Section: Radiation Oncology

Original Research Article

DOSIMETRIC ANALYSIS AND COSMETIC OUTCOME IN CARCINOMA BREAST PATIENTS POST BREAST CONSERVATIVE SURGERY UNDERGOING RADIOTHERAPY BOOST WITH PHOTONS VS ELECTRONS

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ABSTRACT

Background: After breast conservative surgery (BCS) and whole-breast radiotherapy (WBRT) along with tumor bed boost is recommended especially in patients at high risk. However, the standard techniqueof the boost volume irradiation have not been well defined. **Aim:** To evaluate and compare dosimetric parameters and cosmetic outcomes in carcinoma breast patients, post-breast-conservative surgery undergoing radiotherapy boost to tumor bed with photons vs. electrons.

Materials and Methods: It was an institutional-based prospective randomized study done in carcinoma breast patients from November 2018 to April 2020 (18 months). All carcinoma breast patients who fulfilled inclusion criteria and exclusion criteria during this period were included in the study.

Results: In the present study,the mean age for the total (32) study population was around 49.3 years. Of those patients who were treated with photons (50%), the mean age was 47.6 years, and for the remaining 50% of the patients who were treated with electrons, the mean age was 51.1 years. In our study, out of 32 patients, 5 (15.6%) patients presented with T1N0M0, i.e. stage I, of which two of them treated with photons and three were treated with electrons. 19 (59.4%) patients presented with T2N0M0, i.e., stage IIA of which 8 of them were treated with photons and 11 were treated with electrons.8 (25%) patients presented with T2N1M0, i.e., Stage IIB of which 6 of them treated with photons and two were treated with electrons. In our study, out of 32 patients, 17 (53.12%) patients became positive for both E.R. & P.R. receptors. Only 5 (15.6%) patients became positive for HER2NEU receptors. At the end of radiotherapy in our study, grade 1 reactions were seen in 8 patients in photons arm and six patients in electrons boost arm. Grade IIreactions were observed more in the electrons arm, i.e., nine members and eight members in photons arm. Radiation conformity index (RCI) in Electron was 1.13 and with 3DCRT was 1.017. Dose homogeneity index (DHI) in Electron was 0.93 and with 3DCRT was 0.94. Heart mean V10 for PHOTONS was 7.3% and for ELECTRONS was 16.4%. This difference was statistically significant, as p is less than 0.05 (0.001). At 6 months follow-up, a good (grade I) cosmetic score was noticed in eight patients (32%) of electron boost arm and in six patients (24%) of 3DCRT boost arm. Moderate (grade II) cosmetic scores were seen in 13 (52%) of electron boost patients and in 14 (56%) of 3DCRT boost patients. Bad scores (grade III) were seen in four (16%) and five (20%) patients, respectively.

Conclusion: The present study concluded that the photons group showed better coverage than electrons dosimetrically in terms of PTV, but the coverage of electrons is also within the tolerance limits for tumor bed boost in early breast cancer patients who underwent BCS. There is slight increased acute skin toxicity with electrons, but overall skin, subcutaneous toxicities are similar in both groups.
Keywords: Breast Cancer, Cosmetic score, Photons, Electrons, Breast conservation Surgery.

INTRODUCTION

In India and worldwide, breast cancer is the most frequently diagnosed cancer in women.The incidence rates are increasing primarily due to increased utilization of screening mammograms, increased awareness. An annual incidence of approximately 1, 92,000 new breast cancer cases in India as per GLOBOCON 2022 statistics.[1]

As the diagnosed population ages, new factors have to be taken into consideration for successful interventions. According to the National Cancer Institute, 0.44% of women now 30 years old can develop cancer sometime in the next ten years. Thisestimate increases to 4.07% if the time-lapse increases to 30 years after the current age. Nowadays, cancer survival treatments do not only focus onstopping or slowing down the biological disease but also on improving patients' quality of life.

In general, in radiation oncology practice, breast cancer typically comprises approximately 25% of the total patient caseload. Breast Conservation Surgery(BCS) followed by RT to intact breast with or without tumor bed boost is the standard of care for women with early-stage invasive breast cancer.[2]Many techniques using computed tomography (C.T.)based three-dimensional planning, electrons, interstitial brachythapy are being used for adjuvant radiation..

This study evaluates the contrast of photons (3DCRT) vs. electron beam therapy as a boost in post-lumpectomy patients of breast cancer, following whole breast irradiation (WBI) in dosimetric parameters, acute and chronic radiation toxicities, cosmesis, the pattern of failure, and local control.

Aims and Objectives

Aim

To evaluate and compare dosimetric parameters and cosmetic outcomes in carcinoma breast patients, post-breast-conservative surgery undergoing radiotherapy boost to tumor bed with photons vs. electrons.

Objectives

1. The primary objective is to assess dosimetric parameters, radiation toxicities(acute and late), and cosmesis.
2. The secondary objective is to assess local tumor control and pattern of failure.

MATERIALS AND METHODS

This was an institutional-based prospective randomized study done in department of Radiotherapy, GSL Medical College and General Hospital from November 2018 to April 2020 (18 months)

PATIENT SELECTION CRITERIA

Inclusion Criteria

1. Histopathologically proved post breast, conservative surgery patients.
2. Patients with Unicentric primary breast cancer and invasive ductal histology.
3. Patients who received Neoadjuvant chemotherapy /adjuvant chemotherapy.
4. Patients who gave written informed consent

Exclusion Criteria

1. Patients with multicentric/metastatic disease.
2. Patients who received radiotherapy earlier.
3. Post BCS patients with positive / close margins.
4. Patients with skin and connective tissue disorders.
5. Patients with any histology other than ductal carcinoma.
6. Patients with interstitial lung disease.

EXTERNAL BEAM RADIOTHERAPY

All the patients included in the study were positioned and immobilized on a breast board with sternum parallel to the table. Both arms abducted above the head. Before the C.T. scan, skin marks were placed to enable the patient to reposition during treatment. Radio opaque markers placed over the scar to guide in locating the lumpectomy cavity on C.T. images. Then CT images were transferred to the MONACO treatment planning system.

Dose prescription and Treatment delivery:Each patient is initially planned for whole breast irradiation WBI to a dose of 50Gy in 25 fractions at five fractions per week by two tangential fields and then followed by tumor bed boost with electron beam therapy inone arm and 3DCRT with photons in another arm. Boost dose was 10 Gy in 5 fractions at five fractions per week.

The Radiation Therapy Oncology Group (RTOG) scores were used to assess skin and subcutaneous toxicities. The cosmetic outcome was assessed by using Harris and Van Limbergen scale.

Written consent was obtained from those patients who voluntarily willed to participate in the study after explaining the nature of the disease, its treatment, and side effects in her vernacular language.

Statistical Analysis

Statistical analysis was done by SPSS software version 22.0.All descriptive values were presented in the form of mean +/- S.D. and percentages.Student t-test was performed to compare dosimetric parameters. For all statistical analyses, $p<0.05$ was considered statistically significant.

RESULTS

Thirty-two patients were enrolled in this study between November 2018 to April 2020. All patients received EBRT to a total dose of 60 Gy in 30 fractions,50Gy to the whole breast, followed by 10 Gy to boost the tumor bed. This study is done to compare the tumor bed boost irradiation with photons and electrons. The distribution of the various patient factors is as follows. The information collected regarding all selected cases was recorded in a Master Chart. Data analysis was completed with the help of a computer using MS-Excel, SPS 22.0. regression test and P-values were calculated.

Table 1: Patient characteristics

	Photons	electrons
Age (mean in years)	47.6	51.1
Laterality		
Right	9	8
Left	7	8
Stage		
IA	2	3
IIA	8	11
IIB	6	2
Harmone receptor status		
ER +	7	10
ER –	9	6
PR+	7	10
PR-	9	6
Her 2+	2	3
HER2-	14	13

Table 2: Summary of DVH analysis for PTV and organs at risk

PTV	PHOTONS	ELECTRONS	P value
D Mean (Gy)	59.52 ± 3.83	59.69 ± 3.56	
V 100 (%)	84.4 ± 7.1	76.5 ± 12.4	0.04
V 95 (%)	93.8± 7.1	91.2 ± 12.4	
V 90(%)	96.2± 3.8	88.5± 24.6	0.04
HEART			
V10	7.3 ± 5.1	16.4± 8.3	0.001
V5	10.1 ± 7.74	19.1 ± 12.5	0.04
V2	20.3 ± 18.6	50.6± 33.1	0.001
IPSILATERAL LUNG			
Mean (cGy)	468.4	580.3	
V10	17.8 ±18.0	21.35 ±26.4	0.05
V5	23.8 ±24.0	22.9 ±26.3	
V2	34.1 ±31.1	83.4 ±4.7	0.001
CONTRALATERAL LUNG			
Mean	145.6± 87.3	167.8±94.5	
V10	9.7 ±1.9	19.0 ±1.9	0.042
V5	6.5 ±1.3	14.8 ±3.8	
V2	14.5±4.3	23.2±5.3	
CONTRALATERAL BREAST			
D Mean (Gy)	1.58 +/- 0.9	2.69+/- 1.0	0.02

Table 3: COSMETIC SCORE

Cosmetic score grade	PHOTONS %	ELECTRONS%	P-value
End of RT			0.2
E1	9(6.2%)	5 (31.2%)	
E2	7 (93.8%)	10(62.5%)	
E3	0	1 (6.2%)	
3RE Months			0.2
E0	3(18.8%)	1 (6.2%)	
E1	13 (81.2%)	13 (81.2%)	
E2	0	2 (12.6%)	
6TH Months			0.3
E0	7 (37.5%)	4 (68.7%)	
E1	9 (62.5%)	11 (25%)	
E2	0	1 (6.3%)	

Table 4: ACUTE REACTION

SKIN REACTION GRADE	PHOTONS	ELECTRONS
1	8	6
2	8	9
3	0	1
PNEUMONITISGRADE		
1	12	10
2	4	6
3	0	0

Table 5: LATE REACTION

DERMATITIS GRADE	PHOTONS	ELECTRONS
1	12	10
2	4	6
3	0	0
SUB CUTANEOUS FIBROSIS GRADE		
1	9	4
2	7	12
3	0	0

Clinical photographs of cosmetic assessment in both arms

POST RT

6MON POST RT

Figure 1: Patient treated with electrons

POST RT

6MON POST RT

Figure 2: Patient treated with photons

DISCUSSION

A study entitled Dosimetric analysis and cosmetic outcome in carcinoma breast patients post breast conservative surgery undergoing radiotherapy boost with photons vs electrons was undertaken at the Department of Radiotherapy, GSL medical college,

Rajahmundry from November 2018 to April 2020 (18months). The patient population at GSL Hospital have a very low socioeconomic status, and among the cases seen at the Department of Radiation Oncology, there is a high incidence and prevalence of carcinoma breast. Surgical removal of breast lump followed by systemic therapy and to address the microscopic disease with whole-breast irradiation and boost to lumpectomy site is the ideal treatment. The present study is an institutional-based prospective study designed to compare the photons and electrons to boost patients who underwent conservative breast surgery concerning cosmesis and dosimetric parameters.

The purpose of radiation treatment following breast-conserving surgery in breast cancer was to minimize the risk of recurrence and toxicity in the treated breast while maximizing cosmetic results. Different patient, tumor, and surgical variables contribute to the cosmetic and functional outcomes in patients with cancer of breast treated with lumpectomy and radiation, in addition to the effects of the radiation dose-fractionation schedule. A total of 32 patients participated in our present study, of which 50% (16) them treated with photons, and the remaining 50%, (16) were treated with electrons.

PATIENT RELATED FACTORS

AGE

The mean age for the total (32) study population was around 49.3 years. Of those patients who were treated with photons (50%), the mean age was 47.6 years, and for the remaining 50% of the patients who were treated with electrons, the mean age was 51.1 years.

AGE distribution in PHOTONS treated patients was < 30 years1 (6.2%), 30 TO 45 years 4 (25.0%), 45 TO 60 years 10 (62.6%) and>60 years 1 (6.2%). And those who treated with ELECTRONS were, < 30 years 1 (6.2%), 30 TO 45years 4 (25.0%), 45 TO 60 years 9 (56.4%), >60 years 2 (12.4%)

Rajan SS et al.[3] also stated that the Mean age of the study patients was 42 years, and most of them were in the premenopausal stage, which was not in agreement with our study. In their study done by Zhang J et al,[4] the age parameters were, Median age was 43 years, Mean (S.D.) (years) 42.5±10.4 Range 36-56years.

The number of patients in the study was 32, which was similar to the study done by Hashemifard et al.,5 in which 30 patients were included. Kovacs et6 is a large study that included 78 early breast cancers, unlike any other study.

Rajan et al,[3] conducted the study in 50 patients, which is more than half of this study. Park SH Kim JC et al. conducted their study in 20 patients only.

In our present study, out of the total study population, 53.1% of patients were having carcinoma of the right breast, of which nine patients were treated with photons, and eight patients were treated with electrons.

And the remaining 46.9% study population was diagnosed with carcinoma left breast,of which seven patients were treated with photons and eight patients were treated with electrons in our present study.

De Santis MC et al,[7] in their study, presented that Eight right-sided and seven left-sided tumors were treated, which was in agreement with our study. Rajan SS et al,[3] also stated Twentyfour (48%) of the tumors were in the right breast, and twenty-six (52%) were in the left breast, which was quite in disagreement with our study.

DISEASE STAGE

In our study, out of 32 patients, 5 (15.6%) patients presented with T1N0M0, i.e.stage I, of which two of them treated with photons and three were treated with electrons. 19 (59.4%) patients presented with T2N0M0, i.e., stage IIA of which 8 of them were treated with photons and 11 were treated with electrons.8 (25%) patients presented with T2N1M0, i.e., Stage IIB of which 6 of them treated with photons and two were treated with electrons.

In their study done by Zhang J et al,[4] the patients presented with T1 were 16 and T2 were 13.In the study done by Park SH, Kim JC(6),the patients presented with stage - 0 were 24 (18.3%), stage - I was 76 (58.0%), Stage - II was 28 (21.4%), and Stage - III were 3 (2.3%).

The patients ignore the mass as it is commonly painless and does not interfere with the patient's regular lifestyle.There is also a considerable delay in presenting to the hospitals due to ignorance allowing the lump to attain more immense proportions.

RECEPTOR STATUS

In our study, out of 32 patients, 17 (53.12%) patients became positive for both E.R. & P.R. receptors. Only 5 (15.6%) patients became positive for HER2NEU receptors.

The receptor status of our study compares closely with the results of the receptor status study by Tanujash et al, [8] conducted at Tata memorial hospital, Mumbai, from 1999 to 2006. The receptor positivity is 60% in our population and 55.8% in the Tanujash et al. study. It matches the incidence in the Indian population, which is about 10% less than the western population. All the patients with hormone receptor-positive status were put on tamoxifen 20 mg O.D. for five years. It was also noted that receptor status tended to be negative in younger patients.

ACUTE REACTIONS

At the end of radiotherapy in our study, grade 1 reactions were seen in 8 patients in photons arm and six patients in electrons boost arm. Grade II reactions were observed more in the electrons arm, i.e., nine members and eight members in photons arm. There are no grade III reactions seen in photons arm, but one patient had a grade III reaction in electrons arm at the end of R.T.

Fisher et al,[9] in RTOG 97-13 study prospectively assessed skin toxicity throughout breast irradiation; found less than 3% of patients developed grade III toxicity.

Kaija. Hollie et al,[10] have concluded in their study that skin reactions are common after radiotherapy but seldom severe (9%).

In our study, grade I subcutaneous reaction was seen in 9 patients of photons arm and four patients in electrons arm.Grade II reaction was observed in 7 patients in photons arm and 12 patients in electrons arm.

According to Rajan S S et al, [3] during assessment at six months post radiation, grade subcutaneous toxicity was noticed in 16 patients (64%) of electron boost arm and 17 patients (68%) of 3DCRT boost arm. Grade II subcutaneous toxicity was noted in nine (36%) and seven patients (36%), respectively. Grade III subcutaneous toxicity was observed in only one (4%) 3DCRT boost patient, and no grade IV toxicity.

At the end of the 1-year follow-up, grade I subcutaneous toxicity was observed in 15 patients (60%) of the electron boost arm and 16 patients (64%) of the 3DCRT boost arm. Grade II subcutaneous toxicity was noted in 10 (40%)and eight patients (32%), respectively. Grade III subcutaneous toxicity was observed in only one among the 3DCRT boost patient (4%).

In this study, late skin toxicities were assessed post six months of treatment, and the majority have grade I skin toxicity in photons arm I,e 12 members and ten members in electrons arm. Grade II skin reactions were seen in 4 patients in the photos are, and six patients in the electrons are.

In the study by Rajan S S et al,[3] at the end of 6 months post-radiation, grade I skin reactions were noticed in 16 patients (64%) of both electron and 3DCRT boost arms. Similarly, grade II reactions were noted as =]# 'among nine patients (36%) in both arms, thus indicating similar late skin toxicities.

COSMETIC SCORE

Besides tumor control, in radiotherapy to breast cancer patients, the cosmetic outcome is a very important question. The local control is prior to the cosmetic outcome; the boost treatment must be given to the tumor bed. In our present study, at the end of therapy, after three months follow up and after 6 months follow up, the photons show the better cosmetic score when compared to electrons.

The cosmetic score, according to Rajan SS et al, [3]

At six months follow-up, an excellent cosmetic score was observed in one (4%) of the 3DCRT boost patient. Good (grade I) cosmesis was noted in 11 patients (44%) of electron boost arm and in 13 patients (52%) of 3DCRT boost arm. Moderate (grade II) cosmetic scores were seen in 14 (64%) and 10 (40%) patients, respectively, and bad aesthetics was seen in only one of the patients of the 3DCRT boost arm.

At the end of 1 year follow up, the excellent cosmetic score was noted in two patients (8%) of electron boost arm patients and in three (12%) of the 3DCRT photon boost patients, and a good (grade I) cosmetic score was observed in 13 patients (52%) of both the arms. Moderate (grade II) cosmetic scores were seen in 10 (40%) of electron arm and eight (36%) patients of 3DCRT arm, and bad aesthetics was seen in only one (4%) 3DCRT boost patient.

Vrieling, Collette et al,[11] evaluated the influence of a radiotherapy boost on the cosmetic outcome after three years of follow-up in patients treated with breast-conserving therapy (BCT), which reported a limited impact on the cosmetic outcome after three years.

DOSIMETRIC ANALYSIS

Radiation conformity index (RCI) in Electron was 1.13 and with 3DCRT was 1.017. Dose homogeneity index (DHI) in Electron was 0.93 and with 3 DCRT was 0.94. According to Rajan et al.,3 the Radiation conformity index (RCI) in Electron was1.23 and with 3DCRT was1.017. Dose homogeneity index (DHI) in Electron was and with 3DCRT was 0.927. In their study done by Zhang J et al,[4] the dosimetric parameters for target-volume coverage for the six plans as followed, The dosimetric parameters for PTV Eval-breast and the CI and H.I. were significantly better for the VMAT-VB plan than for the other plans ($p < 0.05$). The CI of 3DCRT was considerably worse than that of the other plans ($p < 4.49$). There were no significant differences in CI and H.I. among the four IMRT plans ($p > 0.05$).PTV – Mean for PHOTONS is 5951.8 cGy and for ELECTRONS is 5969.2. cGy

Mean PTV-100 for PHOTONS was 84.4%, and ELECTRONS was 76.5%. The association of PTV-100 between PHOTONS and ELECTRONS was statistically significant as the p-value is 0.04, which means that PTV coverage is better with photon boost rather than electrons. Mean PTV –95 in PHOTONS was 93.8% and in ELECTRONSwas 91.2%. PTV –90in PHOTONS was 96.2% and in ELECTRONS was 88.5%. PTV 90 is significantly more with photons when compared to electrons.

In the study by Rajanss et al.,3 V100 in Electron was 69.46% and with 3DCRT was 67.69 %.V95 in Electron was 94.85%, and with 3DCRT was 97.63%.

HEART–MEAN of PHOTONS was428.3 cGy, and for ELECTRONS, it was 523.8 cGy, which summarizes that Volume of the Heart receiving mean dose is less with photons than electrons.

Heart mean V10 for PHOTONSwas 7.3% and for ELECTRONS was 16.4%. This difference was statistically significant, as p is less than 0.05 (0.001). This explains that the Volume of the Heart receiving (10 Gy) is significantly less with photons than electrons. Heart means – V5 for PHOTONS was 10.1% and for ELECTRONS was 19.1%. This difference was statistically significant as p is less than 0.05 and Heart – V2 for PHOTONS was20.3% and for ELECTRONSwas50.6%. This difference was statistically significant as p is less than 0.05.

In a study by Rajan et al,[3] Heart Mean dose in Electron was 0.24Gy and with 3DCRT was 0.47Gy.V10 Gy in Electron was 0.09% and with 3DCRT was 0.07%.V5 Gy in Electron was 0.66%

and with 3DCRT was 0.26%.V2 Gy in Electron was 3.39% and with 3DCRT was 6.90% for left-sided lesions and V2 Gy in electros was 3.39% and with 3DCRT was 1.42%

IPSILATERAL LUNG MEAN for PHOTONS was 468.4cgy, and for ELECTRONS, it was 580.3cgy. IPSILATERAL LUNG MEAN- V10 for PHOTONS was 17.8% and for ELECTRONS was 21.35%.

IPSILATERAL LUNG MEAN- V5 for PHOTONS was 23.81% and for ELECTRONS was 22.95%. IPSILATERAL LUNG MEAN- V2 for PHOTONS was 36.98% and for ELECTRONS was 59.39%. This difference was statistically significant as p is less than 0.05, depicts that the Volume of the right lung receiving doses 10,5 and 2Gy is significantly less with photons compared to electrons.

According to Rajanss et al,[3] the Mean dose (Gy) in Electron was 2.20GY and with 3DCRT was 0.83gy.V10 Gy in Electron was 6.31% and with 3DCRT was 1.48%.V5 Gy in Electron was 14.83% and with 3DCRT was 7.12%.V2 Gy in Electron was 26.80% and with 3DCRT was 13.21%

CONTRALATERAL LUNG-mean for PHOTONS was 145.6cgy and for ELECTRONS was 167.8±94.5. CONTRALATERAL LUNG MEAN-V10 for PHOTONS was 9,7% and for ELECTRONS was19.7%. This difference was statistically significant as p is less than 0.05.CONTRALATERAL LUNG MEAN- V5 for PHOTONS was 6.5%and for ELECTRONS was 14.8%. CONTRALATERAL LUNG MEAN- V2 for PHOTONS was 14.5% and for ELECTRONS was 23.2%. This difference was statistically significant.

Contralateral lung dose according to Rajan S S et al.,3 Mean dose (Gy) in Electron was 0.03 and with 3DCRT was 0.40.V10 Gy in Electron was 0.00% and with 3DCRT was 0.00%.V5 Gy in Electron was 0.00 %and with 3DCRT was 0.00%.V2 Gy in Electron was 0.01% and with 3DCRT was 0.27%.

Van et al. (2014),[12] conducted a dosimetric assessment of various non invasive approaches for providing an extra boost following whole breast irradiation as part of breast-conserving therapy. Guidelines were presented. Individualized treatment should replace standard approaches. The guidelines offered here can assist in determining the appropriate treatment method for each particular patient.

De Santis et al. (2016),[13] indicated that the results demonstrate the feasibility and accuracy of a neoadjuvant concurrent radio chemotherapy treatment with LD-FRT for Stage IIA-B/IIIA breast cancer. However, the efficacy of LDFRT as an expected boost and concurrent primary systemic treatment with liposomal anthracycline and docetaxel in terms of pathological response rate need additional investigation. More research is needed in terms of evidence-based medicine. An anticipated pre-operative photon boost provides higher coverage than a typical sequential boost while also preserving the OAR and resulting in fewer side effects, albeit the sample size does not allow for clear conclusions.

Kovacs A, et al. (2008), [14] designed this study to compare photon boost to electron boost using objective indicators. Our patients' clinical follow-up is ongoing, and there have been no local recurrences as of January 1, 2006. Further follow-up is planned to assess local control, pulmonary toxicity, and cosmetic effects.

Park SH et al. (2013),[15] conducted this study to compare the dosimetric properties of EB and XB plans for tumor bed boosting. Furthermore, the risk of radiation pneumonitis was assessed across the various boost strategies.

Heart volume sparing is increasingly important in R.T. for breast cancer patients. With therapeutic strategy improvements, cancer patients often survive long enough for long-term cardiac effects to occur. Radiation-associated cardiac diseases in breast cancer survivors include a wide spectrum of cardiac diseases such as coronary artery disease, myocardial dysfunction, valvular heart disease and electrical conduction abnormalities.

CONCLUSION

The present study concluded that Whole breast irradiation followed by tumor bed boost after BCS is the standard treatment in the early stages of breast cancer.The photons group showed better coverage than electrons dosimetrically in terms of PTV, but the coverage of electrons is also within the tolerance limits.Ipsilateral Heart and lung doses were significantly reduced with photons when compared to electrons.

There is slight increased acute skin toxicity with electrons, but overall skin, subcutaneous toxicities are similar in both groups. Since the study had a small sample size in both arms, regarding the pattern of failure, further long-term follow up is necessary for better appreciation of results.

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