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Original Research Article

A study of treatment modalities in breast cancer patients with help of triple marker test

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ABSTRACT

Background: Breast cancer is a leading cause of cancer-related morbidity and mortality worldwide. Advances in early diagnosis and molecular profiling have significantly improved treatment outcomes. The triple marker test, which assesses estrogen receptor (ER), progesterone receptor (PR), and human epidermal growth factor receptor 2 (HER2) status, plays a crucial role in classifying breast cancer subtypes and guiding treatment decisions. Personalized treatment approaches based on molecular characteristics enhance the effectiveness of hormone therapy, targeted therapy, and chemotherapy.
Methods: This prospective study evaluates the impact of the triple marker test in determining breast cancer treatment modalities. Patients were classified based on their ER, PR, and HER2 status to assess their response to various therapeutic interventions. Data collection included clinical examinations, histopathological analysis, and treatment outcomes following neoadjuvant therapy, surgery, and adjuvant therapies.
Results: Findings indicate that ER/PR-positive patients benefit significantly from hormone therapy, while HER2-positive cases show improved outcomes with targeted agents like trastuzumab. Triple-negative breast cancer (TNBC) remains a therapeutic challenge, often requiring aggressive chemotherapy. The study also highlights the role of neoadjuvant therapy in reducing tumor size, facilitating breast-conserving surgery (BCS), and improving overall prognosis.
Conclusions: Molecular profiling using the triple marker test is instrumental in optimizing breast cancer treatment strategies. Personalized treatment plans based on receptor status enhance survival rates and quality of life (QoL). Integrating biomarker-driven approaches into clinical practice ensures more precise and effective breast cancer management.

Keywords: Triple marker test, Breast cancer, Targeted therapy, Chemotherapy, Triple negative breast cancer

INTRODUCTION

Breast cancer remains the most frequently diagnosed malignancy in women worldwide and a leading cause of cancer-related mortality.[1] Advances in early detection, screening, and multimodal therapies have significantly improved survival rates, yet the disease continues to pose a substantial global health burden.[2] Over the past decade, breakthroughs in molecular biology and pharmacology have revolutionized breast cancer management by enabling personalized treatment approaches based on tumor biology rather than a one-size-fits-all model. Among these advancements, the triple marker test, which evaluates ER, PR, and HER2 status, has emerged as a cornerstone in guiding treatment decisions.

Breast cancer is a biologically heterogeneous disease, and molecular profiling plays a crucial role in stratifying tumors into distinct subtypes, each with unique prognostic and therapeutic implications. Based on ER, PR, and HER2

expression, breast cancer is classified into luminal A, luminal B, HER2-positive, and triple-negative (TNBC) subtypes.[3] Luminal subtypes, characterized by hormone receptor positivity, respond well to endocrine therapy, while HER2-positive tumors benefit significantly from targeted agents like trastuzumab. TNBC, which lacks all three markers, is highly aggressive, prone to early metastasis, and often requires intensive chemotherapy due to the absence of targeted therapeutic options.[4]

The clinical utility of the triple marker test extends beyond classification-it plays a pivotal role in treatment planning, prognostication, and predicting therapy response.[5] Neoadjuvant chemotherapy, frequently employed for locally advanced breast cancer (LABC), has shown improved overall survival (OS) and disease-free survival (DFS) rates, particularly when guided by biomarker expression.[6] Emerging therapeutic approaches, including nanoparticle-based drug delivery systems, are being explored to enhance treatment efficacy while minimizing systemic toxicity. However, treatment resistance, intertumoral heterogeneity, and variability in long-term outcomes remain significant challenges.

This study aims to analyze the role of the triple marker test in optimizing treatment decisions and improving patient outcomes. By correlating biomarker expression with treatment responses across different breast cancer subtypes, this research seeks to provide evidence-based insights into the effectiveness of targeted therapies, hormone therapies, and chemotherapy regimens. Furthermore, we explore recent advances in molecular diagnostics, immunohistochemistry (IHC), and gene-expression profiling, which are shaping the future of breast cancer treatment.[7]

Ultimately, a personalized treatment approach based on biomarker-driven decision-making has the potential to improve survival rates, minimize treatment-related toxicity, and enhance the QoL for breast cancer patients. Through this study, we aim to contribute to the growing body of evidence supporting precision medicine in breast cancer care and advocate for the widespread adoption of the triple marker test as a standard tool in clinical oncology.

METHODS

Study design

It was an observational study.

Study period

This study conducted over a period of 18 months with effect from 30 April 2022 to 30 December 2023.

Duration of study

The study lasted for 18 months.

Place of study

Study conducted at OPD and ward of general surgery and oncology in B. J. medical college and Sassoon general hospital, Pune.

Sample size

All patients admitted to the tertiary care centre during the study period. Total patients in the study-116.

Inclusion criteria

Patients of age >18 years, patients presenting with breast cancer and patients giving a written consent and willing to participate in the study would only be included in the study.

Exclusion criteria

Patients of age<18 years, patients not giving consent and not willing to participate in the study, patients whose marker status were not done pre operatively or planned for operation without knowing marker status of the breast cancer and patients who would be discharged against medical advice were excluded.

Methodology used

For each patient after diagnosis of breast cancer was suspected on clinical examination and radiological Investigation, a Tru-Cut biopsy of the breast lump was obtained and the specimen underwent a histopathological examination as well as immunohistochemistry markers available that is ER, PR, and Her-2neu receptor. On the basis of receptor status of the patient, and the TNM staging of the patient, treatment modality for the patient was devised which included-breast conservative surgery, modified radical mastectomy, or a pre operative neoadjuvant chemotherapy followed by either breast conservative surgery or a modified radical mastectomy (MRM), and a post operative adjuvant chemotherapy and radiotherapy. Thus. a personalised treatment plan was curated for each patient on the basis of above points.

RESULTS

This study analyzed 116 breast cancer patients using the triple marker test (ER, PR and HER2) to assess tumor characteristics, treatment modalities, and clinical outcomes.

Demographic and tumor characteristics

The majority of patients (37.07%) were aged 60-70 years, followed by 31.90% in the 50-60 age group.

Tumor size distribution: cT3 (49.14%) was the most common tumor size, cT2 (37.93%) was the second most

prevalent and cT4a-cT4d cases accounted for 6.90%, indicating advanced disease in a subset of patients.

Clinical nodal staging: cN1 (48.28%) was the most frequent, followed by cN0 (30.17%) and cN2a (21.55%).

Tumor staging: Stage IIIA (40.52%) was the most common, reflecting a high proportion of patients presenting with locally advanced disease, (Table 1).

Hormone receptor and HER2 status

ER-positive: 61.21% of patients.

PR-positive: 50.86% of patients.

HER2-positive: 25% of patients.

The most common subtype was ER+PR+HER2- (40.51%) followed by the TNBC with 20.69%.

ER+, PR+, HER2-was the most common in the age group in 50-60 year age (16.38%) followed by 60-70 years age group (12.07%)

ER-, PR-, HER2-(TNBC) was most common in 60-70 years age group (8.62%)

Majority of the patients of ER+PR+ HER2- presented in stage 2 and 3 of the breast cancer staging (Table 2).

Treatment modalities

Neoadjuvant chemotherapy was administered to 29.31% of patients, primarily those with HER2-positive and TNBC subtypes (Table 3).

Surgical treatment

MRM was performed in 85.34% of cases, consistent with aggressive surgical approaches for LABC.

BCS was performed in a smaller subset (14.65%) with and without lymph node dissection, reflecting patient selection based on tumor characteristics and response to therapy.

Post-neoadjuvant staging: Tumor downstaging: Highest in HER2+ (83.3%-100%) and ER+PR+HER2-(77.8%) cases. TNBC Response: Lowest tumor downstaging (37.5%), requiring aggressive chemotherapy.

Surgical trends: MRM was preferred in 84.3% of cases. BCS was performed in 15.7% of cases, primarily in hormone receptor-positive patients with the good response.

Post-operative treatment: Chemotherapy was required for all cases. Radiotherapy was primarily given to BCS patients (Table 4).

Key prognostic factors and clinical implications

Obesity (BMI 25-35 kg/m²) was prevalent in 68.10% of patients, reinforcing the role of metabolic factors in breast cancer progression.

The 75% of patients were postmenopausal, with late menopause (>55 years) in 46.55%, consistent with known hormonal risk factors.

Hormone replacement therapy (HRT) history was low (5.16%), contrasting with global trends, suggesting potential differences in medical practices and patient awareness (Table 5). The 8.62% of the patient were nulliparous, a smaller subset in the sample size.

Summary of treatment responses

Hormone receptor-positive tumors (ER+/PR+) responded well to endocrine therapy reducing need for chemotherapy.

HER2-positive cases benefited from targeted therapy (trastuzumab), though some required additional chemotherapy.

TNBC cases exhibited higher recurrence rates, emphasizing the need for novel targeted therapies.

Table 1: Clinical staging of tumor size of a patients with breast cancer.

Clinical staging of tumor size	N (%)
cT1	7 (6.03)
cT2	44 (37.93)
cT3	57 (49.14)
cT4a	5 (4.31)
cT4b	2 (1.72)
cT4d	1 (0.86)
Total	116 (100)

Table 2: Clinical staging of nodal metastasis of a patient with breast cancer.

Clinical staging of nodal metastasis	N (%)
cN1	56 (48.28)
cN2a	25 (21.55)
cN0	35 (30.17)
Total	116 (100)

Table 3: Staging of tumor of patients with breast cancer.

Staging of tumors	N (%)
IA	6 (5.17)
IIA	3 (11.21)
IIB	42 (36.21)
IIIA	47 (40.52)
IIIB	8 (6.90)
Total	116 (100)

Table 4: Receptor status.

Age group (in years) vs receptors	40-50, N (%)	50-60, N (%)	60-70, N (%)	70-80, N (%)
ER+PR-Her2-	4 (3.45)	2 (1.72)	5 (4.31)	1 (0.86)
ER-PR+Her2-	1 (0.86)	0 (0.0)	2 (1.72)	0 (0.0)
ER-PR-Her2+	3 (2.59)	5 (4.31)	7 (6.03)	1 (0.86)
ER+PR+Her2-	8 (6.90)	19 (16.38)	14 (12.07)	6 (5.17)
ER+PR-Her2+	0 (0.0)	3 (2.59)	1 (0.86)	0 (0.0)
ER-PR+Her2+	1 (0.86)	0 (0.0)	0 (0.0)	0 (0.0)
ER+PR+Her2+	1 (0.86)	3 (2.59)	4 (3.45)	0 (0.0)
ER-PR-Her2-	8 (6.90)	5 (4.31)	10 (8.62)	2 (1.72)

Table 5: Post neoadjuvant clinical staging of tumor size of patients with breast cancer.

Post neoadjuvant clinical staging of tumor size	N (%)
ycT1	16 (13.79)
ycT2	12 (10.34)
ycT3	5 (4.31)
ycT4b	1 (0.86)

Table 6: Post neoadjuvant clinical staging of nodal metastasis of patients with breast cancer.

Post neoadjuvant clinical staging of nodal metastasis	N (%)
ycN0	10 (8.62)
ycN1	23 (19.83)
ycN2a	1 (0.86)

Table 7: Post neoadjuvant clinical staging of tumor of patients with breast cancer.

Post neoadjuvant clinical staging of tumor	N (%)
IA	4 (3.45)
IIA	17 (14.66)
IIB	7 (6.03)
IIIA	6 (5.17)

Table 8: Treatment response based on receptor status and clinical staging.

Receptor status	No. of patients (n=32)	Initial tumor stage (Most common)	Down staged cases after neoadjuvant therapy, N (%)	Surgical procedure	Post-operative treatment
ER+PR+HER2-	9	IIIA, IIB	7/9 (77.8)	MRM: 5, BCS: 4	Chemo: 5, radio + chemo: 4
ER-PR-HER2-(TNBC)	8	IIIA, IIIB	3/8 (37.5)	MRM: 8	Chemotherapy: 8
ER-PR-HER2+	6	IIIA, IIIB	5/6 (83.3)	MRM: 6	Chemotherapy: 6
ER+PR-HER2-	4	IIB, IIIA	3/4 (75)	MRM: 3, BCS: 1	Chemotherapy: 3, radio + chemo: 1
ER+PR+HER2+	3	IIIA	3/3 (100)	MRM: 3	Chemotherapy: 3
ER-PR+HER2-	2	IIIA	1/2 (50)	MRM: 2	Chemotherapy: 2

Table 9: Obesity, HRT use, early menarche <12 years, and late menopause > 55 years table.

Age group (in years)	Obesity	Use of HRT	Early menarche <12	Late menopause >55
	Mean±SD	**Mean±SD**	**Mean±SD**	**Mean±SD**
40-50	26.63±2.92	0.62±1.39	14.23±1.49	52.0±16.95
50-60	26.44±3.82	0.08±0.49	14.14±1.36	49.32±18.60
60-70	26.76±3.65	0.00±0.00	14.16±1.36	50.02±8.31
70-80	26.66±2.97	0.00±0.00	13.70±1.16	52.60±2.66

DISCUSSION

This study provides a comprehensive evaluation of the impact of the triple marker test (ER, PR, HER2) in guiding treatment strategies for breast cancer patients, emphasizing its role in personalized therapy and prognostic assessment. The findings reinforce the clinical utility of molecular subtyping, aiding in optimized therapeutic decision-making for different breast cancer subtypes.[8]

Patient demographics and tumor characteristics

The study population comprised 116 breast cancer patients aged 40 to 80 years, with the highest incidence (37.07%) in the 60-70 age group, followed by 31.90% in the 50-60 age group. The predominance of cT3 tumors (49.14%) and stage IIIA cases (40.52%) reflects the aggressive presentation of the disease at diagnosis, a trend also reported in studies by Hortobagyi et al and Adiga et al which underscore the association between delayed diagnosis, larger tumor sizes, and poorer prognosis.[9,10] These findings highlight the need for enhanced early detection programs to reduce the burden of late-stage breast cancer.

Hormone receptor and HER2 status

The triple marker test revealed that 61.21% of patients were ER-positive, 50.86% PR-positive, and 25% HER2-positive, making ER+, PR+, HER2-the most common subtype. This aligns with Hortobagyi who demonstrated that hormone receptor-positive breast cancers exhibit better prognosis and responsiveness to endocrine therapy.[9] Conversely, ER-negative (38.79%) and PR-negative (49.14%) patients had worse outcomes, requiring chemotherapy-based treatment approaches.[11]

HER2-positive cases, despite targeted therapies like trastuzumab, still required multimodal treatment, reflecting findings from Cortazar et al where HER2-targeted neoadjuvant therapy showed significant tumor shrinkage.[12] However, the observed HER2-positive response rate in this study was slightly lower, suggesting potential tumor biology variations or chemotherapy regimen differences that warrant further investigation.

A particularly concerning observation was the high recurrence rate in TNBC cases, which is consistent with studies by Sasa et al and Lehmann et al confirming TNBC's aggressive nature and poor prognosis due to the absence of targeted treatment options.[13,14] This underscores the urgent need for novel biomarkers and targeted therapies for TNBC patients.

Treatment modalities and therapeutic implications

Neoadjuvant chemotherapy was administered to 29.31% of patients, particularly in HER2-positive and TNBC cases. However, the HER2-positive response rate was slightly lower than the Cortazar et al study, possibly due to differences in patient demographics or chemotherapy regimens.[12]

MRM was performed in 85.34% of cases, while only a small proportion underwent BCS, reflecting the preference for aggressive surgical management in LABC, a strategy historically supported by MD Anderson cancer center studies.[15]

A more aggressive approach in government institutes indirectly indicate a more number or patients with loss to follow up after initial visit to OPD or a loss to follow up to chemotherapy and radiotherapy after breast conservative surgery.

These findings reinforce the importance of multimodal approaches integrating surgery, systemic therapy, and targeted treatments to optimize outcomes in aggressive breast cancer subtypes.

Key findings and correlation with clinical risk factors

Obesity was prevalent in 68.10% of patients (BMI 25-35 kg/m²), supporting existing literature that links obesity with increased breast cancer risk and poorer prognosis.[16]

The 75% of patients were postmenopausal, with late menopause (>55 years) in 46.55%, reinforcing its role as a risk factor for hormone receptor-positive breast cancers.[17]

HRT history was notably low (5.16%), diverging from previous studies suggesting a higher prevalence of HRT use among breast cancer patients.[18]

These findings emphasize the importance of metabolic and hormonal factors in breast cancer progression and treatment response, further advocating for individualized risk assessment in treatment planning.

Contrasts with existing literature and future directions

While the overall findings align with established literature, several discrepancies highlight areas for further investigation:

HER2-positive treatment response

The lower-than-expected response to neoadjuvant chemotherapy in HER2-positive patients suggests potential variations in tumor biology or treatment regimens. Further studies are needed to optimize treatment combinations for HER2-positive patients in different demographic populations.

Absence of fascin-1 as a TNBC biomarker

Unlike studies by Xie et al which demonstrated Fascin-1's strong diagnostic utility in TNBC, this study did not evaluate this marker.[19] Given Fascin-1's role in TNBC

stratification, its inclusion could enhance treatment personalization, particularly in resource-limited settings where advanced diagnostics like FISH are unavailable.

Prognostic role of Ki67

Ki67, a proliferation marker, is a crucial predictor of chemotherapy response and long-term prognosis. As noted in Cabrera-Galeana et al Ki67 assessment in residual disease post-neoadjuvant therapy could help tailor personalized treatment strategies.[20] Incorporating Ki67 into future research could further refine risk stratification and therapeutic guidance. Clinical implications and need for personalized treatment strategies

This study reinforces the triple marker test's critical role in breast cancer classification and treatment selection, supporting the broader paradigm shift toward personalized medicine. However, the variability in treatment response across molecular subtypes, particularly in HER2-positive and TNBC cases, highlights the need for:

Enhanced biomarker integration (e.g., Ki67, Fascin-1) for better prognostication and therapy selection. Further refinement of HER2-targeted therapy strategies to improve treatment efficacy and response rates. More research into TNBC-specific therapies, as current treatment options remain limited and often ineffective in preventing recurrence.

Limitations

Sample size and single-center study: The study includes 116 patients from a single tertiary care center, which may limit the generalizability of the findings to broader populations. A larger, multi-center study would provide more representative data across different demographics and healthcare settings.

Follow-up and long-term outcomes: The study focuses on short-term treatment responses and does not evaluate long-term outcomes such as DFS and OS. A longer follow-up period would be necessary to assess recurrence rates and long-term efficacy of treatment modalities.

Lack of additional biomarkers: The study primarily relies on the triple marker test (ER, PR, HER2) but does not incorporate other prognostic and predictive markers such as Ki67, BRCA mutations, or PD-L1 expression. Including these markers could refine treatment personalization, particularly for TNBC cases.

Limited evaluation of treatment side effects: The study focuses on treatment efficacy but does not extensively analyze adverse effects, toxicity, or QoL measures. Evaluating treatment-related complications could provide a more comprehensive understanding of patient outcomes.

Potential loss to follow-up: Given the study setting in a government hospital, there may be a higher incidence of patients lost to follow-up after initial treatment, impacting long-term assessment.

These limitations highlight areas for future research, such as larger multi-center studies, incorporation of additional biomarkers, and long-term patient monitoring to enhance personalized treatment strategies.

CONCLUSION

This study's findings largely align with established literature on breast cancer subtyping and treatment response, on the basis of ER, PR, and Her2neu, reaffirming the Triple Marker Test as a crucial tool in clinical decision-making. However, observed discrepancies in HER2 positive treatment outcomes and the omission of additional biomarkers underscore the need for continued research into personalized treatment strategies.

The integration of advanced molecular diagnostics, emerging biomarkers, and tailored treatment approaches remains essential for optimizing breast cancer management, particularly for aggressive subtypes like TNBC. Future research should focus on incorporating novel predictive markers, refining chemotherapy protocols, and expanding access to targeted therapies to further enhance patient outcomes and survival rates.

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