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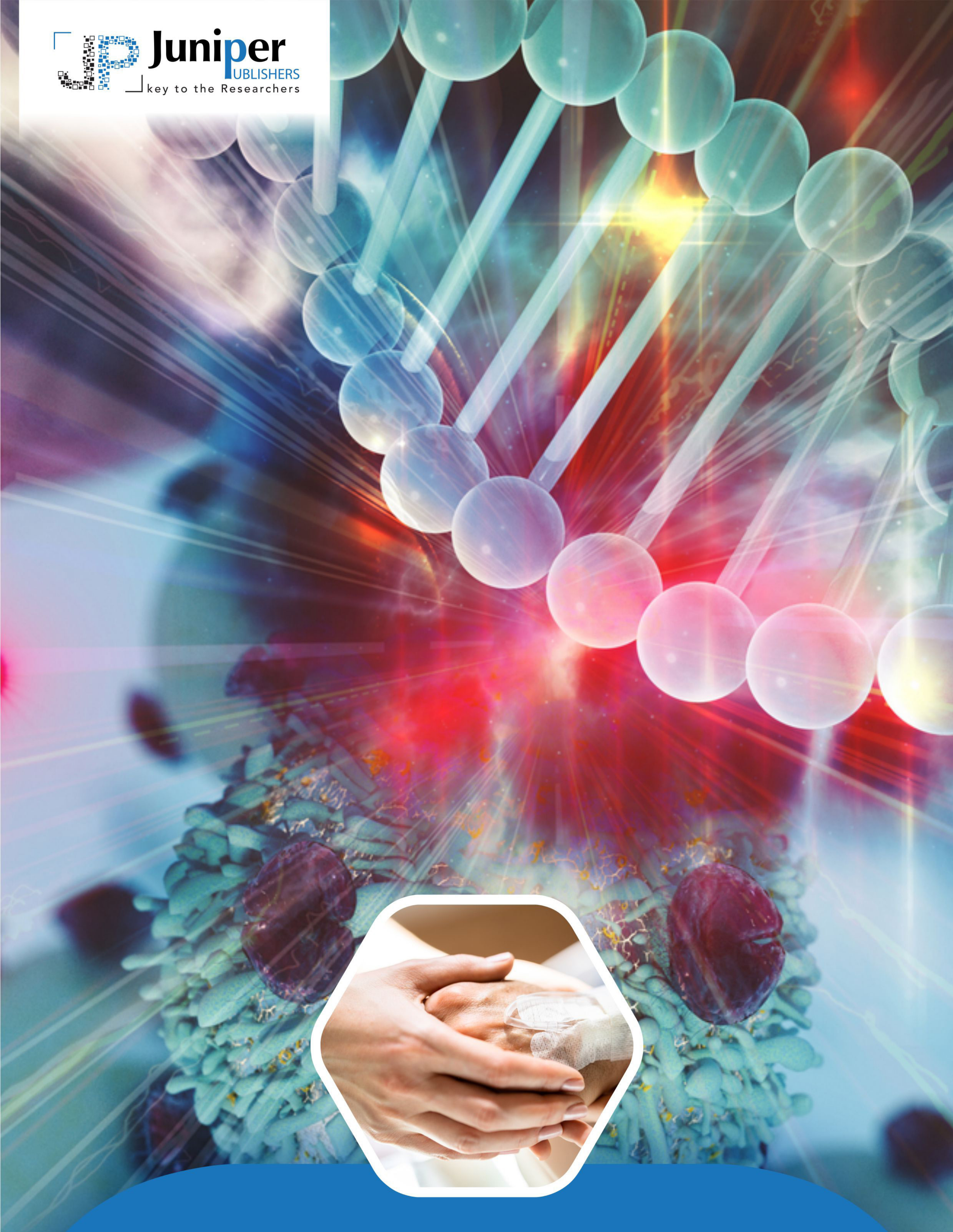

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Comparing Breast Radiation Therapy: Prone Vs. Supine Positions with Pivotal™ Prone Breast Board Couch - A Single-Institution Study

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Abstract

Introduction: Breast radiation therapy in prone position has shown a superior alternative to supine Deep Inspiration Breath Hold (DIBH) technique. Dosimetric parameters, setup error and total treatment time were compared in two approaches.

Methods: In this retrospective study, supine DIBH and free-breathing prone position CT simulation was done for 12 patients. Radiation plans were created for both positions to compare dosimetric parameters, namely mean doses of heart and lung, alongside percentage volume of ipsilateral lung receiving 20Gy (V20). Positional errors and differences in total treatment time were also assessed.

Results: In this study, 12 patients treated with prone breast radiotherapy were included. In left sided breast cancer (Supine versus prone position): average mean lung dose: 9.38 Gy versus 1.83Gy; Mean lung V20: 16.36% versus 1.34%. In right sided breast cancer (Supine versus prone position): average mean lung dose: 9.76 Gy versus 3.44 Gy; Mean lung V20: 17.57% versus 5.10%. Systematic and random errors were comparable between the prone and supine positions. However, there was no significant differences in heart dose between both positions. The total treatment time was prolonged in prone position as compared to supine DIBH treatment.

Conclusion: In our study, there was a reduction in lung doses with prone breast radiation therapy whereas there were no significant differences in heart dose between prone and supine positions. Mean lung dose and lung V20 were lower in prone position whereas overall treatment time was longer. Systematic and random positional setup errors were comparable between the two positions.

Keywords: Radiation therapy; Prone Breast; Deep inspiration breath hold; Toxicity; Set-up error; Comfort

Introduction

Breast cancer is the most common cancer diagnosed in women, accounting for more than 1 in 10 new cancer cases each year [1]. From the past decade, nearly all patients undergoing breast conservation surgery is followed with radiation therapy delivered either in supine or prone position [2,3]. Patient's comfort, daily position reproducibility, easier visualisation of skin markings, and better immobilisation are the main advantages of supine position over the prone technique [4]. External beam radiation therapy (EBRT) with patients in supine position is usually planned with tangential field arrangement along with dose homogenization using wedges and/or additional fields. Commonly applied radiation beam plan is three-dimensional conformal radiation therapy(3DCRT) and intensity modulated radiation therapy (IMRT) with or without deep inspiration breath holding technique (DIBH). In large volume pendulous flacid breast tangential fields frequently cannot include complete breast volume without including a significant amount of lung tissue because they fall too far laterally on the chest [5]. Alternative patient position and techniques for repositioning the patient have been described to address some of these issues [5,6]. In 1994 Merchant and McCormic proposed prone position for large intact breast volume patients for radiation therapy (RT) delivery [7]. The breast and a portion of the chest wall protrude through an aperture in the platform as the patient is positioned prone on the treatment couch [8]. The contralateral breast is moved slightly away from the radiation beam by rolling the torso slightly on the couch. Placing the patient in the prone position helps increase separation of the breast from critical organs at risk. This means that exposure to the lung, heart and surrounding healthy tissue may be minimized, while providing the potential for more uniform dose delivery, less skin toxicity, and reduced respiratory motion due to patient position. The primary objective of this study was to compare the setup error, dosimetric parameters, and average treatment time for daily radiation therapy between the prone position and supine position in breast EBRT.

Methods

In this retrospective study, supine DIBH and free-breathing prone position CT simulation was done for 12 patients. These patients had undergone training for breath holding. For free breathing prone CT simulation, patients were positioned on pivotal prone breast couch from Varian medical systems™ CT data (GE medical systems, USA) was acquired without contrast for both the scans. The range of scanning covered the from mastoid to L2 spine level with 2.5 mm of slice thickness. Both supine and prone CT simulation scans were performed in one planning session, with the patient dismounting the couch between the scans.

Supine position, free breathing / DIBH, CT simulation

The GE medical system, USA Big Bore 16-slice CT simulation was utilized in our department. The all-in-one (AIO) breast board was used for immobilization. At the time of simulation, patient was made to lie down in supine position on the AIO breast board with, hands above the head holding two hand poles according to patient's comfort. The Varian real-time position management (RPM, Varian Medical System, Palo Alto, CA, USA) was used for DIBH CT simulation. Prior to CT scan, radiation oncologists applied a radio-opaque wire-marker to clinically delineate palpable breast tissue circumferentially. After free breathing and DIBH CT simulation, radiation therapist would mark the reference tattoos for daily position reproduction over the sternum in superior, mid, and inferior levels. The tattoos position and AIO scale value in the patient setup note were recorded. The image data set was acquired for all cases.

Prone position breast CT- simulation

The Pivotal™ Prone Breast board is utilized for simulating the prone position during treatment. To ensure both comfort and reproducibility, the patient lies on their stomach with their back as flat as possible, while the head turned to the opposite side and relaxed shoulders. The contralateral breast is gently pulled "Down and Out" and placed on the sternal sponge. The breast designated for EBRT is positioned at the center of the Pivotal™ Prone Breast board aperture, with the inframammary fold positioned just above the lower opening of the insert. The patient's alignment in the medio-lateral and craniocaudal directions is achieved by palpating the spine. Once the position is confirmed, the radiation oncologist places a wire around the circumference of the breast and scar. For daily patient setup, reference points are established using the room laser passing through the nipple as a reference plane tattoo. Additionally, three posterior back tattoos are defined for spine alignment, along with two lateral tattoos at the midpoint of the torso in the anterior-posterior dimension, ensuring avoidance of any tilt or rotation of the patient. An additional tattoo is placed on the treated breast. indicating the superior-inferior and anterior-posterior levels of the isocentre. The ipsilateral scale provides an extra point of reference for laser alignment. This way, the isocentre is simply defined by moving along a horizontal line that intersects the breast tattoo. Within one week after the simulation visit, patients commence radiation therapy for a duration of 15-20 consecutive days, either in the supine position with DIBH or in the prone position, as prescribed by the radiation oncologist (Figure 1).

Figure 1: Prone breast simulation and tattoos marking.

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Radiation therapy treatment Plan

Radiation beam plan for supine free breathing followed by DIBH and free breathing prone were created for comparison of dosimetric parameters. On each CT slice, the target, and organs at risk (OAR) namely bilateral lungs and heart were contoured in both position scan data sets. The entire ipsilateral palpable breast tissue was designated as the clinical target volume (CTV), and the wires were used to help identify the CTV's boundary. Planning target volume (PTV) was derived by uniform expansion of CTV by 5mm.The dose prescription for 11 patients ranged from 40-42.7Gy for the whole breast and 10-12.5Gy for the tumour bed and one patient a dose of 50Gy in 25 fractions at the International Commission on Radiation Units and Measurements (ICRU) prescription point. The prescription point was centrally located in the PTV at the intersection of beam axes. Dose-volume histograms were used to quantify differences in doses for the OARs, namely mean heart dose, mean lung dose, and the percentage volume of ipsilateral lung receiving 20Gy (V20). All 12 study patients were treated in the prone position.

To compare the treatment time required for prone and supine positions, the average treatment time for these 12 patients was compared with that of a separate set of 12 patients who were treated with supine DIBH during the same period. Systematic and random errors were measured for both treatment positions (supine and prone). The total time needed for patient setup, acquisition of imaging, beam time, and overall length treatment duration were also recorded. Patient confidentiality and privacy were maintained. Consent was also obtained for photographing the treatment procedure for educational purposes.

Results

The demographic details of the included patients are presented in. For all 12 patients undergoing prone radiation therapy RT. 95% of the prescribed dose covered at least 90% of the PTV-Eval (Radiation Therapy Oncology Group-RTOG 1005 protocol) [9]. For patients with left sided breast cancer, the average mean heart dose was 3.63Gy in the supine position and 3.27Gy in the prone position. The average mean lung dose was 9.38Gy in the supine position and 1.83Gy in the prone position. The mean lung V20, which indicates the percentage of lung volume receiving 20Gy, was 16.36% in the supine position and 1.34% in the prone position. For patients with right sided breast cancer, the average mean heart dose was 0.79Gy in the supine position and 1.14Gy in the prone position. The average mean lung dose was 9.76Gy in the supine position and 3.44Gy in the prone position. The mean lung V20 was 17.57% in the supine position and 5.10% in the prone position. In supine position, the systematic errors measured were 0.21 cm, 0.38 cm, and 0.22 cm in the medio-lateral (ML), cranio-caudal (CC), and antero-posterior (AP) directions, respectively. The random errors were found to be 0.38 cm, 0.42 cm, and 0.38 cm for the ML, CC, and AP directions, respectively. In the prone position, the systematic errors were determined to be 0.12 cm, 0.22 cm, and 0.26 cm for the ML, CC, and A-P directions, respectively. The random errors were measured as 0.10 cm, 0.30 cm, and 0.32 cm for the ML, CC, and AP directions, respectively. It is noteworthy that the random and systematic errors were comparable in both positions for each of the axes, as observed in individual patients. The total maximum treatment time, starting from the patient's entry into the linear accelerator room until their exit, was significantly longer in the prone position (25.28 ± 7.19 min) compared to the supine treatment with DIBH (13.15 ± 2.10 min) ($p < 0.001$). The p-values were reported for all comparison purposes using a two-sample independent t-test. This study is as per the ethical guidelines of the hospital (Figure 2 & Table 1).

Table 1: Breast cancer radiation therapy patient and tumour characteristics.

Variables	Values
Number of patients	12
Age, mean (range)	(36.58 + 8.87) (26(25, 51))
Married status	
Married	5 (41.7%)
Unmarried	7 (58.3%)
cT stage	
T1	6 (50.0%)
T2	5 (41.7%)
T3	1 (8.3%)
pT stage	
T0	1 (8.3%)
T1	4 (33.3%)
T2	6 (50.0%)
T3	1 (8.3%)
Breast side	
Right	4 (33.3%)
Left	8 (66.7%)
Localisation of tumour bed	
Upper-Outer (UOQ)	1 (8.3%)
Upper-Inner (UIQ)	2 (16.7%)
Lower-Outer (LOQ)	7 (58.3%)
Lower-Inner (LIQ)	2 (16.7%)
RT Dose	
52.5Gy/ 20 fraction	1 (8.3%)
52.7Gy/ 21 fraction	9 (75.0%)
50Gy/ 25 fraction	2 (16.7%)

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Figure 2: Prone treatment setup in linear accelerator.

Discussion

Following breast conserving surgery, RT to breast is commonly practiced with patients in supine position. Radiation oncologists face technical challenges when treating women with large, pendulous breasts due to increased acute and late toxicity of skin and soft tissue. Because of the large separation between the two tangent fields, there is increased inhomogeneity. Excess skin folds have a bolus effect, particularly in the inframammary skin fold and axillary regions leading to skin pigmentation, dry desquamation, and possible ulceration [10]. Various techniques have been explored to overcome technical limitations and ensure optimal cosmetic results for women with large breasts undergoing radiation therapy. These techniques include altering beam energies, using immobilization devices to displace the breast from the chest wall, and modifying patient positioning, such as treating in the lateral decubitus position. Some approaches involve constructing a thermoplastic mould or using a reinforced PVC ring and Styrofoam to pull the lateral breast tissue anteriorly and upright when supine, which can reduce tangent separation and minimize contact between the breast tissue and chest wall at the infra-mammary fold. However, these devices have not been widely adopted due to inferior reproducibility and patient discomfort [6,5,11-18].

Merchant and McCormick from MSKCC, New York published the first report of prone breast RT in women with large breast separation [8]. They showed that prone breast RT takes advantage of the reproducible characters of supine position combined with homogeneity in dose distribution. Irradiation of the heart, lungs and contralateral breast were also minimized. In a calculation accounting for dosimetric parameter, pros, and cons of prone vs supine DIBH, Wang X et al, concluded that prone positioning resulted in a dosimetric advantage of 62% in patients with left sided breast cancer. High pendulousness and moderately large breast predicted for the gain [12].

In the Michigan statewide registry study of 16 centers, Pierce LJ et al, in 4688 breast cancer patients treated with RT, observed that both supine DIBH RT and prone position RT significantly reduced mean heart dose. It was an 18% reduction in supine DIBH position and a much higher 32% reduction in prone position whole breast RT [13]. In 2014 Osa Eoo et al, published the 5-year outcome of 404 breast cancer patients in which 92%were treated prone. The dose was 40.5Gy/15fractions with concurrent boost to tumour bed boost [14]. At 5 years the cumulative breast recurrence was 0.82%. For left breast tumour the in-field lung volume varied from a mean of 2.27 to 16.6 cc whereas for supine it was much higher at 27 to 90cc. There was no significant variation in heart dose. Formenti S et al, in his institutional study evaluated RT planning in 200 patients of left sided breast cancer and 200 of right sided breast cancer. In all the 400 patients the prone position was associated with significantly reduced in-field lung volume. Also, in 85% of patients, the irradiated heart volume was reduced in left sided breast cancer [15].

The dosimetric advantages in prone breast RT was found to be clinically beneficial as shown in the randomized study of supine vs prone position, from Canada [16]. In 378 patients the prone position RT had significantly lower rate of skin moist desquamation. In our small group of 12 patients, a reduction in lung doses were seen with prone breast RT. However, the heart dose was not different in prone compared to supine. Kirby AM et al, found errors were greater using prone technique compared to supine technique, resulting in the need for larger CTV-PTV margins in the prone position [17]. Systematic errors were 1.3-1.9 mm in supine and 3.1-4.3 mm in prone ($p = 0.02$). The random errors were 2.6-3.2 mm in supine and 3.8-5.4 mm in prone ($p = 0.02$). This was not observed in our study, and it shows that both systematic and random errors were similar in prone and supine positions. With the immobilization devices, AIO and prone breast boards, patients experienced more comfort during their treatments. Additionally, the multiple scaling and daily setup

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reproducibility were possible factors in minimizing the set-up variation.

The set-up accuracy studied by Mulliez T et al, for prone as compared to supine, identified that it was significantly worse in the lateral and longitudinal directions, showing 10.4/9.4/9.4 mm margins for supine and 10.5/22.4/13.7 mm for prone position in the vertical direction, lateral direction, and longitudinal directions, reaching statistical significance ($p<0.01$) difference in the lateral and longitudinal directions. Patients with a higher BMI required larger margins [18]. Veldeman L et al, study showed the potential of prone-lateral positioning for more accurate and effective treatments. However, further clinical research is necessary to reduce the duration of prone-lateral setup and to improve the accuracy of the technique [19].

In this learning curve of prone breast RT in our first 12 patients we found that daily treatment with prone breast positioning took longer time to complete than supine breast RT. This was due to the additional time needed for special breast couch placement, alignment in the linear accelerator, and increased time taken for repositioning when the portal images were verified, and couch corrections were applied.

Conclusion

The setup precision position between prone position and supine DIBH had nearly similar random and systematic errors. Mean lung dose and lung V20 were reduced when patients were treated in prone position. The treatment time was longer in prone position and can probably be attributed to more repositioning needs. Prone breast treatment is becoming an important option in the fight against breast cancer due to its ability to significantly reduce dose to the lung and reduce skin toxicities. Growing evidence suggests that it may provide significant advantages over the supine position for many women.

Ethical statement

As per Ethical standard of the hospital the approval was not necessary for this study due to retrospective study analyses. None of these findings affected patient treatment or follow-up care. We prioritized ethical standards, protecting privacy, confidentiality, and data storage through effective anonymization.

Acknowledgement

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References

1. Alkabban FM, Ferguson T (2023) Breast Cancer In- StatPearls. Treasure Island, StatPearls Publishing, FL, USA.
2. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M, et al. (2002) Twenty-Year Follow-up of a Randomized Trial Comparing Total Mastectomy, Lumpectomy, and Lumpectomy plus Irradiation for the Treatment of Invasive Breast Cancer. N Engl J Med 347(16): 1233-1241.
3. De la Rochefordière A, Abner AL, Silver B, Vicini F, Recht A, et al. (1992) Are cosmetic results following conservative surgery and radiation therapy for early breast cancer dependent on technique. Int J Radiat Oncol Biol Phys 23(5): 925-931.
4. Griem KL, Fetherston P, Kuznetsova M, Foster GS, Shott S, et al. (2003) Three-dimensional photon dosimetry: a comparison of treatment of the intact breast in the supine and prone position. Int J Radiat Oncol Biol Phys 57(3): 891-899.
5. Bentel GC, Marks LB (1994) A simple device to position large/flaccid breasts during tangential breast irradiation. Int J Radiat Oncol Biol Phys 29(4): 879-882.
6. Cross MA, Elson HR, Aron BS (1989) Breast conservation radiation therapy technique for women with large breasts. Int J Radiat Oncol Biol Phys 17(1): 199-203.
7. Merchant TE, McCormick B (1994) Prone position breast irradiation. Int J Radiat Oncol Biol Phys 30(1): 197-203.
8. Zierhut D, Flentje M, Frank C, Oetzel D, Wannenmacher M (1994) Conservative treatment of breast cancer: modified irradiation technique for women with large breasts. Radiother Oncol 31(3): 256-261.
9. Chen GP, Liu F, White J, Vicini FA, Freedman GM, et al. (2015) A planning comparison of 7 irradiation options allowed in RTOG 1005 for early-stage breast cancer. Med Dosim 40(1): 21-25.
10. Grann A, McCormick B, Chabner ES, Gollamudi SV, Schupak KD, et al. (2000) Prone breast radiotherapy in early-stage breast cancer: A preliminary analysis. Int J Radiat Oncol Biol Phys 47(2): 319-325.
11. Monson JM, Chin L, Nixon A, Gage I, Silver B, et al. (1997) Is machine energy (4-8 MV) associated with outcome for stage I–II breast cancer patients. Int J Radiat Oncol Biol Phys 37(5): 1095-1100.
12. Wang X, Fargier-Bochaton O, Dipasquale G, Laouiti M, Kountouri M, et al. (2021) Is prone free breathing better than supine deep inspiration breath-hold for left whole-breast radiotherapy? A dosimetric analysis. Strahlenther Onkol 197(4): 317-331.
13. Pierce LJ, Feng M, Griffith KA, Jagsi R, Boike T, et al. (2017) Recent Time Trends and Predictors of Heart Dose from Breast Radiation Therapy in a Large Quality Consortium of Radiation Oncology Practices. Int J Radiat Oncol Biol Phys 99(5): 1154-1161.
14. Osa EO, DeWyngaert K, Roses D, Speyer J, Guth A, et al. (2014) Prone breast intensity modulated radiation therapy: 5-year results. Int J Radiat Oncol Biol Phys 89(4): 899-906.
15. Formenti SC, DeWyngaert JK, Jozsef G, Goldberg JD (2012) Prone vs Supine Positioning for Breast Cancer Radiotherapy. JAMA 308(9): 861-863.
16. Vesprini D, Davidson M, Bosnic S, Truong P, Vallieres I, et al. (2022) Effect of Supine vs Prone Breast Radiotherapy on Acute Toxic Effects of the Skin Among Women with Large Breast Size: A Randomized Clinical Trial. JAMA Oncol 8(7): 994-1000.
17. Kirby AM, Evans PM, Helyer SJ, Donovan EM, Convery HM, et al. (2011) A randomised trial of Supine versus Prone breast radiotherapy (SuPr study): Comparing set-up errors and respiratory motion. Radiother Oncol 100(2): 221-226.
18. Mulliez T, Gulyban A, Vercauteren T, van Greveling A, Speleers B, et al. (2016) Setup accuracy for prone and supine whole breast irradiation. Strahlenther Onkol 192(4): 254-259.
19. Veldeman L, Speleers B, Bakker M, Jacobs F, Coghe M, et al. (2010) Preliminary results on setup precision of prone-lateral patient positioning for whole breast irradiation. Int J Radiat Oncol Biol Phys78(1): 111-118.

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