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Research Article

Immunohistochemical study of ki67 biomarker to identify the intrinsic molecular types of breast cancer in women residing in Al-Najaf Al –Ashraf governorate

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Abstract: The current study comprised sixty Iraqi female patients with breast cancer, ranging in age from 35 to 75 years old, who were diagnosed between January 19, 2023 and May 10, 2025. The current study used paraffin-embedded of female breast carcinoma sections that confirmed histological diagnosis such as tumor size, differentiation degree, and forms of invasive breast cancers. Immunohistochemical biomarker expression of ki67 cases were categorized into two groups based on proliferation index: high (≥25%) and low (<25%) expression levels., with invasive breast cancer and correlation with different clinicopathological variables, in the age group under 40 years, Ki-67 expression was high (>25%) in 3.3% and low (<25%) in 11.7%. Among patients aged 40–49 years, 67 high expression was seen in 8.3%, and low expression in 21.7%. In the 50–59-years age group Ki-67 was expressed at high levels in 10% and low levels in 20% of the cases. Older patients (>60 years) High Ki-67 expression was found in 6.6%, and low expression in 18.3%. Women in the 50–59 age group demonstrated the highest levels of Ki-67, suggesting increased tumor cell proliferation. Elevated Ki-67 expression in older age groups aligns with the observed tendency for higher tumor grades and more aggressive tumor behavior in late-onset breast cancer. Statistical analysis using alphabetical lettering (A, B, C, D) indicated significant differences between age groups at $P \leq 0.05$. In luminal A subtype, high Ki-67 expression (>25%) occurred in 10%, while low

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expression (<25%) was seen in 46.6%, showing significant difference ($P \leq 0.05$). Luminal B tumors showed high expression in 6.6% and low in 5%, also statistically significant. HER2-enriched tumors exhibited high Ki-67 in 3.3% and low in 16.3%, with significant variation ($P \leq 0.05$). Triple-negative tumors showed high expression in 3.3% and low in 8.3%, with notable difference. No grade I tumors showed Ki-67 expression. In grade II, high expression was 13.8%, low 63.3%, with significant differences. Grade III had high expression in 10% and low in 13.8%, also showing statistical significance.These findings suggest Ki-67 is a valuable marker for assessing proliferation across subtypes and grades, especially in luminal A and grade II tumors.

1. Introduction

Breast cancer is a genetic disease caused by alterations in the genomic structure, where changes in tumor suppressor and oncogenic genes lead to the transformation of breast epithelial cells into a malignant form [1]. These genetic changes also influence how breast cancer behaves, including responses to treatment and clinical outcomes. Advances in molecular technologies have significantly simplified the diagnosis and treatment decisions related to breast cancer [2]. Female breast cancer is the most commonly diagnosed cancer, accounting for 11.7% of total cases of cancer [3,4].

In developing countries, the elevated rates of breast cancer incidence and mortality can be attributed to low awareness of the disease, ineffective screening programs, delayed diagnoses, and inadequate healthcare facilities [5]. Implementing a comprehensive awareness program about the risk factors and prevalence of breast cancer is crucial [6]. Additionally, screening initiatives and diagnostic assessments are vital for early detection to mitigate the incidence and mortality rates associated with breast cancer [7,8].

2. Methodology

This study exclusively involved Iraqi female patients who were diagnosed with invasive breast cancer between January 19, 2023, and May 10,2025. A total of 60 participants were included, with ages ranging from 35 to 75 years.

The formalin-fixed, paraffin-embedded (FFPE) tissue samples were obtained from the Histopathology Department of Al-Sadder Teaching Hospital and several private diagnostic laboratories in Al-Najaf Al-Ashraf Governorate. All samples were collected from women with confirmed diagnoses of invasive breast carcinoma, ensuring a representative cohort for biomarker evaluation. The study sample included 60 breast cancer cases, which were classified into four distinct molecular subtypes based on their IHC profiles: Luminal A, Luminal B, HER2-enriched, and Triple-negative breast cancer (TNBC)

All tissue specimens were retrieved from the histopathology departments of Al-Sadder Hospital and collaborating private laboratories.

2.1. Statistical analyze

Chi- square was used to determine the statistical significance between ki-67 status along with their correlation with various clinicopathological parametres such as patient's age, tumor size, tumor grade with respect to infiltrating ductal carcinoma breast subtypes and, it was completed with Pearson's or Spearman rank. A value of $P < 0.05$ was considered as statistically significant difference.

3. Results

In the current investigation, it was discovered that the majority of invasive ductal carcinoma (IDC) type, in women aged (50-59) accounting for 31% of all cases, while the lowest incidence was observed in women under 40 years age representing 9 cases accounting for 15% of all cases in Table 1.

Table 1. Clinicopathological variables of breast cancers.

Variables	**No (%)**
Age (years)	
<40	9 (15)
40-49	17 (28.3)
50-59	19 (31.7)
>60	15(25)
Total	60(100)
$\chi 2$ (p-value)	3.733(0.292)
Histopathological type(Invasive ductal carcinoma (IDC) Sub type	
Luminal A	34(56.7)
Luminal B	7 (11.7)
Her2 enrich	12(20)
Triple negative	7(11.6)
Total	60(100)
$\chi 2$ (p-value)	33.2($2.92251 \times 10^{-}$)
Tumor grade	
I	0 (0)
II	46 (76.7)
III	14(23.3)
Total	60(100)
$\chi 2$ (p-value)	55.6(8.44527×10^{-13})

The majority of invasive ductal breast cancer cases were classified as luminal A subtype (56.7%), followed by HER2-enriched (20%), luminal B (11.7%), and triple-negative (11.6%) subtypes, detected by immunohistochemistry (IHC).

Based on the Nottingham histological grading (WHO) and modified Bloom–Richardson grading system, the vast majority of women diagnosed with breast cancer were in tumor grade (II), which accounted for 46 cases of the studied cases and represented (76.7%) of the total percentage of infected cases, while the lowest percentage was in tumor grade (III), which accounted for 14 cases and represented (23.3%) of the total percentage of infected cases.

Immunohistochemical biomarker expression of ki67 cases were categorized into two groups based on proliferation index: high (≥25%) and low (<25%) expression levels., with invasive breast cancer and correlation with different clinicopathological variables, in the age group under 40 years, Ki-67 expression was high (>25%) in 3.3% and low (<25%) in 11.7%. Among patients aged 40–49 years, 67 high expression was seen in 8.3%, and low expression in 21.7%. In the 50–59-years age group Ki-67 was expressed at high levels in 10% and low levels in 20% of the cases. Older patients (>60 years) High Ki-67 expression was found in 6.6%, and low expression in 18.3%. Women in the 50–59 age group demonstrated the highest levels of Ki-67, suggesting increased tumor cell proliferation. Elevated Ki-67 expression in older age groups aligns with the observed tendency for higher tumor grades and more aggressive tumor behavior in late-onset breast cancer. Statistical analysis using alphabetical lettering (A, B, C, D) indicated significant differences between age groups at $P \leq 0.05$.

Subtype luminal A Ki-67, high expression levels (>25%) were observed in around 10% of cases, whereas low expression levels (<25%) were seen in nearly 46.6%. Statistical analysis revealed significant differences ($P \leq 0.05$) within the luminal A group between high (>25%) and low expression levels of ki67 (<25%) as indicated by distinct alphabetical labels in Table 2.

Luminal B tumors High Ki-67 expression (>25%) was observed in about 6.6% of cases, while low expression (<25%) was noted in around 5%. A statistically significant distinction was observed between high (>25%) and low (<25%) proliferative groups.

HER2-enriched tumors Ki-67 was highly expressed (>25%) in about 3.3% of cases, while low expression (<25%) was observed in nearly 16.3%. Statistical analysis indicated significant differences ($P \leq 0.05$) between high and low of ki67 expression.

Triple-negative Ki-67, high expression levels (>25%) were detected in 3.3% of cases, while low expression (<25%) was seen in approximately 8.3%. a significant difference was observed between the high and low Ki-67 expression groups in triple negative, as shown in Table 2.

In tumor grade I (Low) no cases in this group. No significant differences ($P > 0.05$) were found between high and low Ki-67 levels. In tumor grade II (Intermediate) High Ki-67 expression (>25%) was detected in about 13.8% of cases, whereas low Ki-67 expression (<25%) was more frequent, at around 63.3%. Statistically significant differences ($P \leq 0.05$) were detected in grade II, between high and low of ki-67 expression level as indicated by differing letter groupings in the Table 2. In tumor grade III (High) Ki-67 high expression (>25%) was observed in 10% of cases, and low expression (<25%) in 13.8%. Significant differences were found between high and low Ki-67 levels as shown in Figure 1 and Figure 2.

Table 2. Immunohistochemical biomarkers expression

Variables	**Immunohistochemical biomarkers expression No(%) ki67**	
	High expression (>25%)	**Low low expression (<25%)**
Age (years)		
<40	2(3,3) C,b	7(11.7)C,a
40-49	5(8.3)A,b	13(21.7)A,a
50-59	6(10)A,b	12(20)A,a
>60	4(6.6) B,b	11(18.3)B,a
Total	17(28.)a	43(71.6) a
(Histopathological type (Invasive ductal carcinoma (IDC) Sub type		
Luminal A	6(10)A,b	28(46.6)A,a
Luminal B	4(6.6)B,a	3(5)C,b
Her2 enrich	2(3.3) C.b	10(16.3)B,a

Triple -ve	2(3.3)C,b	5(8.3)C,a
Total	14(23.3)b	46(76.7)a
Tumor grade		
I	0(0) C,a	0(0) C,a
II	8(13.8)A,b	38(63.3) A,a
III	6(10)B,b	8(13.8) B,a
Total	14(23.3)b	46(76.7) a

*The different letters refer to significant differences (P≤0.05) between means while similar letters refer to nonsignificant differences between means according to Kruskal-Wallis test and Mann-Whitney U Test for pairwise comparisons

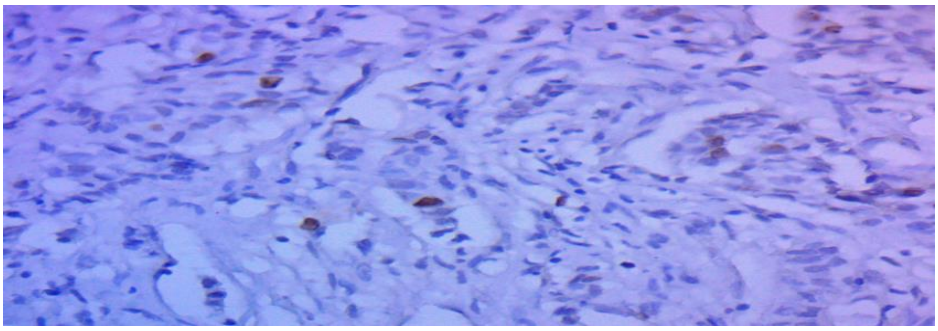

Figure 1. IHC study of Ki67 less than 25% in invasive ductal carcinoma of breast X 400.

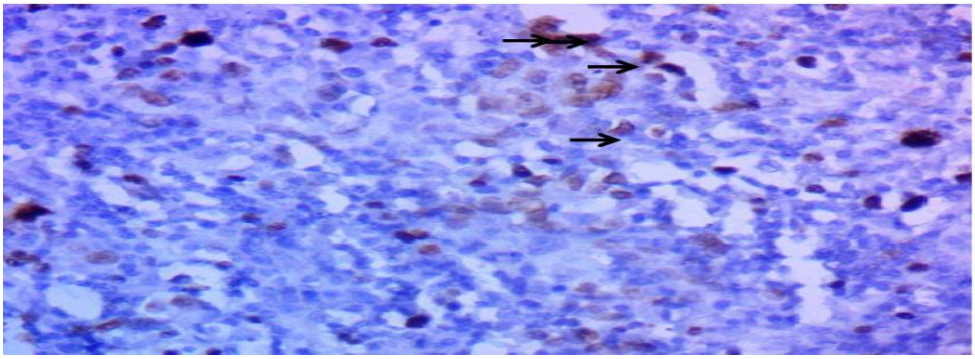

Figure 2. IHC study of Ki67 (➔) more than 25% in invasive ductal carcinoma of breast X 400.

4. Discussion

The present study examined the age distribution of 60 female breast cancer patients, revealing that the highest proportion of cases occurred in the 50–59 age group (31.7%), followed by 40–49 (28.3%), >60 (25%), and <40 years (15%). These findings align with global epidemiological patterns indicating that breast cancer incidence typically rises with age, particularly during the fifth and sixth decades of life [9]. Additionally, tumors in younger women often display more aggressive biological behavior than those in older patients [10].

Despite the differences in case frequency across age groups, chi-square analysis ($\chi^2 = 3.730$, $p = 0.292$) did not reveal a statistically significant association between age group and breast cancer case distribution in this cohort. The distribution of cases across age groups could be due to random variation rather than a true age-related pattern in this population. Similar findings have been documented in other region-specific studies where age did not emerge as a significant determinant

of breast cancer risk, particularly in studies with smaller sample sizes [11]. The lack of statistical significance may be attributed, in part, to the limited sample size (n = 60), which reduces the power to detect subtle associations. Moreover, breast cancer development is influenced by a complex interplay of factors including genetics, reproductive history, environmental exposures, and lifestyle all of which can modulate the impact of age on disease risk [12]. The current study demonstrated that the luminal A subtype was the most prevalent form of invasive ductal carcinoma (IDC), constituting 56.7% of all breast cancer cases. This finding is consistent with global epidemiological trends, where luminal A is commonly the dominant subtype, particularly among hormone receptor-positive tumors [13]. Luminal A is typically characterized by estrogen receptor (ER) and/or progesterone receptor (PR) positivity and low Ki-67 proliferation index, and is associated with a better prognosis and response to hormone therapy [3]. In contrast, HER2-enriched, luminal B, and triple-negative breast cancer (TNBC) subtypes accounted for 20%, 11.7%, and 11.6% of the cases, respectively. The statistically significant chi-square result ($\chi^2 = 32.9225$, $p < 10^{-6}$) consider indicates a statistically significant difference in subtype distribution, likely influenced by the underlying molecular heterogeneity of breast cancer [14,15].

HER2-enriched tumors, which were the second most frequent subtype in this study, are known for their aggressive behavior but have seen significant improvements in outcomes due to targeted anti-HER2 therapies [16]. While TNBC are typically associated with more aggressive behavior and poorer prognosis, the relatively lower frequencies of these subtypes in this study are consistent with previous reports from similar population-based studies [17]. Regarding tumor grade, analysis based on the Nottingham Histological Grading System revealed that the majority of tumors were classified as grade II (76.7%), while grade III tumors accounted for 23.3%. No cases were classified as grade I. The chi-square test yielded a statistically significant result ($\chi^2 = 55.618$, $p \approx 10^{-13}$), indicating a statistically significant difference distribution with a predominance of intermediate grade tumors in this cohort. The absence of grade I tumors may suggest delayed presentation or diagnosis at more advanced histological stages a challenge frequently encountered in low and middle-income countries due to limited access to routine screening programs [18]. Furthermore, the high frequency of grade II tumors underscores the importance of implementing individualized management strategies that integrate both molecular subtype and histopathological grade to improve clinical outcomes. Supporting this observation, a multicenter study by [19] in the Middle East reported that approximately 70% of breast cancer cases were grade II, indicating a moderate degree of differentiation. Likewise, a population-based study by [20] in Asia found that grade II tumors comprised nearly 65% of cases, reinforcing the global trend toward intermediate-grade predominance. Ki-67, a nuclear protein linked to cell proliferation, exhibited age-associated variations with the highest expression (≥25%) in the 50–59 age group. This may reflect the presence of more aggressive tumor biology in this subgroup. High Ki-67 expression is known to correlate with tumor grade, poor prognosis, and luminal B or HER2-enriched subtypes, which are more likely to require chemotherapy and exhibit resistance to hormone therapy [21]. These findings are consistent with previous studies indicating that older women can develop biologically aggressive tumors, particularly when diagnosis is delayed or screening is limited [22]. The significant differences in biomarker expression between age groups ($P \leq 0.05$) reinforce the value of using a multi-marker IHC panel for improved molecular characterization of breast cancer, particularly in resource-limited settings where genetic profiling is unavailable. The expression patterns observed here suggest a trend of higher proliferative indices and possible molecular subtype shifts in midlife patients (50–59 years), supporting the need for age-adapted treatment approaches. Ki-67, the data showed that only 10% of luminal A tumors exhibited high proliferative activity (>25%), if luminal

A subtype tumors in they may be reclassified as luminal B, according to current clinical and molecular guidelines. while 46.6% had low expression (<25%). This distribution supports the traditional classification of luminal A as a low-proliferation, hormone-sensitive subtype with a favorable prognosis. The statistically significant difference ($P \leq 0.05$) between high and low Ki-67 expression indicates internal biological variation, which is important for treatment stratification.

Recent studies have shown that Ki-67 ≥20–25% is associated with poorer outcomes, even within luminal A tumors, and can prompt a reclassification to luminal B in some clinical guidelines [21,23]. Classification into luminal A or luminal B subtypes is based not only on hormone receptor (ER/PR) and HER2 status, but also on proliferative activity, typically assessed by Ki-67 [21].

Ki-67, luminal B tumors are defined by high proliferative activity, often measured by Ki-67 >20–25%. In this study, high expression was observed in ~6.6%, and low expression in ~5% of luminal B cases. While both values are relatively close, the statistically significant difference confirms that Ki-67 expression levels vary significantly within the luminal B group, which may reflect intra-subtype differences in prognosis and treatment response [21]. High Ki-67 expression is associated with shorter disease-free survival, increased recurrence, and a greater likelihood of requiring adjuvant chemotherapy—even in patients who are hormone receptor-positive need for adjuvant chemotherapy [23]. Elevated Ki-67 expression is notably linked to unfavorable clinical outcomes and is commonly utilized to differentiate luminal B tumors from those of the luminal A subtype [24]. HER2-enriched tumors typically display high Ki-67 levels, reflecting rapid proliferative [25]. Variations in Ki-67 expression may arise due to differences in tissue fixation, sampling variability, or underlying tumor biology, especially in small or moderately aggressive HER2-positive cases. The significant statistical difference between high and low expression groups emphasizes the diversity of proliferative activity within this subtype. In terms of proliferation, Ki-67 high expression (>25%) was detected in 3.3%, and low expression (<25%) in 8.3% of TNBC cases. While TNBC is often associated with high Ki-67 levels, which correlate with increased tumor aggressiveness and worse prognosis, variability in Ki-67 expression in this study suggests biological diversity even within TNBC. These findings are disagreed with previous studies by [26,15] who reported that TNBC often displays basal-like features with high Ki-67 and EGFR expression. In contrast, luminal subtypes, particularly luminal A, exhibited significantly lower expression of proliferation and basal markers, correlating with their better prognostic profile [13.25]. The significant difference between high and low Ki-67 groups indicates that proliferation rate remains an important prognostic factor in TNBC, with implications for treatment intensity and follow-up strategies [21].

5. Conclusion

Highest incidence of breast cancer in the present study patients was (31%) in age group (50-59) years. Rates of breast cancer were low in women under 40, and the most common tumor grade according to grading system was in grade II (76.7%), Subtype luminal A, Luminal B tumors, HER2-enriched tumors, and in the triple-negative breast cancer subtype, statistically significant differences ($P \leq 0.05$) were found between the high and low expressions of ki-67. Statistically significant differences ($P \leq 0.05$) were observed in grades I, II, and III in relation to the expression of ki-67. In grade II, III, statistically significant differences ($P \leq 0.05$) were observed between the high and low expressions of ki-67., and Ki-67 provides a measure of tumor proliferation, helping to distinguish between luminal A (low Ki-67) and luminal B (high Ki-67) tumors.

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