ORIGINAL RESEARCH PAPER

Volume-7 | Issue-4 | April-2018 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

DOSIMETRIC COMPARISON OF DEEP INSPIRATION BREATH HOLD WITH ACTIVE BREATHING COORDINATOR VERSUS FREE BREATHING IN CARCINOMA LEFT BREAST PATIENTS RECEIVING ADJUVANT RADIOTHERAPY

Oncology

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ABSTRACT

Total of 31 carcinoma left breast patients were included in the study. All underwent CT simulation in both Deep inspiration breath hold (DIBH) with Active Breathing Coordinator (ABC) and Free breathing (FB) technique. Contouring and 3D-CRT planning was done on both the scans. Dose to PTV was 50Gy in 25 fractions @ 2Gy per fraction, 5 fractions per week. Dosimetric parameters of organs at risk and PTV coverages were compared. Volume of heart receiving 30Gy (V30) and Dmean , volume of lt lung receiving 20Gy, 10Gy (V20, V10) and Dmean , combined lung volume receiving 20Gy, 10Gy, 5Gy (V20, V10, V5) has shown statistically significant dose reduction in DIBH with ABC technique compared to FB technique without compromising PTV coverage.This study concluded that heart and lung doses can significantly be reduced without compromising PTV coverage in left-sided breast cancer patients using DIBH with ABC technique.

KEYWORDS

Lt Breast, DIBH, ABC, FB

INTRODUCTION:

Worldwide among females breast cancer is the most common. During the year 2011- 2012, around 1.7 million women were diagnosed with breast cancer and the prevalence of breast cancer in last five years was 6.3 millions.[1] In India according to urban population based cancer registry, 2009-2011 breast cancer is the first most common cancer among woman.[2]According to hospital based cancer registry, cervical and breast cancers are leading sites of cancers in women .[3]

Multimodality approach that is surgery, chemotherapy and radiation therapy remains the primary therapeutic modalities in the management of breast cancer.[4] Postoperative radiotherapy (RT) after the breast conservative surgery (BCS) or mastectomy have been shown to reduce the rates of local recurrence and death in breast cancer patients.[5] With conventional techniques chest wall irradiation may deliver high doses to underlying organs such as heart and ipsilateral lung which may lead to radiation-related toxicity such as pneumonitis, lung fibrosis, coronary heart disease and secondary malignancies. Higher the doses received by underlying lung and heart there will be higher mortality and morbidity risk has already been described in the literature.[6-13] A recent population-based study noted that the excess risk of ischemic heart disease is proportional to mean heart dose (MHD), is apparent within 4 years of RT, and persists for decades .[14,15]

In the recent years, there is a tremendous development in the radiation treatment techniques of breast or chest wall irradiation aimed at minimizing radiation exposure to organs at risk (OAR). Such as prone positioning, intensity modulated radiation therapy (IMRT) and proton therapy. Another promising technique is deep inspiration breath hold (DIBH) with the Active Breathing Coordinator (ABC) device. ABC device allows for reproducible immobilization of the chest wall by monitoring the patient's breathing cycle and implementing a breath hold at a predefined lung volume. By optimizing the distance between the heart and chest wall, this manoeuvre can shift OAR mainly ipsilateral lung and heart volume out of the RT field while still allowing for therapeutic irradiation of breast tissue or chestwall. With this background we have conducted a study of "Dosimetric comparison of deep inspiration breath hold with active breathing coordinator verses free breathing (FB) in carcinoma left breast patients receiving adjuvant radiotherapy.

MATERIAL AND METHODS:

Type of study: Prospective observational study.

Study design: Study was conducted in department of radiation oncology SVIMS tirupati from March 2016 to July 2017 in carcinoma left breast patients post breast conserving surgery or mastectomy that are going to receive adjuvant radiotherapy after taking informed consent. The study was conducted after obtaining approval from Institutional Protocol Approval Committee and Institutional Ethical Committee

CT SIMULATION AND PLANNING:

Patient was positioned on a breast board in supine position with both arms abducted and raised above the head and face turned to contra lateral side. Slice thickness of 3mm taken both in FB and DIBH with ABC. Adequate training was given to the patient before DIBH with ABC ct simulation. After obtaining both DIBH and FB scans for the same patient images were acquired to eclipse treatment planning system. Clinical target volume (CTV) and organ at risk (OAR) were contoured as per RTOG atlas [16]

The 3D-CRT plan was generated for both DIBH (deep inspiration breath hold) and free breathing technique for each patient. The prescribed total dose is 50 Gy in 25 fractions @ 2Gy/#, 5 fractions per week over 5 weeks

STUDY PARAMETERS:

Dose volume histograms of the organs at risk of the DIBH with ABC and FB plans was generated and compared interms of

- V30Gy, and mean dose to the heart (Dmean)
- V20Gy, V10Gy, V5Gy, and mean dose to the left lung (Dmean).
- V20Gy, V10Gy, V5Gy of combined lung.
- V95% of PTV.

(Here V30Gy V20Gy, V10Gy, and V5Gy represent the percentages of volumes of the normal organs receiving 30, 20, 10 and 5Gy dose or more respectively. V95% represents the planning target volume receiving 95% of prescribed dose.) Combined lung is defined as [volume of (right lung +left lung) – PTV (planning target volume)].

STATISTICALANALYSIS:

Comparison of dosimetric parameters were done by paired T test with significance level $\alpha = 0.05$. The difference between the averages is considered as significant if $p < 0.05$. All calculations are performed using SPSS Ver 20.0 after entering the data in Microsoft office excel format 2007.

RESULTS:

Patient Characteristics:

Mean age of the patients was 45 years (range 27-60 years).

OAR parameters

Heart: Dmean and V30Gy to the heart were decreased in DIBH plan compared to FB plan which was statistically significant.

Table 1: Dose distribution of heart in DIBH and FB technique

Heart	DIBH with ABC	FB	- value
D_{mean}(Gy)	15.27	19.4	<.001
V_{30} (%)	25.7	33.7	<.001

Left Lung and combined Lung: Dmean, V20, V10, V5Gy of the left lung and V20, V10, V5Gy of the combined lung have shown statistically significant reduction in DIBH with ABC plan compared to FB plan.

Table 2: Dose distribution of left lung and combined lung in DIBH with ABC and FB technique of left breast adjuvant radiotherapy

Organ Parameter	DIBH Mean	SD	FB Mean	SD	Difference	- value	remarks
LEFT LUNG D_{mean}(Gy)	19.99	3.394	22.47	4.164	2.48	< 0.001	significant
LEFT LUNG $V_{20(\%)}$	40.46	7.310	45.51	8.670	5.05	< 0.001	significant
LEFT LUNG $V_{10(\%)}$	45.44	7.423	50.20	8.479	4.76	<0.001	significant
LEFT LUNG $V_{5(\%)}$	50.12	11.236	54.49	11.754	4.37	< 0.001	significant
Combined LUNG $V_{20(\%)}$	18.83	3.392	21.15	4.401	2.32	< 0.001	significant
Combined LUNG $V_{10(\%)}$	21.38	3.546	23.42	4.342	2.04	< 0.001	significant
Combined LUNG $V_{5(\%)}$	24.67	3.985	26.70	4.801	2.03	= 0.001	significant

Target coverage (DIBH versus FB): The coverage's of PTV were comparable in both DIBH with ABC and FB plans (Fig 1)

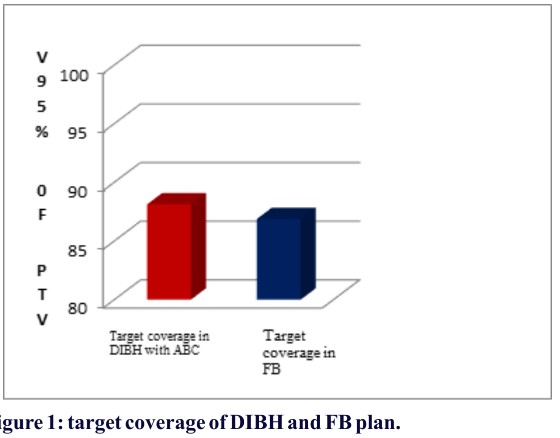

Figure 1: target coverage of DIBH and FB plan.

Discussion:

In our study, with DIBH V30 and Dmean of heart showed statistically significant reduction ($p<0.001$) compared to FB plan. Similar to our results, study conducted by Wang et al[17] showed mean heart dose was decreased from 3.17Gy to 1.32Gy. Swanson et al[18] showed that DIBH plans significantly reduced cardiac mean dose (4.23Gy vs. 2.54Gy; $p<0.001$, V30Gy (3.2% vs 0.39%) in DIBH compared to FB plan.

Similarly prospective trail conducted by Harriet Eldredge-Hindy MD et al [19] showed that DIBH with ABC significantly reduced dose to the heart. Dmean was reduced by 20% or greater with use of ABC ($P < .0001$), the median value for FB was 2.7 Gy compared with 0.9 Gy for ABC.

In our study left lung Dmean (22.47Gy by FB , 19.99Gy by DIBH, $p<0.001$) and V20Gy(45.51% by FB , 40.46% by DIBH, $p<0.001$) , V10Gy(50.2% by FB , 45.44% by DIBH, $p<0.001$),V5Gy(54.49% by FB , 50.12% by DIBH, $p<0.001$) were decreased with DIBH plan when compared with FB plan which was statistically significant .

Study conducted by Wang et al showed that with DIBH the dose to the left lung was reduced from a mean of 520.9cGy to 503.6cGy ($p = .056$). V20Gy of left lung decreased from a mean of 10.4% on the FB plans to 9.6% on the DIBH plans ($p = .002$).

Another study by Swanson et al[18] reported that DIBH showed significant reduction in left lung mean dose (9.08Gy vs.7.86Gy; $p<0.001$), a relative reduction of 13%, as well as significant reduction of other lung DVH parameters evaluated such as V20Gy(17% vs14%.; $p<0.0001$),V10Gy(22% vs20%.; $p<0.0001$),V5Gy(32% vs30%.; $p<0.0001$)

Similarly prospective trail conducted by Harriet Eldredge-Hindy MD et al[19] observed statistically significant reductions in left lung Dmean, V20Gy, V10Gy, and V5Gy in DIBH plan compared to FB plan.

In our study V20Gy, V10Gy, V5Gy of combined lung showed significant dose reduction in DIBH compared to FB plan. Similarly study by Harriet Eldredge-Hindy MD et al[19] observed statistically significant reductions in the V20Gy (median 5.7% by FB to 4.9% by DIBH) and V10Gy (median 7.3% by FB to 6.4% by DIBH) with DIBH compared to FB plan.

LIMITATIONS:

- This is a pure dosimetric study, further more studies have to be done to evaluate clinical outcomes of DIBH with ABC technique
- Small sample size.

CONCLUSION

In treatment planning it is important to spare organs at risk without compromising PTV coverage. This study demonstrates that heart and lung doses can significantly be reduced without compromising PTV coverage in left-sided breast cancer patients using DIBH with ABC technique .

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