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ORIGINAL RESEARCH ARTICLE

Autologous and implant based immediate breast reconstructive trends following unilateral modified radical and radical mastectomy: a SEER database analysis

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ABSTRACT

Longitudinal trends in breast reconstruction after modified radical mastectomy remain under described. This study aims to assess procedural trends in autologous reconstruction (AR) and implant-based reconstruction (IBR), to analyse demographic shifts in these patients, and to examine differences in oncologic management. This retrospective study utilizes the Surveillance, Epidemiology, and End Results (SEER) database to investigate trends in immediate breast reconstruction from 2000 to 2020 following unilateral modified radical and radical mastectomy. Demographic and oncologic variables were collected, and reconstruction types were categorised as IBR, AR, or a combination. Subgroup analyses compared IBR and AR patients, and demographic changes between the 2000–2010 and 2010–2020 cohorts were examined. Chi-square tests in R studio were used for statistical analysis. Of the 25,649 patients, 51.8% underwent IBR and 48.2% AR. AR patients were typically younger, more frequently Black, had higher incomes, and were less likely to live in rural areas compared to IBR patients. A shift from AR to IBR was observed, with AR decreasing from 41.8% in 2000 to 24.5% in 2020. Significant demographic changes in AR patients included increased age, higher proportions of Black and Asian patients, reduced income, and increased non-marital status. Oncologic management differed, as AR patients were less likely to have received chemotherapy and radiation prior to their reconstruction, and experienced longer reconstruction times compared to IBR patients. This study highlights a decline in AR and rising IBR popularity, and reveals evolving patient characteristics. Understanding these trends is crucial for equitable access and informed decision-making in breast cancer reconstructive care.

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Introduction

Breast cancer remains the second most common type of cancer affecting women in the United States (U.S.) behind only skin cancer, and results in the second highest oncologic mortality [1, 2]. The treatment of breast cancer often comprehends a variety of therapies, including surgery, chemotherapy, hormonal, immunotherapy, and radiation therapy [3]. Several significant advancements have enabled a shift away from more radical surgical approaches favouring breast-conserving surgery [4]. Despite this, modified radical and radical mastectomies are still performed and indicated in cases of prior radiation therapy to the chest wall, inflammatory breast cancer, malignant appearing microcalcifications, multicentric tumours, positive pathologic margins after repeat re-excision, active connective tissue disease, focally positive margins, and extensive tumour burden [5].

Post-mastectomy reconstruction is often a critical component of breast cancer care, with the majority of patients electing to include this component of care in their treatment [6]. Numerous benefits have been cited for post-mastectomy reconstruction including satisfaction with breasts, psychological and sexual well-being [7–9]. Reconstruction post radical mastectomy poses unique challenges due to the significant deformity left after resection. Given the significant chest wall defect created during radical mastectomy, reconstruction is often crucial; however, there is debate as over which type of reconstruction is best suited for these patients. Strategies typically include implant-based reconstruction (IBR), autologous reconstruction (AR), or a combination of both. Autologous breast reconstruction is associated with better sexual well-being and satisfaction with breasts and lower risks of seroma and long-term reconstructive failure, but a higher risk of thromboembolic events compared to IBR [10]. Importantly, the authors conclude that most evidence comparing IBR and AR is of low or moderate strength [10]. Another study similarly revealed that AR was associated with higher levels of satisfaction with surgical outcomes, breast appearance, and overall physical well-being, as compared to IBR [11]. General advantages of IBR over AR include shorter operative time, faster patient recovery, and elimination of donor site morbidity [12]. To our knowledge, only one other recent national study has compared the demographics of patients undergoing IBR and AR, and none have examined this trend among patients who have undergone radical mastectomy [13].

In this retrospective observational study utilising data from the Surveillance, Epidemiology, and End Results (SEER) database, we aim to investigate the longitudinal demographic trends in immediate breast reconstruction following unilateral radical mastectomy. Due to the operative time advantage, lower risk of thromboembolic events, and elimination of donor site morbidity, we hypothesize that the proportion of AR is declining compared to reconstruction using implants, and that the demographics of AR patients are evolving to be more diverse.

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Methods

The SEER database is a publicly available dataset organized by the National Cancer Institute's Surveillance Research Program. This database samples approximately 50% of cancer care occurring within the U.S., containing de-identified demographic, oncologic, and outcome data directly from medical records. As a population-based dataset, the SEER utilises trained registrars to collect information from all clinical settings that diagnose or treat cancer, covering a representative portion of the U.S. population. Our study accessed the SEER 17 registry, providing comprehensive insight across 17 geographic regions in the U.S. to allow for representative analysis of nationwide trends in care. Using the SEER*Stat software Version 8.4.2, patients were selected for inclusion based on demographic and oncologic features. Female patients who developed breast cancer requiring unilateral radical mastectomy between 2000 and 2020 were included in this study, providing a 20-year span of surgical data to allow for longitudinal trend analysis. Patients were identified using SEER-specific procedural codes for modified radical mastectomy (codes: 50–59, 63) and radical mastectomy (codes: 60–62, 64–69, 73–74). Patients undergoing other types of breast operations were excluded from this sample.

Detailed demographic (e.g., age, race, income, marital status) and oncologic (e.g., laterality, history or radiation, history of chemotherapy) variables were collected for each patient. The primary outcome measured was occurrence and type of any reconstruction after unilateral radical mastectomy. All reconstruction occurring within four months of initial mastectomy was defined as immediate by the SEER variable dictionary; delayed reconstruction after the four-month window is not included in this database. The type of reconstruction was classified as either using implants (codes: 55, 59, 66, 73), autologous tissues (codes: 54, 58, 65, 69), or a combination of reconstruction techniques/approach not otherwise specified (codes: 53, 56, 57, 63, 64, 67, 68, 74).

The overall demographic and oncologic features of all females who underwent unilateral radical mastectomy were summarised. Then, in subgroup analysis, direct comparisons were assessed between those receiving immediate implant reconstruction versus those receiving AR. Additionally, unilateral radical mastectomy patients from 2000 to 2010 were compared to those undergoing unilateral radical mastectomy from 2010 to 2020 to assess for significant demographic changes between decades. All comparisons were performed using chi-square tests, with significance set at an alpha of 0.05. All statistics were calculated using R and RStudio, and corresponding figures were prepared using the "ggplot" package in R Studio. The SEER database consists only of publicly available and de-identified patient data and is therefore exempt from institutional review.

Ethics

This project was reviewed by the Committee on Clinical Investigations at Beth Israel Deaconess Medical Center, does not constitute human subjects research, and is in accordance under IRB protocol 2024D000464.

Results

Demographics of IBR versus AR patients

A total of 25,649 patients were included in our study with 51.8% undergoing IBR (13,287) and 48.2% undergoing AR (12,362). Complete summary statistics of the sample are included in Table 1, detailing age, race, and median household income of IBR patients compared to patients undergoing AR.

AR patients appeared to be younger, with a larger distribution of AR patients in the 40–49 (34% vs. 32%) and 50–59 (33% vs. 30%) age range compared to a larger 60–69 (18% vs. 16%) and 70–79 (5.4% vs. 3.7%) age range distribution for IBR patients.

There was a greater amount of AR patients who identify as Black compared to the IBR sample (12% vs. 9%), while there were more White patients in the IBR group (84% vs 81%).

AR patients appeared to have a higher median household income, with a larger proportion being in the $75,000+ compared to IBR patients (49% vs. 45%), which had a larger proportion in the $55,000 – $64,999 (18% vs. 16%) and $65,000 – $74,999 (28% vs 25%) median household income. AR patients also came from rural households less frequently compared to IBR patients (6.6% vs. 8.8%; $p < 0.00001$).

Popularity of IBR versus AR

The number of total unilateral immediate breast reconstructions logged in the SEER database ranged from 19,410 in 2000 to 2009 to 17,675 between 2010 and 2020. Between 2000 to 2008, AR was more

Table 1. Demographic summary by type of reconstruction after radical mastectomy from 2000 to 2020

	Implant based reconstruction	Autologous reconstruction	*P*
Total patients, *n*	13,287	12,362	
Age (%)	Median age: 50–54	Median age: 50–54	< 0.00001
< 30 years	224 (1.7)	157 (1.3)	
30–39 years	1,785 (13)	1,494 (12)	
40–49 years	4,217 (32)	4,205 (34)	
50–59 years	3,928 (30)	4,018 (33)	
60–69 years	2,362 (18)	1,955 (16)	
70–79 years	713 (5.4)	456 (3.7)	
80+ years	58 (0.43)	77 (0.62)	
Race (%)			< 0.00001
White	11,138 (84)	10,038 (81)	
Black	1,200 (9.0)	1,493 (12)	
Asian	852 (6.4)	745 (6.0)	
Other/Unknown	97 (0.73)	86 (0.70)	
Hispanic (%)	1,325 (10)	1,238 (10)	0.9264
Median household income (%)			< 0.00001
< $45,000	433 (3.3)	450 (3.6)	
$45,000 – $54,999	892 (6.7)	856 (6.9)	
$55,000 – $64,999	2,362 (18)	1,957 (16)	
$65,000 – $74,999	3,678 (28)	3,096 (25)	
$75,000+	5,922 (45)	6,003 (49)	
Rural household (%)	1,167 (8.8)	851 (6.9)	< 0.00001
Married (%)	8,896 (67)	8,231 (67)	0.5388

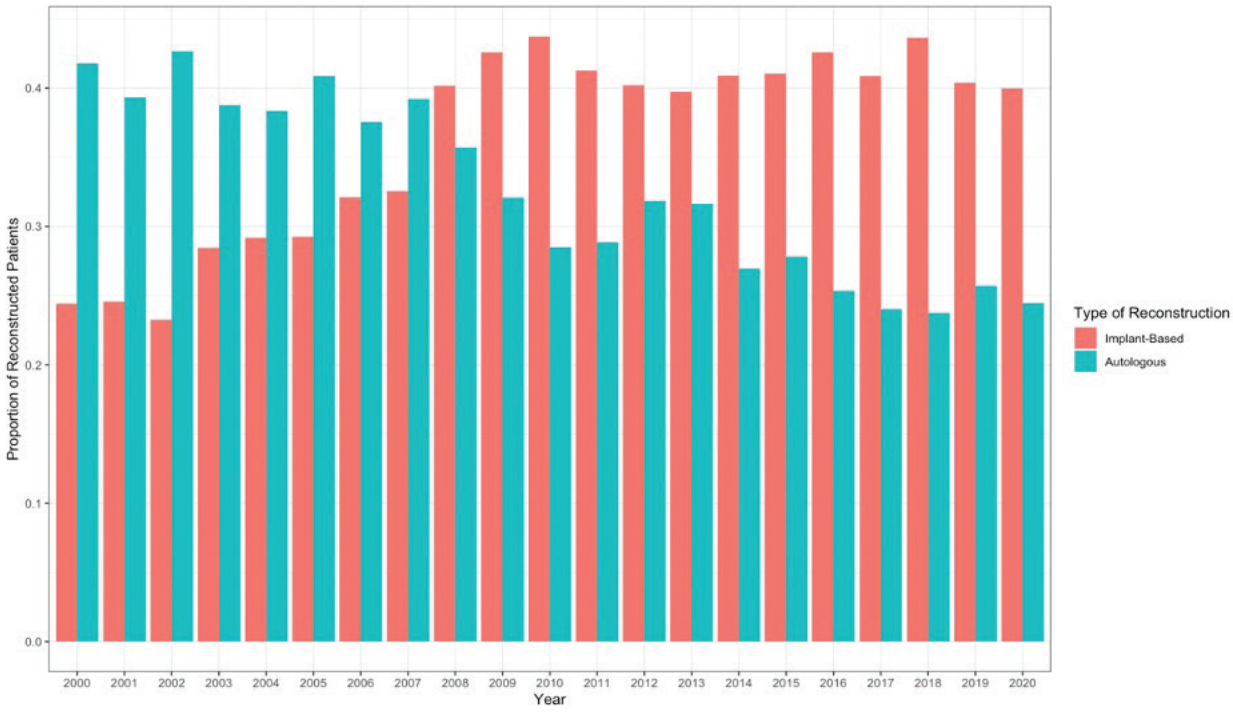

Figure 1. Proportional frequency of breast reconstruction by type of reconstruction.

popular in every year than IBR, with an average difference in the percentage of total reconstructions of 10.0%. Since 2000, AR's percentage of total reconstructions in the SEER database decreased from 41.8% to 24.5% in 2020. Meanwhile, IBR's percentage of total reconstruction increased from 24.4% to 40.0% in 2020, becoming the most popular reconstructive method (Figure 1).

Oncologic management differences between IBR and AR

There were significant differences in oncologic treatments provided prior to unilateral immediate breast reconstruction between AR and IBR patients. Autologous reconstruction patients were less likely to have undergone chemotherapy treatment (61% vs. 64%; $p < 0.00001$) or radiation compared to IBR patients (30% vs. 36%; $p < 0.0001$). AR patients also had a statistically significant longer time to initial treatment (1.07 vs. 1.04 months, $p < 0.05$; Table 2).

Demographic changes from 2000 to 2009 and 2010 to 2020 AR patients

There were significant differences in the demographics of the 7474 AR patients from 2000 to 2009 and the 4888 AR patients from 2010 to 2020. Direct between-decade comparison of AR patients is detailed in below (Table 3).

AR in the decade 2010–2020 appeared to be older, with more patients in the 60–69 (19% vs. 14%) and 70–79 (4.8% vs 3.0%) age range compared to the prior decade with more patients aged 40–49 (35% vs. 31%) and 50–59 (34% vs. 31%) in 2000–2009.

There was an increase in the percentage of Black (14% vs. 11%) and Asian (7.8% vs. 4.9%) patients who underwent AR from 2000–2009 to 2010–2020, while there was a greater proportion of White (84% vs. 77%) AR patients in the first decade.

Additionally, there was a decrease in median income of those undergoing AR over the measured timeframe. AR patients in 2010–2020 less frequently made $75,000+ median household income range compared to the decade prior (41% vs 54%).

Finally, more AR patients were Hispanic compared to the prior decade of patients (13% vs 8.3%; $p < 0.00001$), were less likely to live in a rural household (5.3% vs. 7.9%; $p < 0.00001$), and were less likely to be married (64% vs. 69%; $p < 0.00001$).

Discussion

Our study found that IBR became increasingly more popular compared to AR from 2000 to 2020 in the immediate reconstructive care of patients who underwent unilateral radical mastectomy in the U.S. This finding mirrors statistics on overall breast reconstruction trends from available American Society of Plastic Surgeons (ASPS) 2010–2020 Reports, with IBR accounting for an average of 79% of

Table 2. Oncologic summary of patients by type of reconstruction after radical mastectomy from 2000 to 2020

	Implant based reconstruction	Autologous reconstruction	*P*
Laterality of malignancy (%)			0.8046
Right	6,606	6,159	
Left	6,678	6,199	
History of chemotherapy (%)	8,540 (64)	7,533 (61)	<0.0001
History of radiation (%)	4,756 (36)	3,669 (30)	<0.0001
Mean months to treatment, months (SD)	1.04 (1.08)	1.07 (1.12)	0.0216

SD: standard deviation.

Table 3. Demographic changes of those who receive autologous breast reconstruction in 2000–2009 versus in 2010–2020

	2000–2009	2010–2020	*P*
Total autologous patients (*n*)	7,474	4,888	
Age (%)			< 0.00001
< 30 years	84 (1.1)	73 (1.5)	
30–39 years	906 (12)	588 (12)	
40–49 years	2,583 (35)	1,522 (31)	
50–59 years	2,521 (34)	1,497 (31)	
60–69 years	1,011 (14)	944 (19)	
70–79 years	221 (3.0)	235 (4.8)	
80+ years	48 (0.64)	29 (0.59)	
Race (%)			
White	6,255 (84)	3,783 (77)	< 0.00001
Black	816 (11)	677 (14)	< 0.00001
Asian	366 (4.9)	379 (7.8)	< 0.00001
Other/unknown	37 (0.50)	49 (1.0)	0.00133
Hispanic (%)	623 (8.3)	615 (13)	< 0.00001
Median household income (%)			< 0.00001
< $45,000	239 (3.2)	211 (4.8)	
$45,000 – $54,999	451 (6.0)	405 (8.3)	
$55,000 – $64,999	1,065 (14)	892 (18)	
$65,000 – $74,999	1,701 (23)	1,395 (29)	
$75,000+	4,018 (54)	1,985 (41)	
Rural household (%)	590 (7.9)	261 (5.3)	< 0.00001
Married (%)	5,120 (69)	3,111 (64)	< 0.00001

total breast reconstruction procedures done in that period [14]. IBR accounted for 80.0% of breast reconstructions in 2016–2020, increasing from rates the five years prior [14]. Unfortunately, there were no reliable reports from the U.S. to compare IBR and AR rates prior to 2010. However, Unukovych et al. evaluated breast reconstruction patterns among women who underwent mastectomy in 2000, 2005, and 2010 in a national long-term follow up study in Sweden, revealing that 58% of patients underwent IBR whereas 31% of patients underwent AR [15]. While a multitude of factors ranging from satisfaction, complication rates, and physician and patient preference contribute to whether a patient undergoes IBR or AR, the dramatic increase in IBR popularity over AR, despite increased patient satisfaction with AR was surprising.

A 2022 systemic review by Broyles et al. found that patients undergoing AR had clinically significant better sexual well-being and greater satisfaction [10]. Broyles et al. also found that AR was associated with a greater risk of venous thromboembolism, but that IBR was associated with a greater risk of reconstructive failure in long-term follow-up [10]. Another study by Gümüscü et al. analysed survey data from the Swedish National Breast Cancer Registry, revealing that AR was associated with higher levels of satisfaction with both surgical outcomes and breast appearance, as well as overall physical well-being, as compared to IBR [11]. AR may also be less preferred to IBR as a 2022 study done by Hu et al. found that AR was associated with longer operations, longer lengths of stay, and increased complications [13]. The financial costs of AR compared to IBR may also be driving factor for increased IBR over AR rates [16–18). Despite Lemaine et al. finding that the costs of AR and IBR were comparable after 2 years, IBR may be preferred by patients due to smaller initial upfront costs compared to AR. Lemaine et al. also found that the increased healthcare usage over a 2-year period by IBR patients compensated for the initial price differential, leading to a similar average total cost of breast reconstruction with AR patients [16]. Similarly, over a 1-year period, Berlin et al. found that AR costs were significantly higher than IBR [18]. Furthermore, Oleru et al. found that median out-of-pocket costs are significantly higher for AR than IBR. Patients may be increasingly price sensitive to both initial and out-of-pocket costs and therefore elect to undergo IBR over AR. Physicians may also be financially incentivised to pursue IBR over AR [19]. Odom et al. found that physician reimbursement for IBR was higher across Medicaid, Medicare, and private insurance compared to AR [20]. When adjusting for the duration of procedures, Odom et al. also found that IBR had a higher average per hourly physician reimbursement rate compared to AR for both unilateral and bilateral reconstruction [20]. While AR may generally yield more satisfaction than IBR, it may be that physicians and patients are at heightened aversion to venous thromboembolism and other complications, longer operations, greater initial financial costs, decreased physician reimbursements, and longer lengths of stay particularly among a subgroup of patients who have already undergone more extensive breast surgery, which results in the more frequent decision to pursue IBR.

In terms of oncologic management, our study found that AR patients were less likely to have undergone chemotherapy and were less likely to have undergone radiation therapy than IBR patients. To our knowledge, there has not been a study directly comparing the rates and reasons of AR and IBR for patients who underwent a radical mastectomy with chemotherapy and/or irradiation. A systemic review by Nag et al. found that that there is generally no difference in overall complication, reconstruction loss, or surgical site infection rates between AR and IBR with respect to non-adjacent chemotherapy [21]. Furthermore, a study by Hart et al. found that patients undergoing IBR or AR did not have statistically different likelihoods of complications nor differences in satisfaction with reconstruction or psychosocial well-being [22]. Previous literature prefers AR over IBR in the context of irradiated tissue due to higher patient-reported satisfaction and lower risk of complications [12, 23]. In the context of this study, with patients undergoing modified radical and radical mastectomy coupled with a history of chemotherapy and/or radiation therapy likely indicates a more advanced stage cancer and an indication for a large reconstructive defect that may have limited the desire and feasibility for more extensive reconstructive operations. Larger and more complicated defects may sway physicians and patients towards shorter operative and recovery times, and the avoidance of donor site morbidity [22]. Therefore, there may be a preference for physicians to choose IBR over AR in this context.

Understanding the impact of socioeconomic and cultural factors on access to appropriate care is crucial to ensuring health equity. Our study found that there were significant demographic differences between patients undergoing AR and patients undergoing IBR. In 20 years of SEER data, patients undergoing AR were more likely to be Black, younger, have higher income, and be less rural than patients

undergoing IBR. Additionally, we find that over time, more Black or Asian, Hispanic, older, lower income, and less rural patients received AR. A 2022 study by Hu et al. using the ACS-NSQIP database (2010–2019) to examine overall reconstruction rates for bilateral prophylactic mastectomies similarly found that patients who underwent AR were more likely to be Black and that patients who underwent IBR were more likely to be White [13]. Interestingly, there is evidence arguing that minority women often avoid reconstruction compared to White women [24–26]. One study by Soni et al. found that African American patients were less likely to receive post postmastectomy breast reconstruction than White patients [27]. Another study by Kruper et al. found that Asian patients were one-fifth as likely to undergo reconstruction compared to White patients [28]. The reasons as to why there is an increasing diversity of AR patients, particularly Black and Asian patients, complements current literature surrounding demographic differences in reconstructive surgery, promisingly suggesting increased access to and use of reconstructive options.

Our study found that AR patients were younger than IBR patients. However, in Hu et al.'s cohort of post-bilateral mastectomy breast reconstruction patients, IBR, rather than AR patients were younger [13]. This perceived difference may be due to the different years of data analysed. Our study is based on data from 2000 to 2020, while Hu et al.'s cohort is based on data from 2010 to 2019; therefore, our finding of younger patients receiving AR over IBR may be more reflective of a longer reconstructive trend. This hypothesis holds consistent with our data as there was an older age distribution of AR patients from 2010 to 2020 compared to 2000–2009, which is in line with Hu et al.'s findings. Younger patients may be pursuing implant based radical mastectomy reconstruction because the significant surgical deformity left after this more-invasive operation may prompt younger patients to desire a more substantial, longer-lasting treatment as AR generally lasts the lifetime of a patient while IBR requires additional surgeries [29, 30]. Older patients may be more likely to undergo AR over time as reflective of the increased accessibility of this treatment option to groups who were previously recommended IBR. This can also be partially explained as older AR patients seem to have greater physical higher psychosocial well-being scores than younger AR women [31].

There were also differences in income distribution as AR patients were more likely to be in a higher income distribution than IBR patients. This can be explained by the prices of AR and IBR as traditionally the initial costs of AR appear to be greater than IBR but may be equal longer term [16, 18]. Advances in both surgical techniques and payment methods may reduce the differences in costs to patients and explain why 2010–2020 AR patients have a lower income distribution compared to 2000–2009 AR patients.

Although our study provides novel demographic trends in patients undergoing AR or IBR in the U.S., there are several limitations. Principally, inherent to the SEER database, only immediate reconstructive data is recorded, limiting a complete understanding of all reconstruction patterns for patients undergoing radical mastectomy. Significantly delayed reconstruction (greater than four months between mastectomy and reconstruction) is not included. Despite this limitation, our dataset is very large and contains nationally representative data of all immediate and shortly delayed (occurring within four months of mastectomy) data, providing detailed information of the reconstructive trends for this important patient population. Lastly, while the findings provide valuable insights into reconstructive trends in the U.S., their applicability to other countries may be limited due to differences in healthcare systems, cultural preferences, availability of reconstructive techniques, and variations in insurance coverage.

Conclusion

Our analysis of trends in IBR and AR over time reveals noteworthy shifts in the immediate reconstructive care of patients who undergo unilateral radical mastectomy. IBR has demonstrated a growing popularity compared to AR. Furthermore, there are interesting differences in demographics between those who receive IBR and AR. AR patients were less likely to undergo chemotherapy and/or radiation, and often experienced a longer time to reconstruction. AR patients were more likely to be Black, younger, have higher incomes, and come from less rural backgrounds than patients undergoing IBR. We also found that AR became increasingly frequent in Black or Asian, Hispanic, older, and lower income populations in the latter half of the measured timeframe indicating increases in accessibility to this form of care.

As immediate reconstructive trends continue to evolve to address the unique needs of patients who undergo unilateral radical mastectomy, the insights derived from the SEER database serve as a valuable resource for both reconstructive surgeons and patients, aiding in optimised decision-making.

Disclosure statement

The authors report there are no competing interests to declare.

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