ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 02 | February - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

TATTOOING BREAST TUMORS PREOPERATIVELY: A STRATEGY FOR DECREASING MASTECTOMY RATES IN NEOADJUVANT CHEMOTHERAPY PATIENTS

Surgery

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ABSTRACT

Background: Breast cancer is the most common cancer among women worldwide, with over 2 million new cases diagnosed annually (1). Neoadjuvant chemotherapy (NAC) has become a standard treatment approach for locally advanced breast cancer, aiming to downstage tumors and increase breast-conserving surgery (BCS) options (2). However, significant tumor shrinkage during NAC can make it challenging for surgeons to localize the tumor site, leading to increased mastectomy rates (3). To address this challenge, various localization techniques have been explored, including wire localization, radioactive seed placement, and tattooing (4). Tattooing breast tumors preoperatively has emerged as a simple and effective strategy to improve surgical outcomes and reduce mastectomy rates (5).

KEYWORDS

INTRODUCTION

Breast cancer treatment has evolved significantly over the years, with a shift towards more conservative approaches (6). BCS has become a preferred treatment option for early-stage breast cancer, offering improved cosmetic outcomes and reduced morbidity (7). However, NAC can lead to significant tumor shrinkage, making it challenging for surgeons to localize the tumor site (8).

Breast tattooing, also known as breast marking or breast localization, has been used for decades to help surgeons identify tumor sites during surgery (9). The concept of tattooing breast tumors preoperatively was first introduced in the 1990s, with the aim of improving surgical outcomes and reducing mastectomy rates (5).

Early Methods (1990s-2000s)- Carbon particle injection: A mixture of carbon particles and saline was injected into the tumor site to create a visible mark (10).

- India ink injection: India ink was used to tattoo the tumor site, providing a visible mark for surgeons (11).

Tattooing breast tumors preoperatively has emerged as a simple and effective strategy to improve surgical outcomes and reduce mastectomy rates (5). This technique involves injecting a small amount of ink or dye into the tumor site before starting NAC, allowing the surgeon to visually identify the tumor location during surgery (4).

Tattooing breast tumors preoperatively offers several advantages, including: Improved tumor localization, Increased BCS rates, Reduced mastectomy rates and Enhanced patient satisfaction.

Evolution of Tattooing Techniques (2010s)
- Ultrasound-guided tattooing: Ultrasound guidance was introduced to improve the accuracy of tattoo placement (12).
- Stereotactic tattooing: Stereotactic guidance was used to tattoo tumors that were not palpable or visible on ultrasound (13).
- Magnetic resonance imaging (MRI)-guided tattooing: MRI guidance was used to tattoo tumors that were only visible on MRI (14).
Modern Tattooing Methods (2015-present)- Charcoal-based tattooing: Charcoal-based ink is used to create a durable and visible mark (15).
- Ink-based tattooing: Various ink-based tattooing methods have been developed, using different types of ink and injection techniques (16).
- Radiofrequency identification (RFID) tagging: RFID tags are implanted near the tumor site to provide a detectable mark (17).

AIM & OBJECTIVE OF THE STUDY:

1. To determine extent of resection (lumpectomy vs mastectomy) post neoadjuvant treatment
2. Percentage of negative resection margins on frozen analysis
3. Rates of clinical and pathological complete response and association with molecular subtype

MATERIALS AND METHODS

A hospital based Prospective study titled, "Tattooing Breast Tumors Preoperatively: A Strategy for Decreasing Mastectomy Rates in Neoadjuvant Chemotherapy Patients" has been carried out in the Department of Oncosurgery, State Cancer Institute, Gauhati Medical College and Hospital for a period of 1year from 1st April 2024 to 31st march 2025

Inclusion Criteria-

1. All operable, noninflammatory breast cancers exceeding 3 cm in diameter (T2–3, N0–2, M0) or any breast cancer which need neoadjuvant as per NCCN Guidelines.
2. Patients with good performance status (ECOG less than equal to 2)
3. Those willing to participate in the study

Exclusion Criteria:

1. All nonoperable breast cancer (M1), early breast cancer.
2. Poor performance status (ECOG ≥3)
3. Age less than 18 years
4. Patient not willing to participate in study.

Ethical Issue-

The study has been ethically approved by the Institutional ethical committee. The patients were explained about the research project and written consent was taken from patients.

We describe a technique where the volume of tumor is carefully mapped out prior to the chemotherapy and the breast is tattooed so that the original tumor margins can be accurately reconstructed at the time of definitive sur gery. This is often, but not always, done in the operating room at the time of sentinel node biopsy and port placement. The patient is positioned exactly as she will be later for the definitive surgery. The tumor extent is mapped out by palpation and ultrasound and correlated with mam mography and magnetic resonance imaging (MRI). The area of tumor involvement is drawn on the breast with a marker. Measurements are taken and an incision planned. Three or 4 small tattoo marks are made and digital photographs are taken. At the time of definitive surgery, the tumor extent and planned incision can be precisely reconstructed.

RESULTS AND OBSERVATION

A total number of 68 patients during a period of 1 year from from 1st April 2024 to 31st March 2025 and who fulfilled the inclusion criteria as per stated were enrolled during the study. The age of the patients varied

from 25 to 56 years with peak incidence in the 5th decade. The mean age of the patient was 44.7 years.

Table 1: Distribution Of Cases Of With Respect To Age

Age range	Total	Percentage
21-30	8	11.76%
31-40	12	17.64%
41-50	26	38.23%
51-60	22	32.35%
Total (N=68)	68	

Table 2: Distribution Of Cases With Respect To Completion Of Chemotherapy

Chemotherapy	No of patients	% of patients
Completed	54	79.4%
Still on chemotherapy	14	20.58%

Table 3: Distribution Of Cases With Respect To Clinical Response

Clinical response	No of patients	% of patients
Complete	30	55.5%
Partial	20	37.03%
None	4	7.4%

Table 4: Distribution Of Cases With Respect To Pathological Response

Pathological response	No of patients	% of patients
Complete	12	22.2%
Partial	38	70.37%
None	4	7.4%

Table 5: Distribution Of Cases With Respect To Type Of Surgery Post Chemotherapy

Type of surgery	No of patients	% of patients
Lumpectomy	44	81.48%
Mastectomy	10	18.51%

Table 6: Distribution Of Cases With Respect To Outcome For Lumpectomy Cases

Outcome	Present	Absent	P value
Residual tumor in specimen	34	10	0.0005
Negative margins at frozen	40	4	
Diffusely positive–had mastectomy	4	40	

Table 7: Distribution Of Cases With Respect To Clinical Response And Molecular Subtype

Clinical Response	Complete	Partial	No response	P value
Hormonal	0	8	4	0.0001
Her2 enriched	0	3	0	
Triple negative	30	9	0	
Total	30	20	4	

Table 8: Distribution Of Cases With Respect To Pathological Response And Molecular Subtype

Pathological response	Complete	Partial	No response	P value
Hormonal	11	0	1	0.0001
Her2 enriched	0	2	1	
Triple negative	1	36	2	
Total	12	38	4	

IMAGES

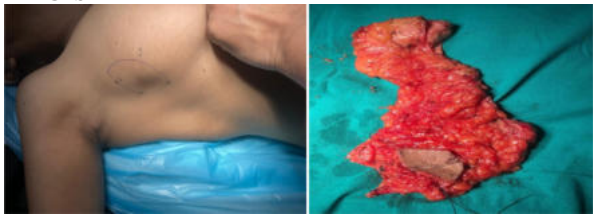

Fig (a): Images showing tattooing of breast for tumor localization prior to chemotherapy, (b) post surgical specimen of breast conserving surgery

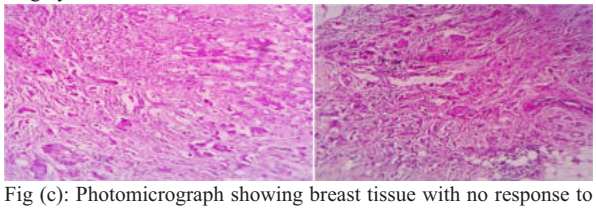

Fig (c): Photomicrograph showing breast tissue with no response to chemotherapy, (d) Partial response to chemotherapy

DISCUSSION

The present study aimed to evaluate the effectiveness of preoperative tattooing of breast tumors in reducing mastectomy rates in patients undergoing neoadjuvant chemotherapy. The results show that tattooing breast tumors preoperatively is a feasible and effective strategy for decreasing mastectomy rates, with 81.48% of patients undergoing lumpectomy. The study also aimed to evaluate the clinical and pathological responses to neoadjuvant chemotherapy in breast cancer patients, as well as the association between molecular subtypes and treatment outcomes.

The majority of patients (70.58%) were between 41-60 years old (Table 1), which is consistent with studies showing that breast cancer incidence increases with age (18). However, other studies have reported a higher incidence in younger women (19).

The most common presenting complaints in this study was lump which were similar to those reported in previous studies, with lump (50%) and pain (30.88%) being the most common symptoms (20).

The majority of patients (79.4%) completed chemotherapy (Table 2), with 55.5% achieving a complete clinical response (Table 3). This is comparable to other studies that reported response rates ranging from 50-80% (21).

The pathological complete response rate was 22.2% (Table 4), which is lower than some studies (22). However, the majority of patients (70.37%) had a partial response, indicating some degree of treatment effect.

The study found a significant association between molecular subtype and clinical response (Table 8, P-value = 0.0001). Triple-negative patients had a higher complete response rate (76.9%), which contradicts some studies that reported poorer responses in this subgroup (23). However, others have reported similar findings, suggesting that triple-negative breast cancer may be more chemosensitive (24).

The type of surgery post-chemotherapy (Table 5) shows that lumpectomy was the most common surgery (81.48%), with a high negative margin rate (90.9%).

The outcome of lumpectomy cases (Table 6) shows that 34 patients had residual tumor in the specimen, with a significant association between outcome and residual tumor (P-value = 0.0005).

The study's findings are consistent with previous studies that have shown that preoperative localization of breast tumors can improve surgical outcomes and reduce mastectomy rates (25). The use of tattooing as a localization technique has been shown to be accurate and reliable, with a study by Rose et al. reporting a 100% success rate in identifying the tumor bed (26).

The study's results also suggest that preoperative tattooing can help achieve negative margins, with 90.9% of patients having negative margins at frozen section. This is comparable to other studies that have reported negative margin rates ranging from 80-90% (27).

CONCLUSION

This study suggests that neoadjuvant chemotherapy is effective in achieving clinical and pathological responses in breast cancer patients, with varying responses across molecular subtypes. Preoperative tattooing of breast tumors may be a useful strategy for reducing mastectomy rates, as suggested by the high lumpectomy rate (81.48%) in this study.

The study's findings have implications for clinical practice, suggesting that preoperative tattooing of breast tumors should be considered as a strategy for reducing mastectomy rates in patients undergoing neoadjuvant chemotherapy.

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