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Role of Ultrasound in Evaluating Breast Cancer Response to Neoadjuvant Chemotherapy

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Abstract **Original Research Article**

Background: Breast cancer is one of the most prevalent malignancies in women worldwide, with neoadjuvant chemotherapy (NACT) increasingly used to downstage tumors and facilitate breast-conserving surgery. Accurate and timely assessment of tumor response to NACT is critical in optimizing treatment plans and predicting outcomes. Ultrasound (USD), due to its safety, accessibility, and cost-effectiveness, is frequently employed for this purpose. ***Objective:*** To assess the role of ultrasound in evaluating tumor response to neoadjuvant chemotherapy in breast cancer patients. ***Method:*** A retrospective observational study was conducted at a tertiary care hospital in Bangladesh between January 2022 to December 2022. A total of 36 female patients with histologically confirmed breast cancer who underwent NACT were included. Ultrasound imaging was used to measure tumor size at three time points: before chemotherapy, mid-therapy, and after completion of chemotherapy. Tumor response was analyzed by comparing pre- and post-treatment tumor sizes. ***Results:*** The majority of patients (60%) were aged between 51 and 56 years. Before chemotherapy, 65% of tumors measured between 5.6×4.5 cm and 8.0×6.0 cm. Following chemotherapy, 54.5% of tumors were reduced to below 2.5×2.0 cm, with 24.5% shrinking to as small as 1.0×1.0 cm. Most of our patients received 6 to 8 cycles of chemotherapy, with a small proportion requiring extended cycles or surgical intervention. Overall, ultrasound effectively demonstrated tumor shrinkage and variability in response. ***Conclusion:*** Ultrasound proved to be a valuable, non-invasive modality for monitoring breast cancer response to NACT. It allowed dynamic assessment of tumor size reduction and informed treatment decisions, supporting its continued use as a primary imaging tool in the neoadjuvant setting.

Keywords: Breast cancer, Ultrasound (USD), Neoadjuvant chemotherapy (NACT).

INTRODUCTION

Breast cancer remains one of the most common malignancies affecting women worldwide, with significant variations in its biological behavior, treatment response, and clinical outcomes. In recent years, neoadjuvant chemotherapy (NAC) — chemotherapy administered before surgical intervention — has become an important strategy in the management of locally advanced and operable breast cancer. [1-2] This approach not only facilitates breast-conserving surgery by reducing tumor size but also allows oncologists to assess tumor responsiveness to treatment in real time. A critical component of this treatment paradigm is the accurate and timely evaluation of tumor response, which can directly influence surgical decisions and long-term prognosis. [3]

Ultrasound imaging, known for its accessibility, safety, and cost-effectiveness, has become a vital tool in monitoring breast cancer throughout the neoadjuvant chemotherapy process. Unlike other imaging modalities that may involve radiation or contrast agents, ultrasound is non-invasive and can be repeated frequently without risk to the patient. [4] Its real-time imaging capability allows for dynamic assessment of the tumor and surrounding tissues, providing valuable insight into changes in tumor size, morphology, and vascularity during therapy. [5]

In clinical practice, ultrasound plays a pivotal role in guiding decisions regarding the continuation or adjustment of chemotherapy regimens. By tracking tumor shrinkage or lack thereof, clinicians can tailor treatment more effectively and intervene promptly if a tumor shows resistance. [6-7] Moreover, ultrasound helps in evaluating axillary lymph node involvement, which is a key factor in staging and determining the extent of surgery required. These features make ultrasound not just a diagnostic tool, but a partner in the therapeutic journey. [8]

Despite its advantages, the use of ultrasound is not without limitations. Operator dependency and variability in interpretation can affect the consistency of results. Additionally, ultrasound may have difficulty in distinguishing between fibrotic tissue and residual tumor post-therapy, which may impact the accuracy of response assessment. [9] Nevertheless, when used alongside other diagnostic modalities, such as mammography and MRI, ultrasound can provide a comprehensive view of the tumor's biological response to treatment.

OBJECTIVE

To assess role of ultrasound in evaluating breast cancer response to neoadjuvant chemotherapy.

METHODOLOGY

This retrospective observational study was conducted at a tertiary care hospital in Bangladesh between January 2022 to December 2022. A total of 36 female patients diagnosed with breast cancer and treated with neoadjuvant chemotherapy (NACT) during this period were included. All patients were selected from the hospital's oncology and radiology database.

Patients received the standard institutional neoadjuvant chemotherapy protocol consisting of four cycles of doxorubicin and cyclophosphamide (AC) followed by four cycles of paclitaxel, administered every three weeks. Tumor response was monitored using ultrasound imaging at three key time points: at baseline prior to the start of chemotherapy, mid-therapy after the first four cycles, and at completion of chemotherapy (after all six to eight cycles). This approach provided a structured and comparative view of the tumor's response to the NACT regimen over time.

All ultrasound scans were performed by senior radiologists using high-resolution ultrasound systems. For uniformity in measurement, the longest diameter (LD) of the index tumor was recorded at each time point, regardless of the imaging plane. This method accounts for the three-dimensional shrinkage of the tumor and allows for consistent comparison of size reduction over time. In cases of multifocal disease, the largest lesion was considered the index lesion. Additionally, qualitative features such as cystic degeneration and perilesional edema at baseline were noted. A p-value of <0.05 was considered statistically significant, with all analyses performed at a 95% confidence interval.

RESULTS

Table-1 outlines the age distribution of the study group. The majority of patients (60%) were between 51 and 56 years old, while 25% were older than 56 years. A smaller proportion (15%) fell within the 45 to 50-year age range, indicating that most participants were in their early to mid-50s, reflecting the typical age group affected in this clinical context.

Table 1: Age distribution of the study group

Age Distribution	%
45-50 years	15%
51-56 years	60%
>56 years	25%

Before the initiation of chemotherapy, ultrasound (USD) measurements revealed that the majority of tumors (65%) ranged in size from 5.6×4.5 cm to 8.0×6.0 cm. Additionally, 25% of tumors were larger, measuring between 8.1×6.0 cm and 10.0×8.0 cm, while only 10% were relatively smaller, falling within the range of 2.0×1.5 cm to 5.5×4.5 cm. This distribution indicates that most patients presented with moderately to significantly large tumors prior to treatment.

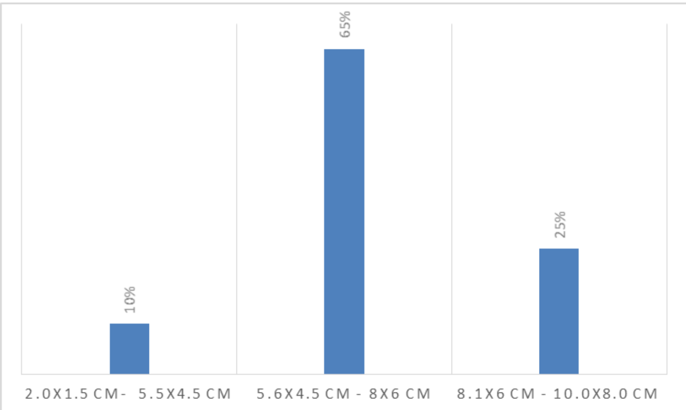

Figure 1: Size of tumor on USD before chemo

Figure-2 shows the number of chemotherapy cycles received by patients. The majority (80%) underwent 8 cycles (C8), while 20% completed 6 cycles (C6). This distribution suggests that most patients responded well to chemotherapy.

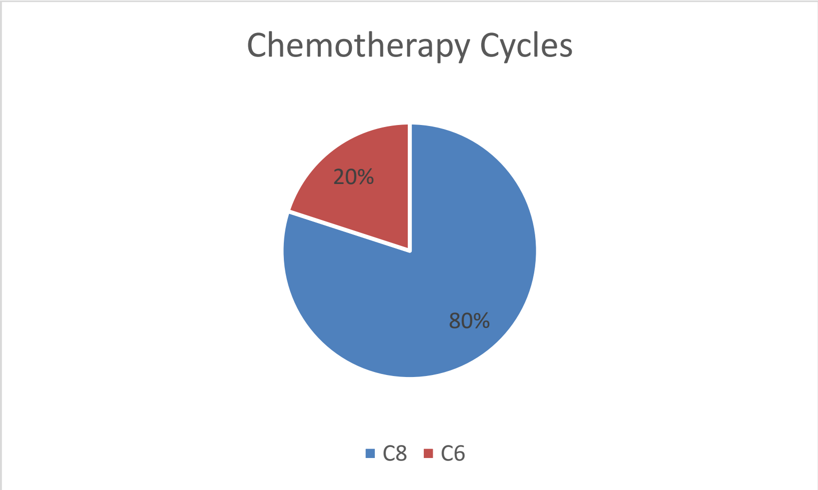

Figure 2: Chemotherapy cycles

Table-2 presents the distribution of tumor sizes on ultrasound (USD) following chemotherapy. The majority of tumors (40%) measured between 2.6×2.0 cm and 6.5×5.0 cm, while 30% fell within the range of 1.9×2.0 cm to 2.5×2.0 cm. Additionally, 24.5% of tumors were reduced to sizes between 1.0×1.0 cm and 1.8×2.0 cm. In a small number of cases, chemotherapy was halted (0.5%) or the tumor was surgically removed (5%), indicating varied treatment responses among patients.

Table-2: Size of tumor on USD after chemo

Size of tumor on USD after chemo	%
1.0x1.0 cm to 1.8x2.0 cm	24.50%
1.9x2.0 cm to 2.5x2.0 cm	30%
2.6x2.0 cm to 6.5x5 cm	40%
Chemo stopped	0.50%
Removed	5%

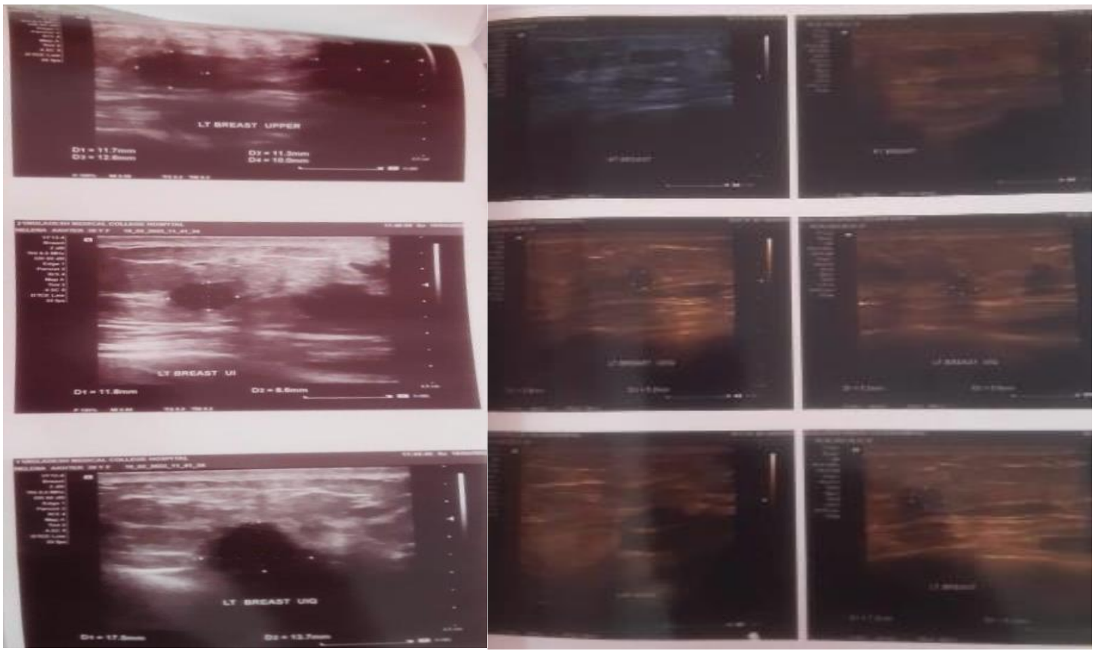

Figure-3a and 3b: Tumor size before and after Neoadjuvant Chemotherapy

Discussion

The age distribution in our study indicates that the majority of patients were between 51 and 56 years of age, comprising 60% of the cohort, followed by 25% above 56 years and 15% between 45 and 50 years. This pattern aligns with findings reported by other study, where the peak incidence of breast cancer was observed in women aged 50–55 years, suggesting a consistency in the age-related vulnerability across different populations.[9] Our results reinforce the notion that breast cancer in this age group is prevalent and may benefit from targeted screening and intervention strategies.

Pre-treatment ultrasound measurements revealed that 65% of patients presented with tumors sized between 5.6×4.5 cm and 8.0×6.0 cm, while 25% had even larger tumors. This observation is consistent with the other findings, who reported a predominance of locally advanced tumors at diagnosis in over 60% of cases in a similar demographic. [10] Such data highlights the tendency for delayed presentation in certain populations, likely due to lack of awareness, screening, or access to healthcare services.

Chemotherapy cycles administered varied among patients, with a significant proportion (80%) receiving standard treatment protocol of 8 cycles. This contrasts with standard treatment protocols observed in the other study, where a majority of patients received a minimum of four cycles of neoadjuvant chemotherapy (NACT). [11] The discrepancy in our findings may be attributed to treatment-related toxicities, patient comorbidities, or early tumor shrinkage prompting surgical intervention. Nonetheless, the data suggests that in our cohort, individualized treatment decisions played a significant role.

Post-chemotherapy tumor size assessment revealed that the highest proportion of tumors (40%) fell within the 2.6×2.0 cm to 6.5×5.0 cm range. Approximately 54.5% of patients had tumors reduced to less than 2.5×2.0 cm, demonstrating a notable response to chemotherapy. In comparison, a study found that only 35% of patients exhibited similar tumor size reduction after NACT. This suggests that our cohort showed a relatively better tumor response, which could be influenced by tumor biology, chemotherapy regimen, or patient compliance.[12]

A small number of patients had chemotherapy discontinued (0.5%) or underwent surgical tumor removal (5%) after chemotherapy. These findings mirror those in the study, where early cessation or surgical conversion occurred in roughly 4% of cases due to patient intolerance or rapid response. [13] Taken together, our results underscore the heterogeneity of treatment responses and the necessity for continuous monitoring and individualized care plans throughout the chemotherapy course.

Conclusion

The findings of this study underscore the significant role of ultrasound (USD) in evaluating breast cancer response to neoadjuvant chemotherapy (NACT). Pre-treatment USD effectively documented that most of the patients presented with moderate to large-sized tumors, while post-chemotherapy measurements demonstrated a marked reduction in tumor size in most cases, with over 54% showing shrinkage to less than 2.5×2.0 cm. This highlights the utility of ultrasound as a reliable, non-invasive, and accessible tool for monitoring tumor response, guiding treatment decisions, and identifying candidates for surgical intervention.

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