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Original Research

Effects of Breast-Conserving Surgery Combined with Sentinel Lymph Node Biopsy on Breast Cosmetic Appearance and Systemic Stress of Patients with Breast Cancer

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Abstract

Background: We aimed to evaluate breast-conserving surgery plus sentinel lymph node biopsy in affecting breast cosmetic appearance and systemic stress of breast cancer patients. **Methods**: A total of 150 early breast cancer patients admitted between January 2020 and September 2022 were retrospectively analyzed. Propensity score matching was performed to minimize selection bias based on baseline characteristics, resulting in two matched groups of 55 patients each. The observation group received breast-conserving surgery and sentinel lymph node biopsy, while the control group underwent breast-conserving surgery and axillary lymph node dissection. **Results**: The observation group experienced shortened operation time and extubation time compared with the control group, and there were significantly different blood losses between the two groups ($p < 0.05$). The observation group was significantly superior to the control group in terms of the postoperative quality of life ($p < 0.05$). After treatment, the levels of plasma procalcitonin (PCT) and tumor necrosis factor-α (TNF-α) in the two groups decreased. By contrast to those in the control group, PCT, TNF-α, carcinoembryonic antigen and carbohydrate antigen 125 presented significantly reduced levels in the observation group following treatment ($p < 0.05$). The observation group, compared to the control group, exhibited significant improvement of the breast appearance ($p < 0.05$). No significant difference was observed between the two groups regarding human epidermal growth factor receptor-2 (HER-2) expression ($p > 0.05$). **Conclusion**: Breast-conserving surgery and sentinel lymph node biopsy are simple and can reduce the complications and benefit the recovery of patients.

Keywords: biopsy; breast cancer; sentinel lymph node; stress; surgery

1. Introduction

Breast cancer (BC) refers to a ubiquitous malignancy in females, without obvious symptoms. It is mainly manifested as nipple discharge, breast mass, breast skin abnormalities and other local symptoms in the early stage [1]. The incidence of BC in women is 24%, seriously endangering their health [2,3]. At present, the diagnosis, staging and treatment of BC have attracted widespread attention. Conventional total mastectomy causes great trauma and many complications and is time-consuming, so it seriously affects patients' quality of life after surgery [4]. Breast-conserving surgery combined with radiotherapy and chemotherapy for early BC (EBC) can significantly ameliorate the function of the affected limb while greatly improving patients' quality of life [5]. Sentinel lymph node usually serves as a metastatic site of BC, so sentinel lymph node biopsy can be used as a novel diagnostic approach [6].

Procalcitonin (PCT) is widely used as a biomarker for systemic inflammatory response and infection. During such surgeries as breast-conserving surgery, elevated PCT levels can reflect postoperative inflammatory stress, which provides insight into the systemic response to the surgical intervention [7]. Besides, tumor necrosis factor-α (TNF-α), an essential cytokine influencing inflammation and immune responses, plays a critical role in cancer progression. Measuring TNF-α before and after surgery allows the evaluation of inflammatory responses triggered by both the cancer itself and the surgery [8]. Moreover, although primarily associated with ovarian cancer, carbohydrate antigen 125 (CA125) can also be elevated in BC and other malignancies. Its measurement provides additional insight into the tumor burden and the overall systemic impact of the cancer [9]. Furthermore, carcinoembryonic antigen (CEA) is a well-established tumor marker for several cancers, including BC. It is used to monitor tumor presence, recurrence, or progression [10]. Thus, the evaluation of these levels pre- and post-operation can help monitor the impact of breast-conserving surgery on BC patients.

Thereby motivated, the changes in the breast cosmetic appearance and systemic stress of BC patients after different surgical methods were compared, aiming at laying a theoretical foundation for the rational selection of surgical methods.

2. Materials and Methods

2.1 Subjects

The protocol was approved by the Ethics Committee of Nanjing First Hospital, Nanjing Medical University (approval number: KY20230615-02-KS-01) on June 26th, 2023. Initially, a total of 150 early breast cancer patients hospitalized for surgery herein between January 2020 and September 2022 were identified, including 80 patients in the observation group (breast-conserving surgery + sentinel lymph node biopsy) and 70 patients in the control group (breast-conserving surgery + axillary lymph node dissection). After propensity score matching using the nearest-neighbor method with a caliper width of 0.2 to ensure robust comparability, 55 matched patients were included in each group for the final analysis. The key baseline characteristics (age, tumor size, etc.) were evaluated to confirm that the two groups were well-matched, without statistically significant differences. To protect patient confidentiality, the following measures were implemented: data anonymization, confidential storage, minimization of identifiable information, and secure communication.

In the control group, the diameter of tumor was <2 cm in 23 cases and ≥ 2 cm in 32 cases. The lesions were located in the inferior medial breast in 4 cases, superior medial breast in 7 cases, inferior lateral breast in 10 cases, and superior lateral breast in 19 cases. Histologically, there were 32 and 8 cases of invasive ductal carcinoma and invasive lobular carcinoma, respectively. Among them, American Joint Committee on Cancer (AJCC) stage I in 29 cases and stage II in 11 cases were detected. In the observation group, the diameter of tumor was <2 cm in 24 cases and ≥ 2 cm in 31 cases. The lesions were located in the inferior medial breast in 3 cases, superior medial breast in 6 cases, inferior lateral breast in 11 cases, and superior lateral breast in 20 cases. Histologically, invasive ductal carcinoma and invasive lobular carcinoma were recorded as 29 and 11 cases, respectively. Among them, 30 cases were in AJCC stage I and 10 cases were in stage II. All enrolled patients were classified according to the classification criteria for BC in the *Diagnosis and Treatment Guidelines for Breast Cancer* (2011 Edition) [6].

2.2 Inclusion and Exclusion Criteria

The under-mentioned inclusion criteria were adopted: (1) patients eligible for the criteria for BC diagnosis, (2) those with lesions less than 3.0 cm in size, (3) those with single lesions ≥ 2 cm away from the areola margin, and (4) those who could tolerate the operation and had no contraindication to intraoperative anesthetics.

The exclusion criteria involved: (1) patients with non-primary BC, (2) those with severe damage to the heart, cerebrovascular system, liver, kidney or other organs, or (3) those with local lymph node metastasis or distant organ metastasis. All patients were informed of details of the treatment and signed surgical protocols.

2.3 Operation Methods

Axillary lymph node dissection + breast-conserving surgery were implemented for the control group. Under general anesthesia and intubation, the patient lay flat, with the upper limb abducted by 90°. The breast shape and weight and the location and size of tumors were detected in advance. The tumor was excised. With the nipple as a plane, the breast skin surface was made with an arc incision if the tumor was above the plane, while the breast skin surface was made with a radial incision if the tumor was below the plane. The excision extent was at least 2 cm away from the tumor boundary to ensure that the tumor tissue was completely removed. The incisal margin was sent for pathological biopsy, and tissue excision was repeated if it was tested positive. Routine axillary lymph node dissection: An oblique incision parallel to the axillary fold line was made for ipsilateral axillary lymph node dissection, with the anterior end inside the lateral edge of the pectoralis major and the posterior end not exceeding the lateral edge of the latissimus dorsi. If the armpit was narrow, a U-shaped incision was made. Group I lymph nodes (i.e., subaxillary group: lateral to pectoralis minor, including lateral mammary, central, subscapular and axillary venous lymph nodes, and lymph nodes between pectoralis major and pectoralis minor) and group II lymph nodes (i.e., midaxillary group, including axillary venous lymph nodes deep to pectoralis minor) were dissected during operation.

The observation group was treated with breast-conserving surgery + sentinel lymph node biopsy. Under general anesthesia, breast-conserving surgery was conducted by the same surgeons in the same way as that for the control group. Meanwhile, axillary lymph node biopsy with nano-carbon suspension was performed. Specifically, 0.4–0.6 mL of nano-carbon suspension was injected into the breast tissue at the direction of 3, 6, 9 and 12 o'clock. The injection site under the skin at the direction of 12 o'clock or near the intraoperative biopsy site was gently massaged to make the staining solution move faster. About 10 min after the staining solution was injected, the pectoralis major muscle layer was carefully incised at the level of the third rib to find the stained lymphatic vessels from bottom to top and from inside to outside. After the sentinel lymph nodes were identified, all the stained lymphatic vessels were removed, and intraoperative tissue sections and postoperative paraffin sections were prepared. Sentinel lymph nodes were evaluated on the basis of rapid pathological examination, and axillary lymph nodes were dissected if they were tested positive.

2.4 Observation of Indicators

Comparisons and analyses were conducted on the extubation time, intraoperative blood loss, mean operation time, and postoperative drainage volume.

The World Health Organization Quality of Life Scale was employed to assess patients' quality of life, mainly cov-

Table 1. Clinical indicators of patients ($\bar{x} \pm$ SD).

Group	n	Extubation time (h)	Intraoperative blood loss (mL)	Operation time (min)	Postoperative drainage volume (mL)	Length of stay (d)
Control	55	10.47 ± 6.47	203.74 ± 22.35	90.24 ± 9.12	300.24 ± 3.88	6.49 ± 1.21
Observation	55	5.24 ± 0.92	84.34 ± 9.68	68.13 ± 7.08	126.24 ± 5.12	3.29 ± 0.78
t		5.935	36.356	14.202	200.872	16.485
p		<0.001	<0.001	<0.001	<0.001	<0.001

$\bar{x} \pm$ SD, mean ± standard deviation; *t*, *t* value.

Table 2. Stress indicators before and after operation ($\bar{x} \pm$ SD).

Group	n	TNF-α (pg/mL)		PCT (ng/mL)	
		Before operation	After operation	Before operation	After operation
Control	55	1.68 ± 0.17	3.65 ± 0.38	2.77 ± 0.34	6.53 ± 0.68
Observation	55	1.66 ± 0.23	2.74 ± 0.27	2.68 ± 0.35	4.12 ± 0.57
t		0.519	14.476	1.368	20.143
p		0.605	<0.001	0.174	<0.001

TNF-α, tumor necrosis factor-α; PCT, plasma procalcitonin.

ering cognitive function, social function, emotional function, physical function and general health, with 100 points for each item. The higher the score was, the better the quality of life would be [11].

The Functional Assessment of Cancer Therapy-Breast (FACT-B) was applied for evaluation of patients' social adaptability. The range of FACT-B scores was 0–144 points, and a higher score indicated stronger social adaptability.

Elbow venous blood (10 mL) was collected from all patients before and at 72 h after operation, and centrifuged at 4000 r/min to obtain the supernatant. Then enzyme-linked immunosorbent assay was carried out to determine the levels of PCT and TNF-α, and those of serum CA125 and CEA were measured by chemiluminescence assay and radioimmunoassay, respectively.

The postoperative cosmetic effect (excellent, good and poor) was evaluated according to the Joint Center for Radiation Therapy criteria [12].

Human epidermal growth factor receptor-2 (HER-2) expression was determined by staining of cancer cell membrane: (+++), (++), (+) and (–).

2.5 Statistical Analysis

Statistical analysis was completed by means of SPSS 19.0 software (IBM Inc., Armonk, NY, USA). The expression format of mean ± standard deviation ($\bar{x} \pm$ SD) was selected for continuous variables, and the independent samples *t*-test for normally distributed data was adopted for between-group comparisons. The Shapiro-Wilk test was performed to appraise the normality of distribution. In case of non-normally distributed data, the Mann-Whitney U test was used as a non-parametric alternative. Relative frequencies (percentages) were applied to describe categorical variables, which were subjected to the Chi-square (χ^2) test or Fisher's exact test for comparison. The rank-sum test was used to compare the rank data. Multiple comparisons were conducted across multiple variables, and potential type I errors were adjusted through the Bonferroni correction. $p < 0.05$ signified a difference of statistical significance.

3. Results

3.1 Clinical Indicators of Patients

The observation group had significantly shortened extubation time and operation time, as well as decreased intraoperative blood loss and postoperative drainage volume contrasted with the control group ($p < 0.05$) (Table 1).

3.2 Stress Indicators Prior and Subsequent to Operation

Before operation, TNF-α and PCT levels showed no significant between-group differences ($p > 0.05$). After operation, TNF-α and PCT levels significantly declined in the two groups, with significant inter-group differences ($p < 0.05$) (Table 2).

3.3 Levels of CEA and CA125 before and after Operation

The levels of CEA and CA125 in the two groups were not significantly different before operation. Both levels significantly declined after operation, and by contrast to those in the control group, such levels presented significant decreases in the observation group ($p < 0.05$) (Table 3).

3.4 Postoperative Quality of Life Scores

Compared to the control group, the observation group displayed significantly raised scores of cognitive function, social function, emotional function, physical function and general health ($p < 0.05$) (Table 4).

Table 3. Pre- and post-operative content of CEA and CA125 ($\bar{x} \pm$ SD).

Group	n	CEA (ng/mL)		CA125 (U/mL)	
		Before operation	After operation	Before operation	After operation
Control	55	1.55 ± 0.26	1.33 ± 0.23	10.95 ± 2.57	8.68 ± 2.53
Observation	55	1.47 ± 0.25	1.14 ± 0.21	10.78 ± 2.73	7.01 ± 2.06
t		1.645	4.524	0.336	3.796
p		0.103	<0.001	0.737	<0.001

CEA, carcinoembryonic antigen; CA125, carbohydrate antigen 125.

Table 4. Scores on quality of life after operation ($\bar{x} \pm$ SD, point).

Group	n	Cognitive function	Social function	Emotional function	Physical function	General health
Control	55	76.52 ± 12.83	75.52 ± 19.21	70.48 ± 22.14	71.65 ± 17.43	76.50 ± 11.72
Observation	55	85.57 ± 11.79	86.45 ± 19.35	82.45 ± 19.58	83.55 ± 11.32	89.21 ± 16.65
t		3.852	2.973	3.004	4.246	4.629
p		<0.001	0.004	0.003	<0.001	<0.001

Table 5. FACT-B scores before and after operation ($\bar{x} \pm$ SD, point).

Group	n	Before operation	6 months after operation
Control	55	48.59 ± 9.65	105.54 ± 15.34
Observation	55	49.18 ± 10.14	74.87 ± 12.75
t		0.315	11.403
p		0.755	<0.001

FACT-B, Functional Assessment of Cancer Therapy-Breast.

3.5 FACT-B Scores before and after Operation

The two groups were not significantly different in terms of FACT-B score before operation. However, the FACT-B score rose significantly in both groups at 6 months following operation in comparison with that before operation, and the observation group, contrasted with the control group, had a significantly higher score ($p < 0.05$) (Table 5).

3.6 Breast Appearance

The observation group had 32 excellent cases, 17 good cases and 6 poor cases. One patient died, one patient relapsed, and one patient underwent bone metastasis. Totally 23 excellent cases, 10 good cases and 22 poor cases were recorded in the control group. Two patients died, two patients relapsed, and two patients underwent bone metastasis. The good appearance rate had a statistically significant between-group difference (89.09% *vs*. 60.0%) ($p < 0.05$). No significant differences were observed between the control group and the observation group regarding the postoperative mortality rate, recurrence rate and metastasis rate (1.82% *vs*. 3.64%, 1.82% *vs*. 3.64%, 1.82% *vs*. 3.64%) ($p > 0.05$) (Table 6).

3.7 HER-2 Expressions

In the observation group, 18 cases were HER-2 (+), 2 cases were HER-2 (++), 14 cases were HER-2 (+++), and 21 cases were HER-2 (–). The control group was detected with 6, 5, 26 and 18 cases of HER-2 (+), HER-2 (++), HER-2 (+++) and HER-2 (–), respectively. The difference in the expression of HER-2 between the two groups was of no statistical significance (Z = 0.881, $p = 0.379$).

4. Discussion

The pathogenesis of BC may be related to heredity, abnormal secretion of progesterone and estradiol, early menarche, infertility and other factors [13,14]. EBC poses less threat to women's health, but as the disease progresses, tumor cells may metastasize distantly, causing multiple organ lesions that may lead to death [15]. The safety of breast-conserving surgery has been verified [16,17], and it can exert the similar clinical efficacy to total mastectomy. This safe and effective procedure has been applied in more than 50% of patients with EBC [18]. Some minimally invasive procedures, such as sentinel lymph node biopsy, have been performed for elderly EBC patients with hypertension, heart disease and diabetes mellitus [19–21]. They are rapid, safe and effective, which can effectively improve patients' quality of life.

The observation group in the present study experienced significantly shorter operation time, smaller blood loss during operation, and quicker recovery after operation than the control group. These results are consistent with a growing body of evidence supporting the benefits of breast-conserving surgery plus sentinel lymph node biopsy in EBC patients. For instance, Giuliano *et al*. [22] reported that sentinel lymph node biopsy achieved comparable long-term survival outcomes to axillary lymph node dissection, while significantly reducing the risk of lymphedema and other postoperative complications. Meanwhile, this combination can give better functional outcomes and cosmetic satisfaction [23]. Lymph node metastasis of BC occurred step by step, and axillary sentinel lymph nodes function as the earliest metastasis site [24]. In the case of a negative sentinel lymph node, the subsequent metastatic lymph node is also negative, so axillary lymph node dissection is unnecessary. Therefore, successful breast-conserving surgery + sentinel

Table 6. Appearance, recurrence and mortality [n (%)].

Group	Excellent	Good	Poor	Death	Relapse	Bone metastasis
Observation	32 (58.18)	17 (30.91)	6 (10.91)	1 (1.82)	1 (1.82)	1 (1.82)
Control	23 (41.82)	10 (18.18)	22 (40.00)	2 (3.64)	2 (3.64)	2 (3.64)
Z/χ^2		2.633		0.000	0.000	0.000
p		0.009		1.000	1.000	1.000

Z, Z value; χ^2, Chi-square value.

lymph node biopsy can reduce surgical trauma. If the lymph nodes are tested negative by nano-carbon staining during operation, the impairment of normal tissues like lymphatic vessels and blood vessels can be reduced, thereby mitigating paresthesia of skin and upper limb dysfunction [25].

Moreover, our study revealed that compared to the control group, the observation group showed lowered postoperative levels of TNF-α and PCT, reflecting a milder inflammatory response in the observation group. Similarly, it has previously been reported that patients undergoing less invasive procedures like sentinel lymph node biopsy had lower postoperative cytokine levels and faster recovery [26]. Surgical treatment is invasive and causes physical stress responses. In breast-conserving surgery plus sentinel lymph node biopsy, stress response can be alleviated by reducing operation time and relieving wound reaction [27].

Regarding the quality of life, observation group exhibited significant improvement. As the combination preserved breast shape and function, patients reported better body image and less emotional distress, which, as indicated by our study, contributed to a better prognosis. Likewise, Kridis *et al*. [28] performed breast-conserving surgery in combination with sentinel lymph tissue biopsy on BC sufferers. As a result, the effective rate reached 93.30%, the postoperative quality of life was significantly ameliorated, whereas the recurrence rate was greatly decreased.

Nevertheless, such limitations as a small sample size and short study time exist in this study. In the future, the role of this surgical method remains to be further confirmed by long-term follow-up studies with large sample sizes, probably involving the trends in recurrence rates, survival, chronic inflammation, and changes in cosmetic results. Additionally, this study focuses on the HER2-positive BC subtype without extensive analysis of other biological subtypes, such as hormone receptor-positive and triple-negative BC. Future studies should include stratification by additional subtypes to evaluate the potential differences in cosmetic outcomes, systemic stress responses, and biomarker changes across the full spectrum of BC patients.

5. Conclusion

To sum up, breast-conserving surgery and sentinel lymph node biopsy for BC patients are able to reduce blood loss, shorten the operation time, mitigate the pressure on patients and enhance their quality of life.

Availability of Data and Materials

All data and materials are available on reasonable request from the corresponding author.

Author Contributions

JJ and JS designed and performed the study, and drafted the paper; XD and GW performed the study and analyzed the data; JX designed the study and significantly revised the paper. All authors read and approved the final manuscript. All authors contributed to editorial changes in the manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Nanjing First Hospital, Nanjing Medical University (approval number: KY20230615-02-KS-01).

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Conflict of Interest

The authors declare no conflict of interest.

References

[1] Amato O, Guarneri V, Girardi F. Epidemiology trends and progress in breast cancer survival: earlier diagnosis, new therapeutics. Current Opinion in Oncology. 2023; 35: 612–619. https://doi.org/10.1097/CCO.0000000000000991.

[2] Benitez Fuentes JD, Morgan E, de Luna Aguilar A, Mafra A, Shah R, Giusti F, *et al*. Global stage distribution of breast cancer at diagnosis: A systematic review and meta-analysis. JAMA Oncology. 2024; 10: 71–78. https://doi.org/10.1001/jamaoncol.2023.4837.

[3] Boman C, Edman Kessler L, Bergh J, Matikas A, Foukakis T. Women with short survival after diagnosis of metastatic breast cancer: A population-based registry study. Breast Cancer Research and Treatment. 2022; 194: 49–56. https://doi.org/10.1007/s10549-022-06591-7.

[4] Su H, Li X, Lv Y, Qiu X. Breast cancer epidemiology and survival analysis of shenyang in northeast china: A population-based study from 2008 to 2017. The Breast Journal. 2022; 2022: 6168832. https://doi.org/10.1155/2022/6168832.
[5] Cejudo-Arteaga S, Guerrero-Ramos MÁ, Kuri-Exome R, Martínez-Cordero E, Farias-Serratos F, Maldonado-Vega M. Epidemiology of breast cancer in Mexican women with obesity as a risk factor. International Journal of Molecular Sciences. 2022; 23: 10742. https://doi.org/10.3390/ijms231810742.
[6] Zhang B, Cao X, Chen J, Chen J, Fu L, Hu X, *et al*. Guidelines on the diagnosis and treatment of breast cancer (2011 edition). Gland Surg. 2012; 1: 39–61 https://doi.org/10.3978/j.issn.2227-684X.2012.04.07.
[7] Hamade B, Huang DT. Procalcitonin: Where are we now? Critical Care Clinics. 2020; 36: 23–40. https://doi.org/10.1016/j.ccc.2019.08.003.
[8] Tseng WC, Lai HC, Huang YH, Chan SM, Wu ZF. Tumor necrosis factor alpha: implications of anesthesia on cancers. Cancers. 2023; 15: 739. https://doi.org/10.3390/cancers15030739.
[9] Li Q, Kong F, Ma J, Wang Y, Wang C, Yang H, *et al*. Nomograms based on fibrinogen, albumin, neutrophil-lymphocyte ratio, and carbohydrate antigen 125 for predicting endometrial cancer prognosis. Cancers. 2022; 14: 5632. https://doi.org/10.3390/cancers14225632.
[10] Baselice S, Castaldo R, Giannatiempo R, Casaretta G, Franzese M, Salvatore M, *et al*. Impact of breast tumor onset on blood count, carcinoembryonic antigen, cancer antigen 15-3 and lymphoid subpopulations supported by automatic classification approach: A Pilot Study. Cancer Control. 2021; 28: 10732748211048612. https://doi.org/10.1177/10732748211048612.
[11] Sinha S, Bhatia R, Narasimamurthy M, Rayne S, Grover S. Epidemiology of breast cancer presentation in Botswana, South Africa, and the United States. The Journal of Surgical Research. 2022; 279: 533–539. https://doi.org/10.1016/j.jss.2022.04.071.
[12] Offersen BV, Boersma LJ, Kirkove C, Hol S, Aznar MC, Sola AB, Kirova YM, Pignol JP, Remouchamps V, Verhoeven K, Weltens C. ESTRO consensus guideline on target volume delineation for elective radiation therapy of early stage breast cancer. Radiotherapy and Oncology. 2015; 114: 3-10. https://doi.org/10.1016/j.radonc.2014.11.030.
[13] El Masri J, Phadke S. Breast cancer epidemiology and contemporary breast cancer care: A review of the literature and clinical applications. Clinical Obstetrics and Gynecology. 2022; 65: 461–481. https://doi.org/10.1097/GRF.0000000000000721.
[14] Smolarz B, Nowak AZ, Romanowicz H. Breast cancer-epidemiology, classification, pathogenesis and treatment (review of literature). Cancers. 2022; 14: 2569. https://doi.org/10.3390/cancers14102569.
[15] Ezeome ER, Yawe KDT, Ayandipo O, Badejo O, Adebamowo SN, Achusi B, *et al*. The African female breast cancer epidemiology study protocol. Frontiers in Oncology. 2022; 12: 856182. https://doi.org/10.3389/fonc.2022.856182.
[16] Levine PH, Veneroso CC. Recent advances in the epidemiology of inflammatory breast cancer. Breast Disease. 2021; 40: 133–142. https://doi.org/10.3233/BD-210014.
[17] Levine PH, Veneroso CC. Erratum to: Recent advances in the epidemiology of inflammatory breast cancer. Breast Disease. 2022; 41: 163. https://doi.org/10.3233/BD-210914.
[18] Gamboa-Loira B, López-Carrillo L, Mar-Sánchez Y, Stern D, Cebrián ME. Epidemiologic evidence of exposure to polycyclic aromatic hydrocarbons and breast cancer: A systematic review and meta-analysis. Chemosphere. 2022; 290: 133237. https://doi.org/10.1016/j.chemosphere.2021.133237.
[19] Zhu J, Wu G, Zhao Y, Yang B, Chen Q, Jiang J, *et al*. Epidemiology, treatment and prognosis analysis of small cell breast carcinoma: A population-based study. Frontiers in Endocrinology. 2022; 13: 802339. https://doi.org/10.3389/fendo.2022.802339.
[20] Latif S, Perveen S, Iqbal M, Ahmed T, Moula Bux K, Jafri SNA. Epidemiology of carcinoma breast in young adolescence women. Cureus. 2022; 14: e23683. https://doi.org/10.7759/cureus.23683.
[21] McDonald JA, Vilfranc CL, Terry MB. The epidemiology of pregnancy-related breast cancers: Are we ready to deliver? Cancer Epidemiology, Biomarkers & Prevention. 2022; 31: 518–520. https://doi.org/10.1158/1055-9965.EPI-21-1445.
[22] Giuliano AE, Ballman KV, McCall L, Beitsch PD, Brennan MB, Kelemen PR, *et al*. Effect of axillary dissection vs no axillary dissection on 10-year overall survival among women with invasive breast cancer and sentinel node metastasis: The ACOSOG Z0011 (Alliance) randomized clinical trial. JAMA. 2017; 318: 918–926. https://doi.org/10.1001/jama.2017.11470.
[23] Gentilini OD, Botteri E, Sangalli C, Galimberti V, Porpiglia M, Agresti R, *et al*. Sentinel lymph node biopsy vs no axillary surgery in patients with small breast cancer and negative results on ultrasonography of axillary lymph nodes: The SOUND randomized clinical trial. JAMA Oncology. 2023; 9: 1557–1564. https://doi.org/10.1001/jamaoncol.2023.3759.
[24] Garcia-Etienne CA, Ferrari A, Della Valle A, Lucioni M, Ferraris E, Di Giulio G, *et al*. Management of the axilla in patients with breast cancer and positive sentinel lymph node biopsy: An evidence-based update in a European breast center. European Journal of Surgical Oncology. 2020; 46: 15–23. https://doi.org/10.1016/j.ejso.2019.08.013.
[25] Pilger TL, Francisco DF, Candido Dos Reis FJ. Effect of sentinel lymph node biopsy on upper limb function in women with early breast cancer: A systematic review of clinical trials. European Journal of Surgical Oncology. 2021; 47: 1497–1506. https://doi.org/10.1016/j.ejso.2021.01.024.
[26] Balbaloglu H, Tasdoven I, Karadeniz Cakmak G. Can inflammatory indices predict sentinel lymph node status in patients with early-stage breast cancer? Medicine. 2023; 102: e34808. https://doi.org/10.1097/MD.0000000000034808.
[27] Kim R, Kawai A, Wakisaka M, Kin T. Current status and prospects of anesthesia and breast cancer: does anesthetic technique affect recurrence and survival rates in breast cancer surgery? Frontiers in Oncology. 2022; 12: 795864. https://doi.org/10.3389/fonc.2022.795864.
[28] Kridis WB, Baklouti F, Lajnaf M, Khmiri S, Toumi N, Chaaben K, *et al*. Epidemiological and clinical characteristics of breast cancer in the southern of Tunisia: about 1067 cases. Breast. 2021; 56: S40.