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Original Research

Effects of regular bra-wearing on acute skin toxicity in breast-conserving radiotherapy women

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Purpose: To evaluate the effects of regular bra-wearing during radiotherapy on acute skin toxicity (AST) and the Quality of Life (QOL) in women with breast conserving therapy (BCT). **Methods:** A prospective study of 99 patients with any stage of breast cancer who underwent BCT. Patients were instructed to wear an appropriate bra then they were classified by total hours of wearing bra during the radiotherapy treatment course into Non-Bra-Wearing (NBW) (0 hr.) and Bra-Wearing (BW) groups (>0 hr.). The AST was assessed weekly and one week after treatment end by CTCAE v 4.03. The QOL was assessed before and one week after treatment end by The Functional Assessment of Cancer Therapy-Breast Cancer (FACT-B) Thai version 4. **Results:** 66 patients were in the BW group and 33 patients were in the NBW group. The rate of ≥ G2 AST was lower in the BW group compared to the NBW group (16.7% vs. 54.5%, p<0.001, respectively). In the multivariate analysis, the statistically significant factors that were associated with increased the risk of ≥ G2 AST were NBW (0 hr.) (p<0.001), high body mass index (p=0.001), and high percentage of maximum dose (p=0.043). There was no differences in all parts of after treatment FACT-B between the two groups (118.4 vs. 114.7, p=0.256, respectively). **Conclusions:** Regular BW during radiotherapy is not associated with increased risk of ≥ G2 acute skin toxicity and does not affect the QOL compared to NBW.

Introduction

Breast cancer is the most common cancer in Thai women with the annual Age-Standardized Rate (ASR) per 100,000 being 31.4 in 2015 [1]. According to breast cancer treatments, breast conserving therapy is one of the loco-regional treatment options. Radiotherapy after wide local excision reduces the locoregional recurrence rate as well as the risk of breast cancer death [2][3][4]. Conventional radiotherapy regimens, after breast conservation surgery, deliver a total dose of 46-50 Gy in 23-25 daily fractions over 5 weeks [3][4][5][6][7]. A boost to the tumor bed is recommended in patients with a higher risk of recurrences with the typical boost doses being 10-16 Gy in 4-8 fractions [5][7][8][9][10][11][12]. Acute skin toxicity is the most common side effect of breast radiotherapy, and the development of acute skin reactions may begin immediately, increasing in toxicity occurring at 2-3 weeks. The effects accumulate across the course of treatment, and may persist for up to 4 weeks after treatment ends. In conventional radiotherapy schedules, 30-80% of breast radiotherapy patients developed more than grade 1 acute skin

reactions according to the Radiation Therapy Oncology Group (RTOG) and the common terminology criteria for adverse events (CTCAE) guidelines [13][14][15][16]. The factors associated with an increased risk of ≥ G2 acute skin toxicity that found in previous studies are high BMI, large bra cup size, large breast separation, breast volume received > 107 % of the prescribed dose, smoking, prone treatment position, and concurrent hormonal used [13][14][15][16]. Presently, there are no standard skincare guidelines regarding skincare during radiotherapy. Some instructions advise patients to avoid tight-fitting clothes made of irritating fabric, but are unclear in their instructions about wearing a bra during treatment [17]. Because of no evidence to support regular bra-wearing during radiotherapy, regular bra-wearing during treatment is still controversial, and causes worry among some patients along with physicians in concerns to the effect of a bra increasing acute skin reactions. Furthermore, some patients, who are not allowed to wear a bra, may develop a lack of confidence in daily living. So, this study's purpose was to evaluate the effect of regular bra-wearing during radiotherapy on acute skin toxicity, and the Quality of Life (QOL) in women undergoing breast conserving therapy.

Materials and Methods

Population

This study is a prospective cohort study. Women patients with breast cancer who underwent breast conserving radiotherapy, were enrolled from; June 2017 to July 2018, at the Department of Radiology, Faculty of Medicine, Prince of Songkla University, Thailand. The inclusion criteria were: those aged over 18 years, any stage of breast cancer patients who underwent breast conserving therapy, requiring adjuvant external beam radiotherapy to the breast after primary surgery (BCS), available for follow up, and able to understand the Thai language. The exclusion criteria included: patients who underwent an immediate reconstruction, patients with any pre-existing skin rash, ulceration, or open wound in the treatment area, and patients with known systemic skin diseases, even if not directly affecting irradiated fields For all eligible participants the total hours per week of using a bra, weekly, during radiotherapy and one week after treatment completion were observed, and then all participants were classified by total hours of wearing bra throughout their radiotherapy treatment course into either: a non-bra-wearing (0 hr.), or a bra-wearing groups (>0 hr.). Participants who decided to discontinue wearing a bra, were asked about their major decision for discontinuing use of a bra, and their reasons were recorded in a data collection form. At the time of enrollment, all participants were asked to provide signed informed consent.

Breast radiotherapy regimens

All participants received a standard regimen of 50 Gy in 25 fractions (2 Gy/fraction) over 5 weeks. Doses were prescribed to international reference points [18]. Participants who indicated the need to receive a boost to the tumor bed, received a boost, using an electron field of appropriate energy, to deliver 10-15 Gy in 5 fractions (2-3 Gy/fraction), after initial radiotherapy.

Breast irradiation technique

Treatment planning and simulation

We performed standard computer tomography (CT)-based treatment planning, using Philips CT simulation version 3.5.4.17001. The participants' positions were all in the supine position, with the ipsilateral arm, or both arms extended above the head using breast-boards for immobilization. The treatment plans were created by using eclipse treatment planning version 10.0.45, and planned by experienced radiation oncologists.

Treatment volume

The treatment volume was defined as the whole breast. The participants who the regional lymph nodes radiotherapy was indicated, the treatment volume was the whole breast, supraclavicular nodes, infraclavicular nodes, internal mammary nodes, or axillary bed at risk. The tumor bed boost volume included the site of the primary tumor (seroma cavity +/- surgical clips).

Radiation quality

Participants were treated with a linear accelerator, with a minimum photon energy of 6 mega voltages (MV) to the whole breast and regional lymph nodes if indicated. The boost was delivered with either electrons or photons. The .

General instructions for skincare during breast radiotherapy

Participants were advised to wear an appropriate bra, that should have a broad under-band, no underwire, full, plain, separate cups with minimal seams, good cleavage support, wide, fully adjustable straps, back fastening, and a snug fit against the rib, at the lower breast, without gaping. The bra type, as well as bra fit, of all participants, were assessed by an experienced radiation oncology resident weekly, during radiotherapy at the time of follow up. All participants were instructed to record times of using their bra as hours per day, by using a patient record form, and were advised to follow the existing institutional skincare protocol coupled with the general skincare protocol; which allows participants to take a bath in the irradiated area, with water only and without any prophylactic, or supportive medication allowed [17]. Participants who developed more than grade II of acute skin toxicity, according to the Common Toxicity Criteria for Adverse Events (CTCAE) version 4.03, were instructed to discontinue using a bra and a dressing was applied, until the wound healing, as per standard care.

Assessment of skin reactions and quality of life during treatment and follow up

All participants underwent skin assessment, using some skin and subcutaneous disorders part in CTCAE version 4.03, which consists of eight adverse events relating to acute skin reactions in breast irradiation: dry skin, erythroderma, pain of skin, photosensitivity, pruritis, skin hyperpigmentation, skin induration, and skin ulceration [Table. 1S]. The range of score, for each adverse event, is from 0-5. A higher score represents more severe toxicity. Skin reactions for all participants were assessed by an experienced radiation oncology resident, before radiotherapy, weekly during radiotherapy, and one week after treatment completion. The radiation oncology resident was both trained and qualified by two radiation oncologists, before the beginning of the study, to score the worst toxicity present at the time of assessment within the breast treatment field, but excluding the boost field. The QOL related to acute skin toxicity, and bra usage were assessed by using the Functional Assessment of Cancer Therapy-Breast Cancer (FACT-B) Thai version 4, which was validated by Ratanatharathorn V et al. [19][20], and using a locally designed subset of questions specific to the sense of well-being associated with wearing or not wearing a bra [Table. 2S]. FACT-B is a breast cancer-specific questionnaire, which measures five aspects: Physical Well-Being (PWB), Social Well-Being (SWB), Emotional-Well-Being (EWB), Functional Well-Being (FWB), and Breast Cancer Subscale (BCS). The range of these scores is from 0-144, and a higher score represents a better QOL. The locally designed subset of questions is composed of three questions: I am not confident when not wearing a bra, I cannot live a normal life without wearing a bra, I feel unaccepted when not wearing a bra. The range of score is from 0-12, and a higher score represents higher confidence about not wearing a bra. These tools were administered to all eligible participants 2 times during the study: before treatment and one week after treatment completion, at the time of follow up.

Statistical analysis

The primary outcome of this study is the proportion of equal to more than grade 2 acute skin toxicity, assessed by CTCAE version 4.03. The sample size was calculated by using a formula for a

non-inferiority trial for binary data, with a 1-sided significant level of 0.05, to test the hypothesis that the probability of equal to more than grade 2 acute skin toxicity in the Bra-Wearing group (BW) is no more than 20% worse than the non-bra-wearing group (NBW). This is assuming a proportion of equal to more than grade 2 acute skin toxicity is equal in both groups, about 40%, 5% of the sample size was added, so the calculated sample size was 158 patients. Data were entered and validated by EpiData software version 3.1 and analysed using R version 3.5.1 Differences in baseline patient characteristic, and acute skin toxicity grades, between each group (BW group and NBW group), were assessed using the Chi-square test, and a Fisher's exact test for categorical variables. Continuous variables were compared using Student's t-test, for the normal distribution data, with the use of Wilcoxon rank-sum test for the non-normally distributed data. The quantitative variables were presented as mean ± standard deviation, or median ± interquartile range, whilst the qualitative variables were demonstrated as; frequency and percentages. The effect of potential predictors on the risk of equal to more than grade 2 acute skin toxicity were analyzed by using logistic regression analyses and were demonstrated in form of odds ratio along with a corresponding 95% confidence interval. Statistical significances were evaluated using the Wald test. A *p*-value of less than 0.05 was considered statistically significant. The QOL scores, and the locally designed subset of questions related to bra using scores between each group (BW group and NBW group) were compared using Student’s t-test. .

Results

	No Bra (%)	Bra (%)	p value
N	33	66	
Age (years old)			0.239
Mean (SD)	53.1 (12)	50.7 (8.2)	
Body mass index (kg/m2)			0.425
<18.5	4 (12.1)	3 (4.5)	
18.5-24.9	16 (48.5)	38 (57.6)	
25-29.9	10 (30.3)	16 (24.2)	
≥30	3 (9.1)	9 (13.6)	
Median (IQR)	23.5 (21.8-26.8)	24 (21.6-26.6)	0.792
ECOG			0.817
0	9 (27.3)	21 (31.8)	
1	24 (72.7)	45 (68.2)	
Smoking			0.282
Never	23 (95.8)	61 (100)	
Ever	1 (4.2)	0	
Previous using bra			1
Yes	32 (97)	66 (100)	
No	1 (3)	0	
Bra cup size			0.138
A	2 (6.1)	9 (13.6)	
B	18 (54.5)	34 (51.5)	
C	12 (36.4)	14 (21.2)	
D	0	7 (10.6)	
E	1 (3)	2 (3)	
Breast separation (cm.)			0.421
<19	10 (30.3)	17 (25.8)	
19-22	11 (33.3)	31 (47)	
>22	12 (36.4)	18 (27.3)	

Median (IQR)	20.4 (18.5,22.9)	20.2 (18.7,22.4)	0.64
DM			0.155
No	28 (84.8)	62 (93.9)	
Yes	5 (15.2)	4 (6.1)	
Hypertension			0.372
No	26 (78.8)	58 (87.9)	
Yes	7 (21.2)	8 (12.1)	
Bra type			1
Nonstandard	0 (0)	1 (1.5)	
Standard	33 (100)	65 (98.5)	
T			0.032
Tis	0 (0)	11 (16.7)	
T1	15 (45.5)	28 (42.4)	
T2	18 (54.5)	26 (39.4)	
T3	0 (0)	0 (0)	
T4	0 (0)	1 (1.5)	
N			0.076
N0	53(80.3)	21(63.6)	
N1	7 (21.2)	11(11.67)	
N2	4 (12.1)	2 (3)	
N3	1 (3)	0 (0)	
Tumor grade			0.809
1	4 (12.1)	9 (13.6)	
2	16 (48.5)	25 (37.9)	
3	12 (36.4)	30 (45.5)	
unknown	1 (3)	2 (3)	
Boost			0.063
No	7 (21.2)	28 (42.4)	
Yes	26 (78.8)	38 (57.6)	
Maximum dose (%)			0.043
Median (IQR)	110.2 (109,111.7)	108.8 (107.7,110.7)	
Maximum dose (%)			0.117
≤ 107	3 (9.1)	10 (15.2)	
>107-110	13 (39.4)	36 (54.5)	
>110	17 (51.5)	20 (30.3)	
Position			1
Supine	33 (100)	66 (100)	
Lymphatic treatment			0.082
None	3 (9.1)	17 (25.8)	
Surgery/no RT	16 (48.5)	32 (48.5)	
RT/no surgery	1 (3)	4 (6.1)	
Surgery + RT	13 (39.4)	13 (19.7)	
Adjuvant treatment			0.391
None	1 (3)	3 (4.5)	
Endocrine/no CMT	3 (9.1)	15 (22.7)	
CMT/no endocrine	6 (18.2)	10 (15.2)	
Endocrine + CMT	23 (69.7)	38 (57.6)	

Table 1. Demographic and clinical characteristics.

^{2} p

Total	No Bra (%)	Bra (%)	p value
N	33	66	
Total AST			< 0.001
1	15 (45.5)	55 (83.3)	
2	18 (54.5)	11 (16.7)	
Dry skin			0.599
0	2 (6.1)	2 (3)	
1	31 (93.9)	64 (97)	
Erythroderma			1
0	33 (100)	66 (100)	
Pain of skin			0.164
0	5 (15.2)	20 (30.3)	
1	28 (84.8)	46 (69.7)	
Photosensitivity			0.333
0	32 (97)	66 (100)	
1	1 (3)	0 (0)	
Pruritis			0.035
0	3 (9.1)	4 (6.1)	
1	27 (81.8)	62 (93.9)	
2	3 (9.1)	0 (0)	
Skin hyperpigmentation			1
1	33 (100)	66 (100)	
Skin induration			0.024
0	22 (66.7)	58 (87.9)	
1	11 (33.3)	8 (12.1)	
Skin ulceration			< 0.001
0	7 (21.2)	45 (68.2)	
1	10 (30.3)	10 (15.2)	
2	16 (48.5)	11 (16.7)	

Table 2. Maximal acute skin toxicity (AST).

pp Equal to more than grade 2 acute skin toxicity appeared after 4^{th} weeks of treatment in both groups and were higher in the NBW group compared with the BW group throughout the treatment course, which showed a statistically significant difference at 6^{th} week after the start of treatment ($p<0.001$) (Figure 1).

Figure 1. Proportions of ≥ G2 acute skin toxicity in each week between the two groups.

At the end of the treatment, all patients developed at least grade 1 acute skin toxicity, that begin to appear earlier in the NBW group compared with the BW group (1^{st} week vs. 2^{nd} week, respectively). The rate of grade 1 acute skin toxicity continuous increased, until its maximum at the 4^{th} week in the NBW group (all patients in this group had grade 1), and at the 5^{th} week in the BW group, after that the proportion of grade 1 were gradually replaced by grade 2 acute skin toxicity in both groups (Figure 2).

Figure 2.Proportions of acute skin toxicity in each week. (A) bra-wearing group and (B) non-bra-wearing group.

In the univariate analysis (Table 3), we found multiple factors that were associated with the risk of ,

including the total hours of wearing a bra, this had statistically significant lower rates of ≥ G2 acute skin toxicity in the BW group compared with the NBW group, regardless of bra wearing hours (p<0.001), high body mass index (p=0.004), large bra cup size (p=0.027), large breast separation (p<0.001), which median breast separation of ≥ G2 acute skin toxicity patients was 22.6 cm. vs. 20 cm. in < G2 acute skin toxicity patients (p<0.001), and the high percentage of maximum dose (p=0.005), which the median maximum dose among ≥ G2 acute skin toxicity patients were 112.3% vs. 108.8% in < G2 acute skin toxicity patients (p<0.001). In the multivariate analysis (Table 4), the remaining statistically significant factors that associated with ≥ G2 acute skin toxicity were non-bra-wearing (0 hr.) (p<0.001), high body mass index (p=0.001), and a high percentage of the maximum dose (p=0.043). All patients completed the FACT-B. Baseline FACT-B assessment found statistically significantly higher mean scores of PWB part in the BW group than that of the NBW group (24 vs. 22.5, p=0.035, respectively), the remaining parts including total mean scores were well balanced between the two groups. At one week after treatment completion, there was (118.4 vs. 114.7, p=0.256, respectively) [Table. 3S].; however, the BW group trended towards higher mean scores in four parts; including PWB, SWB, EWB, FWB, and total mean scores. In both groups, after treatment FACT-B mean scores were higher than before treatment mean scores, in all parts, and the difference of before and after treatment scores were not statistically significantly different between the BW group and the NBW group [Table. 4S]. The locally designed subset of questions related to bra wearing, the questions are about confidence, daily living, and acceptance of patients if they were asked to not wear a bra. The baseline means total scores in the NBW group were significantly higher than the BW group (8.7 vs. 6, p=0.002, respectively), and also significantly higher after treatment (10.9 vs. 6.7, p<0.001, respectively) [Table. 5S]. The after-treatment mean scores were higher than baseline scores in all parts, and the difference of total mean scores between before and after treatment revealed no statistically significant difference between BW group and NBW group, but had a trend toward higher scores in the NBW group [Table. 6S].

	G1 (%)	G2 (%)	p value
N	70	29	
Total hours using bra (hr.)			< 0.001
0	15 (21.4)	18 (62.1)	
1-350	29 (41.4)	8 (27.6)	
> 350	26 (37.1)	3 (10.3)	
Age (years old)			0.972
Mean (SD)	51.4 (9.2)	51.5 (10.9)	
Body mass index (kg/m2)			0.008
< 18.5	5 (7.1)	2 (6.9)	
18.5-24.9	45 (64.3)	9 (31)	
25-29.9	15 (21.4)	11 (37.9)	
≥ 30	5 (7.1)	7 (24.1)	
Median (IQR)	23.4 (21.3,26.3)	26 (22.9,29.6)	0.004
ECOG			1
0	21 (30)	9 (31)	
1	49 (70)	20 (69)	
Smoking			1
Never	69 (98.6)	29 (100)	
Ever	1 (1.4)	0 (0)	
Bra cup size			0.027
A	9 (12.9)	2 (6.9)	
B	40 (57.1)	12 (41.4)	
C	15 (21.4)	11 (37.9)	
D	6 (8.6)	1 (3.4)	
E	0 (0)	3 (10.3)	
Breast separation (cm.)			< 0.001
<19	23 (32.9)	4 (13.8)	

19-22	34 (48.6)	8 (27.6)	
>22	13 (18.6)	17 (58.6)	
Breast separation (cm)			< 0.001
Median (IQR)	20 (18.3,21)	22.6 (21,24.1)	
DM			0.719
No	64 (91.4)	26 (89.7)	
Yes	6 (8.6)	3 (10.3)	
Hypertension			0.362
No	61 (87.1)	23 (79.3)	
Yes	9 (12.9)	6 (20.7)	
N	70	29	
Bra type			1
Nonstandard	1 (1.4)	0 (0)	
Standard	69 (98.6)	29 (100)	
T			0.605
Tis	9 (12.9)	2 (6.9)	
T1	32 (45.7)	11 (37.9)	
T2	28 (40)	16 (55.2)	
T4	1 (1.4)	0 (0)	
N			0.099
N0	56 (80)	18 (62.1)	
N1	10 (14.3)	8 (27.6)	
N2	4 (5.7)	2 (6.9)	
N3	0 (0)	1 (3.4)	
Tumor grade			0.87
1	9 (12.9)	4 (13.8)	
2	28 (40)	13 (44.8)	
3	30 (42.9)	12 (41.4)	
Not applicable	3 (4.3)	0 (0)	
Boost			0.083
No	29 (41.4)	6 (20.7)	
Yes	41 (58.6)	23 (79.3)	
Maximum dose (%)			0.005
≤107	11 (15.7)	2 (6.9)	
>107-110	40 (57.1)	9 (31)	
>110	19 (27.1)	18 (62.1)	
Median (IQR)	108.8 (107.6,110.2)	112.3 (109.3,115.3)	< 0.001
Lymphatic treatment			0.062
None	17 (24.3)	3 (10.3)	
Surgery/no RT	34 (48.6)	14 (48.3)	
RT/no surgery	5 (7.1)	0 (0)	
Surgery + RT	14 (20)	12 (41.4)	
Adjuvant treatment			0.641
None	3 (4.3)	1 (3.4)	
Endocrine/no CMT	15 (21.4)	3 (10.3)	
CMT/no endocrine	11 (15.7)	5 (17.2)	
Endocrine + CMT	41 (58.6)	20 (69)	

Table 3. Univariate analysis of the predictors for increased ≥ G2 acute skin toxicity.

	Adj. OR (95%CI)	*p* (Wald's test)	*p* (LR-test)

Total hour using bra (hr.)			< 0.001
Ref.= 0			
1-350	0.16 (0.04,0.58)	0.005	
>350	0.08 (0.02,0.43)	0.003	
Body mass index (kg/m2)			0.002
Ref.= 18.5-24.9			
<18.5	2.16 (0.24,19.5)	0.493	
25-29.9	4.23 (1.17,15.36)	0.028	
≥30	20.45 (3.46,120.77)	<0.001	
Maximum dose (%)			0.022
Ref.= >107-110			
≤107	0.83 (0.1,6.58)	0.859	
>110	4.65 (1.23,17.63)	0.024	

Table 4. Multivariate analysis of the predictors for increased ≥ G2 acute skin toxicity.

Discussion

This prospective cohort study was designed to evaluate the effects of regular bra-wearing during radiotherapy on acute skin toxicity and the quality of life in women with breast conserving therapy. It was found that regular bra-wearing during radiotherapy, in comparison to non-bra-wearing, resulted in significantly lower rates of ≥ G2 acute skin toxicity. Other factors that were also associated with an increased rate of ≥ G2 acute skin toxicity were: high body mass index (p=0.001), and a high percentage of maximum dose (p=0.043). We found no difference between the two groups of after treatment FACT-B but the BW group had a trend toward higher mean scores in four parts; including PWB, SWB, EWB, FWB, and total mean scores. Equal to more than G2 acute skin toxicity, according to CTCAE version 4, was considered to be a moderate to a severe skin reaction. Grade 2 acute skin toxicity is the maximum acute skin toxicity that occurred in our study patients, including, grade 2 skin ulceration and pruritis; defined by partial thickness skin loss, involving skin or subcutaneous fat, intense pruritis, skin changes from scratching, or oral intervention indicated. The overall grade 2 acute skin toxicity in our study was 29%, and in the NBW group is 54.5%, which is comparable to previous studies that demonstrate a rate of ≥ G2 acute skin toxicity or moist desquamation of about 30-60% in conventional regimens [13][14][15][16]; however the rate of ≥ G2 acute skin toxicity in the BW patients was only 16.7%, lower than the previously reported percentages. Furthermore, we found the subgroup of total hours of wearing a bra, whether it be 1-350 hrs. or >350 hrs. are significantly lower in the rate of ≥G2 acute skin toxicity. We hypothesize that the lower rate of moderate to severe acute skin toxicity in the bra-wearing patients maybe from using standard bra prevents the occurrence of the skin fold, especially at the inframammary fold, helping to immobilize breast movement, and preventing skin scratching from outer clothes. We also found several factors that were associated with equal to more than grade 2 acute skin toxicity, including high body mass index (p=0.004), large bra cup size (p=0.027), large breast separation (p<0.001), and the high percentage of maximum dose (p=0.005). In the multivariate analysis, we found non-bra-wearing (p<0.001), high body mass index (p=0.001), and the high percentage of maximum dose (p=0.043) remained associated with the increased rate of ≥ G2 acute skin toxicity. These results are consistent with the previous reports [13][14][15][16]. We suggest; that, patients with high BMI, large bra cup size, and large breast separation are at risk to occur moderate to severe acute skin toxicity, because this group of patients often had a large breast size, which had more skin folding, which in turn caused dose inhomogeneity and increased the percentage of maximum dose in their treatment plans. There were 17 patients (51.5%) in the NBW group and 20 patients (30.3%) in the BW group that received the maximum dose of more than 110%. We attempted to minimize the volume of tissue receiving greater than 110% of the prescription dose to as low as possible, but treatment planning in some patients was very difficult to plan, and to make a homogeneous dose, thus, causing a high percentage of maximum dose in the plan. However, we suggest that the percentage of the

maximum dose that is more than 110% should be avoided. This study found BW patients had a trend towards higher mean scores of after treatment FACT-B, in four parts including PWB, SWB, EWB, FWB, and total mean scores. The total mean scores of FACT-B, at one week after treatment, in the BW patients was 118.4 and 114.7 in the NBW patients (p=0.256). We newly develop the locally designed subset of questions related to bra usage, the questions are about confidence, daily living, and acceptance of patients if they were asked to not wear a bra during treatment. NBW patients had higher mean scores at baseline, and one week after treatment, compared to BW patients. Likely, NBW patients had more confidence in daily-living, without wearing a bra than BW patients, so they decided to not wear a bra during treatment. The results of these questions demonstrate that the majority of patients (66 patients in BW group, 66.7% of all patients) in this study lack of confidence in daily-living, and were unacceptable if they were asked to not wear a bra. To our knowledge, our study is the first prospective study that evaluated the effects of regular bra-wearing on acute skin toxicity in breast-conserving radiotherapy patients. So this is a strength of our study. This study had some limitations including small sample size in the NBW group that did not meet the targeted sample size that we calculated using a formula for a non-inferiority trial for binary data, the study design is not a randomized control trial, included patients come from a single center in Thailand, and the locally designed subset of questions related to bra usage has not been validated.

In conclusion,this prospective cohort study shows that regular bra-wearing during radiotherapy does not increase the rate of ≥ G2 acute skin toxicity, compared to non-bra-wearing and does not affect the quality of life. These finding should be carefully applied in skincare protocol and carefully communicated with breast-conserving patients. An additional control study, with a larger sample size, is required to further assess the effect of regular bra-wearing during radiotherapy, for generalized breast conserving patients.

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Compliance with ethical standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee [the Research Ethics Committee, Faculty of Medicine, Prince of Songkla University, Thailand (REC 60-100-07-4)] and with the 1964 Helsinki declaration and its later amendments or comparable ethical standard. Written informed consent was obtained from all individual participants included in the study.

Conflict of interest

The authors declare that they have no conflict of interest.

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