50	44	16.4
Histology, *n* (%)		
Ductal carcinoma *in situ*	60	22.4
Invasive ductal ca	168	62.7
Invasive lobular ca	24	9.0
Other/unknown	16	5.9
ER status, *n* (%)		
(+)	211	78.7
(−)	46	17.2
Unknown	11	4.1
Laterality, *n* (%)		
Left	146	54.5
Right	122	45.5
Her2Neu status, *n* (%)		
(+)	13	4.9
(−)	164	61.2
Unknown	91	34.0
Tumor size		
Gross tumor size (cm) ± std (range)	1.5 ± 1.03 (0.1–5.3)	
0–2 cm	197	73.5
2–5 cm	66	24.6
5+ cm	1	0.4
Unknown	4	1.5
Tumor location, *n* (%)		
Upper, inner quadrant	30	11.2
Lower, inner quadrant	15	5.6
Upper, outer quadrant	142	53.0
Central	44	16.4
Lower, outer quadrant	18	6.7
Unknown	19	7.1

Total patient cohort with cosmesis data $n = 268$, but some patients with cosmesis data had missing fields represented in table as unknown.