Breast-Conserving Therapy is Associated with Better Survival than Mastectomy in Early-Stage Breast Cancer: A Propensity Score Analysis

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Abstract

Background: Recent retrospective studies have reported that breast-conserving therapy (BCT) led to improved overall survival (OS) than mastectomy in some populations. We aimed to compare the efficacy of BCT and mastectomy using the SEER database.

Methods: Between 2010 and 2015, 99,790 eligible patients were identified. We included early-stage breast cancer patients with 5cm or smaller tumors and three or fewer positive lymph nodes in our study. We compared the OS results among patients with BCT and mastectomy. Kaplan-Meier plots, Cox proportional hazard regressions were used to evaluate the outcomes. Propensity-score matching was used to assemble a cohort of patients with similar baseline characteristics.

Results: In our study, 77,452 (77.6%) patients underwent BCT and 22,338 (22.4%) underwent mastectomy. The 5-year OS rate was 94.7% in the BCT group and 87.6% in the mastectomy group (P <0.001). After matching, multivariate analysis in the matched cohort showed that women underwent mastectomy was associated with worse OS results compared with those with BCT (Hazard ratio (HR) = 1.628; 95% confidence intervals (CIs) = 1.445- 1.834, P<0.001). Patients with different subtypes and age group (>50 years old; ≤50 years old) received BCT all showed significantly better OS than those received mastectomy. The effect of surgery choice on survival was the same in matched and all cohorts.

Conclusions: Our study showed that BCT was associated with improved survival compared with mastectomy in early-stage breast cancer patients. It seems advisable to encourage patients to receive BCT rather than mastectomy in early-stage patients when feasible and appropriate.

1. Background

Breast cancer is the most common neoplasm among females over the world.[1] The leading locoregional managements of early or locally advanced breast cancer are breast-conserving therapy (BCT) and mastectomy.[2] BCT refers to breast-conserving surgery followed by radiotherapy to eradicate any microscopic residual disease. It is cosmetically acceptable and offers equivalent overall survival to mastectomy. [3]

In recent years, multiple studies have compared BCT's long-term effects with mastectomy in OS, local, and regional recurrence. One of the most influential studies was the NSABP B-06 trial, which demonstrated a decrease in the rate of ipsilateral breast cancer recurrence in breast cancer patients with tumors less than 4 cm in size received BCT than those who underwent a mastectomy. However, the OS rate was shown no significant differences between the groups.[4] A contemporary analysis compared the OS of mastectomy, mastectomy with radiation, and BCT using the SEER database with more than 130,000 patients from 1998 to 2008. They concluded that patients who received BCT had higher survival than those who underwent mastectomy or mastectomy with radiation matching for tumor size and lymph node.[5] In a registry-based follow-up study containing 6,387 breast cancer patients, there is a benefit of BCT over mastectomy in patients with stage T1N1M0. There was no such survival benefit in other stages of breast cancer. [6] However, many previous studies have no access to tumor subtypes, and some with a small number of samples may be confounded by selection bias. In the past, BCT was underutilized due to surgeon and patients' choice.[7] It is increasingly vital to re-examine survival outcomes for mastectomy and BCT, to inform an optimal surgery choice for the individual

patient, especially with the development of radiotherapy techniques which can eliminate micrometastasis.[8] In our study, we aimed to compare the OS rate between BCT and mastectomy in a large number of early-stage breast cancer patients. We further explored survival outcomes in breast cancer patients stratified by tumor subtypes, age, tumor, and lymph node stage in the Surveillance, Epidemiology and End Results (SEER) database.

2. Methods

2.1 Study design

It is a retrospective cohort study consisting of breast cancer patients from the SEER cancer registries between 2010 and 2015. The data on patients' demographics, vital status, tumor characteristics, treatment, and survival time were extracted using SEERStat software. The follow-up cutoff was on December 31, 2019. To better compared the survival outcomes of standard BCT and mastectomy, our study focused on invasive ductal carcinoma who underwent lumpectomy plus radiotherapy, and those underwent mastectomy with or without radiotherapy.

2.2 Participants

We identified eligible cases based on the following criteria: female, age between 18–80 years old, unilateral breast cancer, pathologically diagnosed, with primary breast cancer, with a tumor size of 5 cm or smaller, with three or fewer positive lymph nodes, received surgery (lumpectomy (site-specific surgery codes 20–24) with radiation, mastectomy (site-specific surgery codes 41,50–51, 80)), and without metastasis at diagnosis. The stage was based on the 7th edition of the AJCC Cancer Staging Manual.

The exclusion criteria were 1) not invasive ductal carcinoma (n = 89,110); 2) bilateral tumor (n = 249); 3) without histologically confirmed (n = 623); 4) without underwent lumpectomy, mastectomy, underwent surgery with unknown surgery type (n = 73,139); 5) underwent lumpectomy without received radiotherapy (n = 31,217); 6) advised to receive radiotherapy but reject (n = 1,983); 7) tumor stage T0, Tis, T3,T4 or unknown (n = 10,360); 8) lymph node stage N2, N3 or unknown (n = 7,240); 9) with distant metastasis (n = 644);10) with unknown tumor subtypes (n = 6,339); 11) not primary breast cancer (n = 18,587). Patients with > 3 positive lymph nodes were excluded in our study because these patients would be more likely be indicated to receive radiation therapy regardless of surgery type. The flow chart of inclusion was shown in Fig. 1.

In our study, the primary endpoint was overall survival (OS). OS was calculated from the date of diagnosis as breast cancer to death for any cause or last follow-up time.

2.3 Statistical analysis

Clinicopathological features between BCT and mastectomy group were compared using Pearson's chi-square test. To balance the different characteristics between each group, propensity-score matching (PSM) was used with a ratio of 1.0. PSM is a statistical method in which a treatment case is matched with one or more control cases based on their propensity score, strengthening causal argument's observational studies by reducing the selection bias.[9] The matching was performed with a caliper width equal to 0.001 of the standard deviation of the logit of the propensity score. OS rate was estimated, and survival curves were plotted by the Kaplan-Meier method. The log-rank test was used to identify prognostic factors for OS across different groups.

Cox proportional-hazards regression models evaluated the hazard ratios (HRs) with 95% confidence intervals (CIs) for OS results in mastectomy and the matched BCT cohort. The comparative risk of OS results was further evaluated using a Cox regression model stratified on tumor and lymph node stage in the matched cohort to preserve the benefit of matching. The Kaplan-Meier method and multivariate Cox models were also used in all eligible patients.

All statistical analyses and survival plots were done using SPSS 22.0 (IBM Corporation, Armonk, NY, USA) and R software (Version 3.6.1, R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/). In our study, a P-value < 0.05 was considered as statistically significant.

3. Results

3.1 Demographic and matched characteristics

A total of 99,790 patients with primary breast cancer who met the criteria were eventually selected. 77,452 (77.6%) patients underwent BCT and 22,338 (22.4%) underwent mastectomy in our study. Patients' demographics and tumor characteristics were shown in Table 1. There were significant differences in the distribution of all variables between the BCT and mastectomy group (P < 0.001). With propensity-score matching, 21,578 patients who underwent mastectomy were matched with 21,578 patients who underwent BCT.

Table 1
Patient-, tumor-, and treatment-related characteristics in our cohort

	Before Matching				*P**	After Matching				*P**
	BCT		Mastectomy			BCT		Mastectomy		
	n	%	*n*	%		*n*	%	*n*	%	
Age (years)					0.001					0.720
≤ 50	16190	20.9	4905	22.0		4808	22.3	4776	22.1	
> 50	61262	79.1	17433	78.0		16770	77.7	16802	77.9	
T stage					< 0.001					0.899
T1	60337	77.9	12409	55.6		12306	57.0	12292	57.0	
T2	17115	22.1	9929	44.4		9272	43.0	9286	43.0	
N stage					< 0.001					0.951
N0	63707	82.3	14578	65.3		14303	66.3	14310	66.3	
N1	13745	17.7	760	34.7		7275	33.7	7268	33.7	
AJCC 7th stage					< 0.001					0.103
□	54826	70.8	10151	45.4		10265	57.0	10095	46.8	
□	22626	29.2	12187	54.6		9272	43.0	11483	53.2	
Race					< 0.001					0.767
White	62031	80.1	15824	70.8		15523	71.9	15525	71.9	
Black	7939	10.3	2735	12.2		2706	12.5	2647	12.3	
Other	7085	9.1	3665	16.4		3254	15.1	3308	15.3	
Unknown	397	0.5	114	0.5		95	0.4	98	0.5	
Tumor subtype					< 0.001					0.491
HR- /HER2+ (HER2-enriched)	2481	3.2	1507	6.7		1298	6.0	1333	6.2	
HR+ /HER2- (Luminal A)	59956	77.4	14817	66.3		14753	68.4	14622	67.8	
HR+ /HER2+ (Luminal B)	7063	9.1	3036	13.6		2756	12.8	2843	13.2	

	Before Matching				*P**	After Matching				*P**
	BCT		Mastectomy			BCT		Mastectomy		
	n	%	*n*	%		*n*	%	*n*	%	
HR- /HER2- (Triple-negative)	7952	10.3	2978	13.3		2771	12.8	2780	12.9	
Chemotherapy					< 0.001					0.482
No/ Unknown	49988	64.5	11856	53.1		11221	52.0	11295	52.3	
Yes	27464	35.5	10482	46.9		10357	48.0	10283	47.7	
Nuclear grade					< 0.001					0.796
I /II	54176	69.9	13075	58.5		12815	59.4	12867	59.6	
III / Ⅲ	21702	28.0	8750	39.2		8284	38.4	8248	38.2	
Unknown	1574	2.0	513	2.3		479	2.2	463	2.1	
Radiation therapy					-					
No/ Unknown	0	0.0	18157	81.2		0	0.0	17535	81.2	-
Yes	7752	100.0	4181	18.7		21578	100.0	4043	18.7	
Total	77452	100.0	22338	100.0		21578	100.0	21578	100.0	
BCT = breast-conserving therapy; *P** ≤ 0.05 was significant.										

Between the matched cohort, the distribution of baseline variables besides radiotherapy showed no statistically significant difference. Patients who underwent lumpectomy must receive radiotherapy in our study. The distributions of related variables are shown in Table 1.

3.2 Survival analysis

After matching, the median follow-up time was 43.0 months (interquartile range, IQR 26.0–62.0 months), and 2,965 died of all-cause. There were 1,020 (4.73%) death events observed in the BCT group and 1,945 (9.01%) in the mastectomy group. The 5-year OS rate was 92.9% in the BCT group and 88.0% in the mastectomy group ($P < 0.001$) (Table 2). Kaplan-Meier survival estimates showed that patients who underwent BCT had a better OS result than those who underwent a mastectomy. The log-rank test p-value was < 0.001 at 5-year points (Fig. 2A). In univariate analysis, age at diagnosis, tumor stage, node stage, race, tumor subtypes, nuclear grade, and radiotherapy were significantly associated with OS (Table 2). All univariate factors associated with OS were included in the multivariable Cox model. We found that patients underwent mastectomy was associated with worse OS result compared with those with BCT in multivariable analysis (Hazard ratio (HR) = 1.628; 95%

confidence intervals (CIs) = 1.445–1.834, $P < 0.001$). The survival benefit of BCT was also seen in the PSM cohort when evaluated by multivariate analysis.

Table 2
Univariate and Multivariate analysis of overall survival (OS) in matched cohort

Covariate	Univariate analysis			Multivariate analysis		
	5-year OS (%)	95% CI (%)	P*	HR	95% CI (%)	P*
Surgery type			< 0.001			
BCT	92.9	92.5–93.4		1.0 [reference]		
Mastectomy	88.0	87.4–88.5		1.628	1.445–1.834	< 0.001
Age (years)			< 0.001			
≤ 50	93.8	93.1–94.4		1.0 [reference]		
> 50	89.4	88.9–89.8		1.984	1.789–2.202	< 0.001
T stage			< 0.001			
T1	92.9	92.5–93.3		1.0 [reference]		
T2	87	86.3–87.6		1.627	1.506–1.758	< 0.001
N stage			< 0.001			
N0	91.6	91.2–92.0		1.0 [reference]		
N1	87.9	87.3–88.6		1.373	1.270–1.485	< 0.001
Race			< 0.001			
White	90.1	89.7–90.5		1.0 [reference]		
Black	86.3	85.1–87.5		1.240	1.127–1.366	< 0.001
Other	95.0	94.3–95.7		0.548	0.478–0.628	< 0.001
Unknown	99.1	97.3–100.0		0.091	0.013–0.649	0.017
Tumor subtype			< 0.001			

Covariate	Univariate analysis			Multivariate analysis		
HR- /HER2+ (HER2-enriched)	89.1	87.5–90.7		1.0 [reference]		
HR+ /HER2- (Luminal A)	91.8	91.3–92.2		0.905	0.777–1.054	0.197
HR+ /HER2+ (Luminal B)	92.7	91.7–93.6		0.712	0.593–0.855	< 0.001
HR- /HER2- (Triple-negative)	81.6	80.3–82.9		1.658	1.415–1.941	< 0.001
Chemotherapy			0.800			
No/ Unknown	90.5	89.9–91.0				
Yes	90.3	89.8–90.8				
Nuclear grade			< 0.001			
I /II	92.7	92.3–93.2		1.0 [reference]		
III / Ⅳ	86.9	86.2–87.6		1.427	1.312–1.552	< 0.001
Unknown	88.8	86.1–91.7		1.344	1.050–1.721	0.019
Radiation therapy			< 0.001			
No/ Unknown	88.3	87.7–88.9		1.166	1.038–1.310	0.009
Yes	91.8	91.4–92.3		1.0 [reference]		
*The propensity-score–matched cohort included 48,311 patients in the BCT group and 48,311 patients in the mastectomy group						
BCT = breast-conserving therapy; *P**< 0.05 was significant.						

Subgroup analyses were conducted to determine further the effect of surgery type choice on OS among patients with distinctive features by the Cox model. In the matched cohort, patients with different subtypes received BCT all showed significantly better OS than that received mastectomy. The Kaplan-Meier survival plots were shown in Fig. 3. Patients with different age subgroups also showed improved OS results in the BCT group (Fig. 4). Moreover, patients with tumor stage T1, T2, and node stage N0, N1 were associated with improved survival results in the BCT group (Table 3). The survival plots for patients with different stages were shown in Supplementary Figure S1.

Table 3
The Overall Survival (OS) Rate in Matched Cohort Patients Subgroup

Subgroup	BCT	Mastectomy	*P**
	5-year OS rate (%) 95% CI	5-year OS rate (%) 95% CI	
T stage			
T1	95.0 (94.5–95.6)	90.9 (90.3–91.6)	< 0.001
T2	90.2 (89.3–91.0)	84.0 (83.0- 84.9)	< 0.001
N stage			
N0	94.1 (93.5–94.6)	89.3 (88.7–90.0)	< 0.001
N1	90.8 (89.9–91.7)	85.3 (84.3–86.3)	< 0.001
Age			
≤ 50	94.8 (94.0- 95.7)	92.7 (91.8–93.7)	< 0.001
50	92.4 (91.8–92.9)	86.6 (85.9–87.3)	< 0.001
Tumor subtype			
HER2-enriched	90.9 (88.7–93.2)	87.4 (85.1–89.8)	0.001
Luminal A	94.2 (93.7–94.8)	89.5 (88.8–90.1)	< 0.001
Luminal B	94.6 (93.4–95.8)	90.9 (89.5–92.4)	< 0.001
TNBC	85.8 (84.1–87.5)	77.7 (74.9–78.9)	< 0.001

3.3 Sensitivity analysis

There were 2,850 (3.7%) deaths observed in the BCT group in all eligible breast cancer patients and 2,080 (9.3%) among patients underwent a mastectomy. BCT was proved a superior survival result compared with the mastectomy group (94.7% compared with 87.6%, $P < 0.001$). The survival plots were shown in Fig. 2B. In Kaplan-Meier analysis, the surgery type choice, age, tumor stage, lymph node stage, race, tumor subtypes, chemotherapy, and radiotherapy were important prognostic factors for OS in breast cancer patients. After adjusting the relevant factors in Kaplan-Meier analysis, it is found that mastectomy (HR 1.776; 95% CI 1.591–1.983; $P < 0.001$), age over 50 years old (HR 1.903; 95% CI 1.751–2.068; $P < 0.001$), T2 stage (HR 1.819; 95% CI 1.708–1.937; $P < 0.001$), N1 stage (HR 1.592; 95% CI 1.489–1.701; $P < 0.001$), Black race (HR 1.227; 95% CI 1.135–1.327; $P < 0.001$), triple-negative subtype (HR 1.630; 95% CI 1.426–1.863; $P < 0.001$), without chemotherapy (HR 1.594; 95% CI 1.485–1.711; $P < 0.001$), and nuclear grade / (HR 1.615; 95% CI 1.507–1.730; $P < 0.001$) were associated with higher risk of death (Table 4).

Table 4
Univariate and Multivariate analysis of Overall Survival (OS) in all Patients

Covariate	Univariate analysis			Multivariate analysis		
	5-year OS (%)	95% CI (%)	*P**	HR	95% CI (%)	*P**
Surgery type			< 0.001			
BCT	94.7	94.4–94.9		1.0 [reference]		
Mastectomy	87.6	87.0- 88.1		1.776	1.591–1.983	< 0.001
Age (years)			< 0.001			
≤ 50	95.5	95.1–95.8		1.0 [reference]		
> 50	92.3	92.1–92.6		1.903	1.751–2.068	< 0.001
T stage			< 0.001			
T1	94.8	94.6–95.1		1.0 [reference]		
T2	88.0	87.5–88.5		1.819	1.708–1.937	< 0.001
N stage			< 0.001			
N0	94.0	93.8–94.3		1.0 [reference]		
N1	89.2	88.7–89.8		1.592	1.489–1.701	< 0.001
Race			< 0.001			
White	93.1	92.9–93.3		1.0 [reference]		
Black	89.6	88.8–90.4		1.227	1.135–1.327	< 0.001
Other	95.4	94.9–96.0		0.588	0.525–0.659	< 0.001
Unknown	99.7	99.0-100.0		0.087	0.022–0.348	< 0.001
Tumor subtype			< 0.001			

Covariate	Univariate analysis			Multivariate analysis		
HR- /HER2+ (HER2-enriched)	90.2	88.9–91.4		1.0 [reference]		
HR+ /HER2- (Luminal A)	94.2	94.0- 94.4		0.787	0.690–0.898	0.206
HR+ /HER2+ (Luminal B)	94.0	93.3–94.6		0.727	0.624–0.849	< 0.001
HR- /HER2- (Triple-negative)	85.3	84.4–86.1		1.630	1.426–1.863	< 0.001
Chemotherapy			< 0.001			
No/ Unknown	93.7	93.4–93.9		1.594	1.485–1.711	< 0.001
Yes	91.9	91.6–92.3		1.0 [reference]		
Nuclear grade			< 0.001			
I /II	94.9	94.6–95.1		1.0 [reference]		
III / Ⅳ	89.0	88.6–89.5		1.615	1.507–1.730	< 0.001
Unknown	92.2	90.6–93.7		1.388	1.148–1.678	< 0.001
Radiation therapy			< 0.001			
No/ Unknown	87.8	87.2–88.5		1.118	1.426–1.863	0.052
Yes	94.2	94.0- 94.4		1.0 [reference]		
BCT = breast-conserving therapy; *P**< 0.05 was significant.						

In multivariate analysis, Other races (HR 0.588; 95% CI 0.525–0.659; $P < 0.001$), Luminal B (HR 0.727; 95% CI 0.624–0.849; $P < 0.001$) were proved contributed to improved OS. While without radiotherapy did not significantly associate with OS results in breast cancer patients (HR = 1.118, CI = 1.426–1.863, $P = 0.052$).

In the subgroup analysis of tumor subtype, age subgroup, tumor, and lymph node stage, we found that the BCT group had better survival results than the mastectomy group (Table 5). It is by the results of the matched cohort. The survival plots of subgroup analysis were shown in Supplementary Figure S2, S3, and S4.

Table 5
The Overall Survival (OS) Rate in Matched Cohort Patients Subgroup

Subgroup	BCT	Mastectomy	*P**
	5-year OS rate (%) 95% CI	5-year OS rate (%) 95% CI	
T stage			
T1	95.7 (95.5–95.9)	90.9 (90.3–91.6)	< 0.001
T2	90.9 (90.3–91.5)	83.3 (82.4–84.2)	< 0.001
N stage			
N0	95.2 (95.0- 95.5)	89.1 (88.5–89.8)	< 0.001
N1	92.0 (91.3–92.6)	84.7 (83.6–85.7)	< 0.001
Age			
≤ 50	96.4 (96.0- 96.8)	92.6 (91.6–93.5)	< 0.001
50	94.2 (93.9–94.5)	86.2 (85.5–86.8)	< 0.001
Tumor subtype			
HER2-enriched	92.2 (90.8–93.7)	87.0 (84.8–89.2)	< 0.001
Luminal A	95.5 (95.2–95.7)	89.4 (88.7–90.0)	< 0.001
Luminal B	95.8 (95.1–96.4)	90.0 (88.6–91.5)	< 0.001
TNBC	88.6 (87.7–89.5)	76.7 (74.8–78.6)	< 0.001

4. Discussion

Since the release of the NSABP-B06 trial, the BCT was proved equivalent in survival to mastectomy. Moreover, there was a decline in the amount of early-stage breast cancer patients who received mastectomy. However, recent studies have shown an increased rate of mastectomy in breast cancer patients.[10] The increased uptake of mastectomy probably because of the perception of a worse survival result in patients with unfavorable factors such as younger age, HER2-enriched subtype, and reconstructive surgery advances.[11] Our study showed that patients treated with BCT had an improved overall survival outcome than those who underwent a mastectomy in the real-world analysis. These findings were also confirmed in the matched cohort after adjusting for variables.

It is the first study to examine BCT's potential benefit over mastectomy in the different subtypes of breast cancer patients. Similar to previous studies, we support the practice of BCT. Agarwal S et al. [5] found that BCT reduced the mortality risk among patients with tumors smaller than 4 cm and node-matched patients. And Hwang et al. [12] demonstrated a lower hazard of death associated with BCT. Several small population-based studies conferred the same results.[13, 14]

However, these studies did not match essential factors such as tumor subtypes and age in many populations. Our study using the PSM method to evaluate closely matched populations can provide the simulation of

randomization on the comparison between the survival results of BCT and mastectomy. In our study, the survival results showed that BCT had better OS than mastectomy regardless of tumor subtypes, tumor stage, and lymph node stage subgroups.

It is not clear why our study and the studies mentioned above show different survival outcomes, while several clinical trials discovered equivalent survival between patients who underwent BCT and mastectomy in early-stage breast cancer patients. There are some plausible explanations. One is that the radiation-related cardiac toxicity of older radiation techniques may mask the benefit of BCT. The benefit conferred by BCT may be associated with incidental irradiation of the regional lymphatics in breast cancer patients with a high recurrence score and improved three-dimensional conformal radiotherapy planning. [15, 16] In clinical practice, some patients who underwent mastectomy with clinically uninvolved lymph nodes may not receive additional lymph node irradiation.[17] The abscopal effects of radiation may be another possible reason for improved OS in patients with BCT. It has unique biological effects to prevent early migration of tumor cells to distant organs and induces an anti-tumoral immune response in breast cancer.[18] Moreover, radiation can induce immunogenic cell death, which involves the release of signals and various cytokines to modify tumors' microenvironment.[19]

Young age is a well-known predictive factor for local recurrence after BCT. Numerous studies have reported that patients < 50 years have more aggressive lesions with a higher risk of recurrence than old patients. Moreover, the equivalency of BCT and mastectomy has not been well established in younger women like it in older patients, since related seminal trials did not include a large percentage of younger patients. In our study, when we compare mastectomy and BCT, there was no difference in OS result stratified by age. A longer-term follow-up study is needed to detect a difference between BCT and mastectomy in young women.[20]

Decision-making for breast cancer surgery is unique in that there are various patient-selected options based on patients’ own goals and perspectives with equivalent outcomes. The changing landscape of systemic therapies and the evolving understanding of patient subgroups may affect the benefit of various local therapies. If a physician believes that a treatment will not conduct an improved outcome, he is less likely to follow the treatment recommendations. In our study, BCT had improved survival outcomes compared to mastectomy, even in the matched cohort. Patients were matched 1:1 regarding variable associated with surgery type choice and survival to reduce confounding. It means that each mastectomy patient has an exactly matched BCT case with the same tumor formula was present. The improved OS results in the BCT group remained significant in the matched cohort.

Our study has some limitations. First, the SEER database did not provide local-regional recurrence information and the irradiated technique and scope details. Second, we excluded medical cases with missing data on tumor characteristics and loss of follow-up. Recurrence score (RS) is involved in treatment decisions in ER-positive, HER2-negative, and node-negative breast cancer, but we have no information about RS in our study. The retrospective design of our study and the inherent potential selection bias is also our limitations. We attempt to minimize the impact of potential bias by matching all available factors, and validate the result by sensitivity analysis. Another weakness of our study is the short-term follow-up for patients with tumor subtype because the information of HER2 was accessible after 2010.

5. Conclusion

Our analysis of a large cohort of patients demonstrated that BCT is associated with better OS results than mastectomy in early-stage breast cancer patients. Although not a randomized prospective trial, it contributes to growing evidence that suggests the benefit of BCT in this population. The conclusion deserves further investigation to determine the factors contributing to the efficacy. It seems advisable to encourage patients to receive BCT rather than mastectomy in early-stage patients when feasible and appropriate.

Abbreviations

BCT: breast-conserving therapy; PSM: propensity-score matching

SEER: Surveillance, Epidemiology, and End Results; OS: overall survival; HR: Hazard ratio; HR: hormone receptor; HER2: human epidermal growth factor receptor 2;

Declarations

Ethics approval and consent to participate

This article does not contain any studies with human participants or animals performed by any of the authors.

Consent for publication

Not applicable.

Availability of data and materials

Our study data was publicly available in the SEER database.

Competing interests

The authors indicated no competing interest.

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Authors' contributions

JJ, LY, and XH contributed to the design and conception of the study; JJ, SY, and JH collected and analyzed the protocol data; JJ, SY, and JH wrote the manuscript; LY and XH revised the manuscript. All authors reviewed and approved the final version of the manuscript.

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Figures

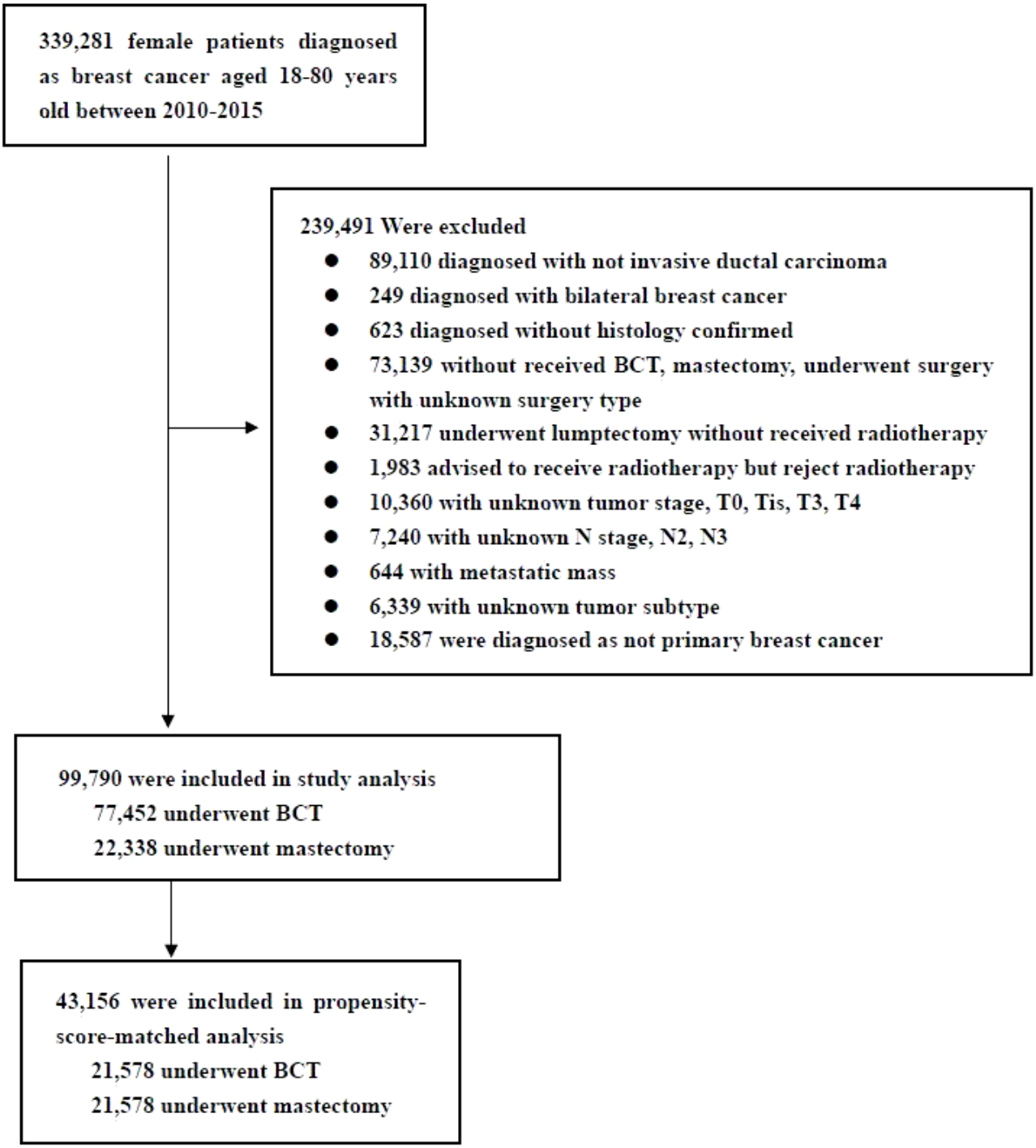

Figure 1

Flow chart of patient selection.

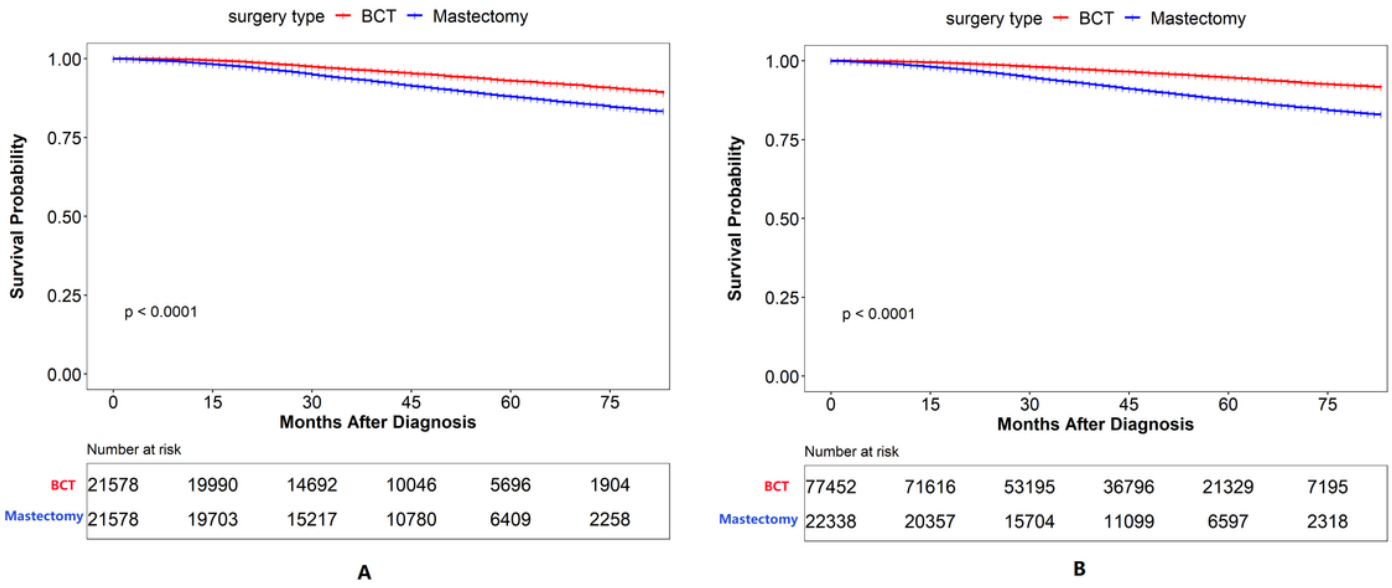

Figure 2

Overall survival (OS) rate of patients underwent BCT and mastectomy in propensity-score matching (PSM) cohort and all eligible patients. A: OS rate of patients underwent BCT and mastectomy in PSM cohort B: OS rate of patients underwent BCT and mastectomy in all eligible patients BCT: breast-conserving therapy.

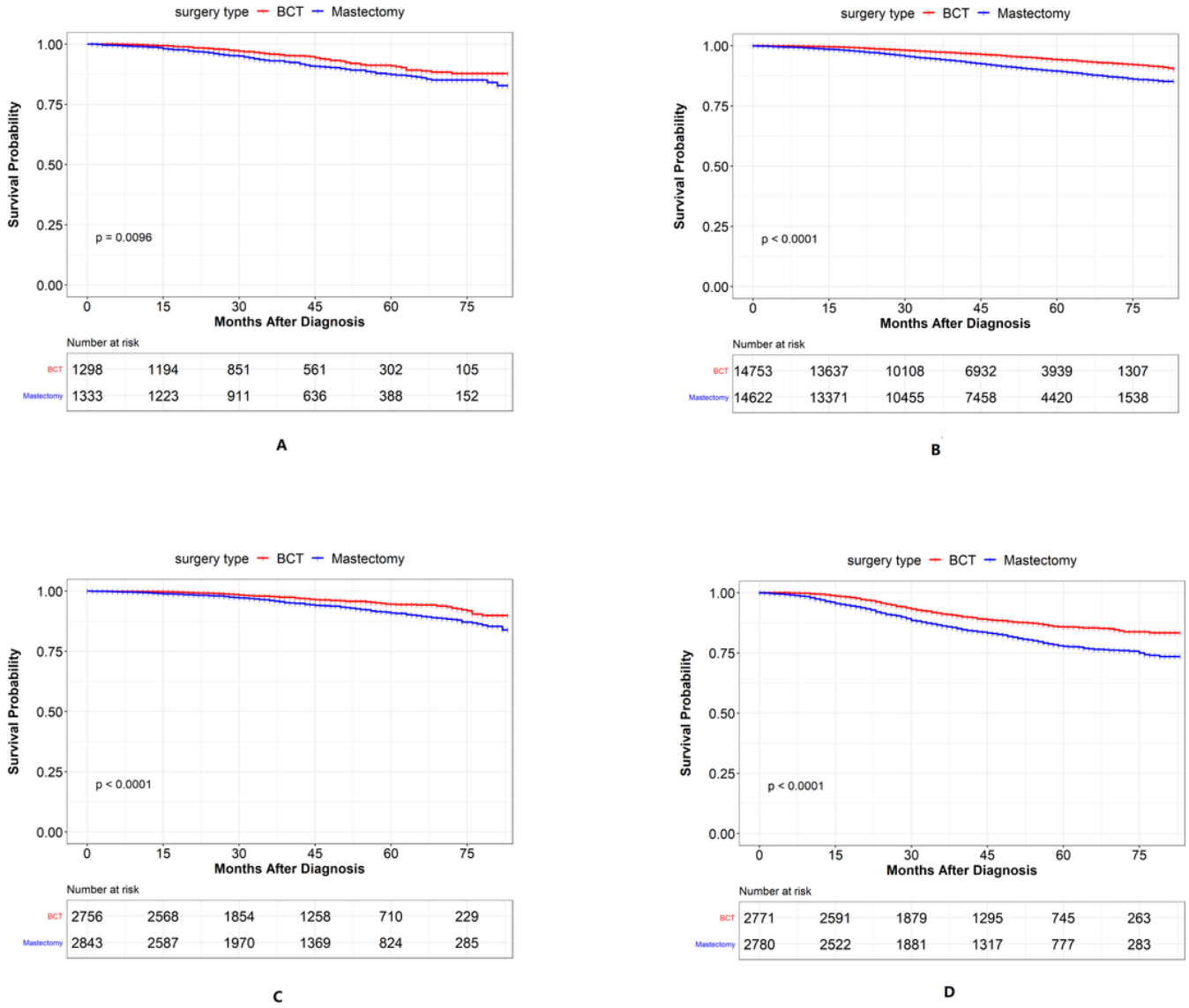

Figure 3

Overall survival (OS) rate of patients underwent BCT and mastectomy in the propensity-score matching (PSM) cohort stratified in tumor subtype. A: OS rate of patients underwent BCT and mastectomy in HER2+ breast cancer B: OS rate of patients underwent BCT and mastectomy in Luminal A breast cancer C OS rate of patients underwent BCT and mastectomy in Luminal B breast cancer D: OS rate of patients underwent BCT and mastectomy in Triple-negative breast cancer

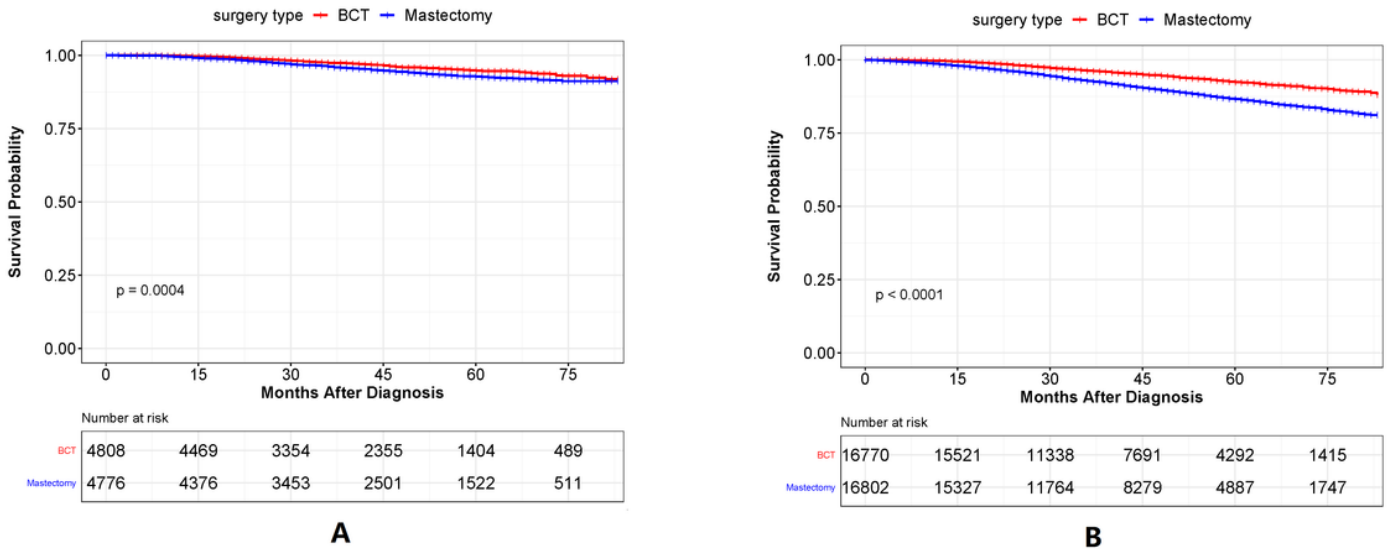

Figure 4

Overall survival (OS) rate of patients underwent BCT and mastectomy in the propensity-score matching (PSM) cohort stratified in the different age groups. A: OS rate of patients underwent BCT and mastectomy aged ≤50 years old breast cancer B: OS rate of patients underwent BCT and mastectomy aged >50 years old breast cancer

Supplementary Files

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- Supplementaryfigures.docx