Research Article

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Prediction of pathological complete response after neoadjuvant treatment in triple negative breast cancer: a single center experience

Üçlü negatif meme kanserinde neoadjuvan tedavi sonrası patolojik tam yanıtın öngörülmesi: tek merkez deneyimi

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Abstract

Purpose: To identify clinicopathological factors associated with pathological complete response (pCR) after neoadjuvant chemotherapy (NAC) in patients with triple-negative breast cancer (TNBC).

Matherials and methods: A retrospective study of 51 women with stage I–III TNBC who received NAC between January 2019 and December 2024 at Antalya Training and Research Hospital. Binary logistic regression was used to determine independent predictors of pCR.

Results: The median age was 49 years (range: 28-79), and 28 patients (54.9%) achieved pCR. Patients aged ≥60 were significantly less likely to achieve pCR (OR: 0.22; 95% CI: 0.05-0.98; *p*=0.048*). No significant associations were found for carboplatin or pembrolizumab use.

Conclusion: This real-world cohort confirms that pCR rates are consistent with literature. Advanced age was a significant negative predictor, emphasizing the importance of personalized approaches in elderly patients.

Keywords: Triple-negative breast cancer, neoadjuvant treatment, pathological complete response.

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Öz

Amaç: Üçlü negatif meme kanseri (TNBC) hastalarında neoadjuvan kemoterapi (NAK) sonrası patolojik tam yanıt (pTY) ile ilişkili klinikopatolojik faktörleri belirlemektir.

Gereç ve yöntem: Ocak 2019 - Aralık 2024 tarihleri arasında Antalya Eğitim ve Araştırma Hastanesi'nde NAK almış evre I–III TNBC tanılı 51 kadın hastanın verileri retrospektif olarak incelendi. pTY'yi öngören bağımsız değişkenleri belirlemek amacıyla ikili lojistik regresyon analizi yapıldı.

Bulgular: Ortanca yaş 49 (28-79) idi ve 28 hastada (%54,9) pTY elde edildi. Yaş ≥60 olan hastalarda pTY elde etme olasılığı anlamlı şekilde düşüktü (OR: 0,22; %95 GA: 0,05-0,98; *p*=0,048*). Karboplatin ve pembrolizumab kullanımı ile pTY arasında istatistiksel olarak anlamlı ilişki bulunmadı.

Sonuç: Gerçek yaşam verilerine dayanan bu çalışmada, pTY oranı literatürle uyumluydu. Yaşlı hastalarda pTY oranının düşük olması, kişiselleştirilmiş tedavi yaklaşımlarının gerekliliğini vurgulamaktadır.

Anahtar kelimeler: Üçlü negatif meme kanseri, neoadjuvan tedavi, patolojik tam yanıt.

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Introduction

Triple-negative breast cancer (TNBC) constitutes approximately 10-15% of all breast cancer cases and is defined by the absence of estrogen receptor (ER), progesterone receptor (PR), and human epidermal growth factor receptor 2 (HER2) expression. This subtype is associated with a more aggressive clinical course, higher recurrence rates, and poor survival outcomes, particularly in the absence of targeted therapies [1, 2]. Given its biological aggressiveness and lack of hormone-driven targets, NAC remains the mainstay of treatment for early-stage TNBC. It enables assessment of tumor responsiveness and may eradicate potential micrometastatic disease [3].

Achieving pCR after NAC is a robust surrogate for improved disease-free and overall survival (OS) in TNBC [4]. Standard NAC regimens typically consist of anthracycline- and taxane-based combinations. In recent years, the incorporation of carboplatin into these regimens has significantly improved pCR rates, with meta-analyses reporting an absolute increase of approximately 13-19% [5]. Furthermore, the addition of immune checkpoint inhibitors such as pembrolizumab has shown promising efficacy. The KEYNOTE-522 trial demonstrated that pembrolizumab combined with chemotherapy significantly improved pCR, event-free survival, and OS in early-stage TNBC, supporting its inclusion in clinical guidelines [6].

Despite these advances, real-world data on predictors of pCR remain limited. Factors such as age, tumor grade, Ki-67 index, BRCA status, and clinical stage have been proposed, but results across studies vary [7]. This study aims to explore clinicopathological predictors of pCR in TNBC patients treated with NAC at a single tertiary oncology center.

Materials and methods

Study population and data collection

This retrospective observational study was conducted at Antalya Training and Research Hospital, a high-volume tertiary oncology center. The study included women aged ≥18 years who were diagnosed with stage I–III TNBC and received NAC between January 2019 and December 2024. Patients with distant metastasis at diagnosis or those who underwent primary surgery without prior NAC were excluded. Patients lost to follow-up or with incomplete data were also excluded. Out of 65 patients initially screened, 14 were excluded due to having undergone surgery prior to NAC. Ultimately, 51 patients were eligible for final analysis.

Clinical and pathological data were extracted from electronic medical records and patient follow-up files. Collected data included age at diagnosis, tumor size (T stage), nodal status (N stage), tumor grade, Ki-67 index, pathological response, BRCA germline mutation status, and NAC regimen details (including use of carboplatin and/or pembrolizumab). Staging was performed according to the 8th edition of the American Joint Committee on Cancer (AJCC). pCR was defined as the absence of residual invasive carcinoma in both breast and axillary lymph nodes (ypT0/Tis, ypN0) based on postoperative pathology.

The study was approved by the Scientific Ethics Committee for Medical Research of Antalya Training and Research Hospital (approval date: 17.04.2025 and approval number: 7/10) and conducted in accordance with the Declaration of Helsinki.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics version 24.0. Descriptive statistics were expressed as medians (range) and frequencies. Categorical variables were compared using Pearson's Chi-square test. Binary logistic regression was conducted to identify independent predictors of pCR. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported. Due to the high proportion of missing data, BRCA status was excluded from the regression model. A p-value <0.05 was considered statistically significant.

Results

A total of 51 female patients with TNBC who received NAC were included in the study. The median age at diagnosis was 49 years (range: 28-79). pCR was achieved in 28 patients (54.9%). Clinical T3-T4 disease was noted in 15 patients (29.4%), and 13 (25.5%) were clinically node-negative at diagnosis. Regarding tumor grade, 24 patients (47.1%) had grade 2 tumors, and 25 (49.0%) had grade 3 tumors. A high

Ki-67 index (>40%) was seen in 35 patients (68.6%). BRCA germline testing was available for 15 patients, with pathogenic mutations found in 3 (5.9% of the entire cohort); due to the limited availability, this variable was excluded from further analysis.

Carboplatin was included in the NAC regimen for 36 patients (70.6%), while pembrolizumab was administered to 6 patients (11.8%). Comparison between pCR and non-pCR groups showed no statistically significant differences in clinicopathological characteristics (Table 1).

Table 1. Comparison of clinical and pathological characteristics according to pathological response

	Complete Pathological Response Group (n=28)	Non-Pathological Complete Response Group (n=23)	*p*
Age (Years), n (%)			
<60	23 (82.1)	15 (65.2)	0.168 (χ^2=1.901)
≥60	5 (17.9)	8 (34.8)	
T stage, n (%)			
T1-2	22 (78.6)	14 (60.9)	0.167 (χ^2=1.910)
T3-4	6 (21.4)	9 (39.1)	
N stage, n (%)			
Negative	5 (17.9)	8 (34.8)	0.168 (χ^2=1.901)
Positive	23 (82.1)	15 (65.2)	
Histological Grade, n (%) *			
1	0 (0.0)	0 (0.0)	0.674 (χ^2=0.177)
2	12 (46.2)	12 (52.2)	
3	14 (53.8)	11 (47.8)	
c-ERBB2 (IHC Score), n (%)			
0	19 (67.9)	16 (69.4)	0.896 (χ^2=0.017)
1-2	9 (32.1)	7 (30.4)	
Ki-67 index, n (%) ¥			
≤40	6 (23.1)	6 (28.6)	0.668 (χ^2=0.184)
>40	20 (76.9)	15 (71.4)	
Affected Breast Side, n (%)			
Left	14 (50.0)	13 (56.5)	0.642 (χ^2=0.216)
Right	14 (50.0)	10 (43.5)	
Breast Cancer Family History, n (%)			
No	27 (96.4)	21 (91.3)	0.439 (χ^2=0.599)
Yes	1 (3.6)	2 (8.7)	
BRCA 1-2 Analysis, n (%)			
Wild	6 (21.4)	6 (26.1)	0.653 (χ^2=0.852)
Mutated	1 (3.6)	2 (8.7)	
Unknown	21 (75.0)	15 (65.2)	
Carboplatin Administration, n (%)			
No	9 (32.1)	6 (26.1)	0.637 (χ^2=0.223)
Yes	19 (67.9)	17 (73.9)	
Pembrolizumab Administration, n (%)			
No	23 (82.1)	22 (95.7)	0.136 (χ^2=2.223)
Yes	5 (17.9)	1 (4.3)	

IHC: Immunohistochemistry, *: Histological grade was not available for two patients, ¥: Ki-67 index was not available for four patients
χ^2: Chi-Square test; *p<0.05

In binary logistic regression analysis, age ≥60 years was significantly associated with reduced likelihood of achieving pCR (OR: 0.22; 95% CI: 0.05-0.98; *p*=0.048*). Use of carboplatin (OR: 1.28; 95% CI: 0.25-6.69; *p*=0.764) and pembrolizumab (OR: 3.45; 95% CI: 0.31-39.04; *p*=0.316) did not reach statistical significance (Table 2).

Table 2. Clinicopathological effectors of pathological complete response

Risk Factor	OR (95% CI)	*p*
Age (years)		
<60 (Ref.) ≥60	0.22 (0.05-0.98)	0.048*
T stage		
T1-2 (Ref.) T3-4	0.38 (0.1-1.51)	0.170
N stage		
Negative (Ref.) Positive	2.94 (0.65-13.21)	0.160
Histological Grade		
Grade 2 (Ref.) Grade 3	0.62 (0.13-3.03)	0.554
c-ERBB2 (IHC score)		
0 (Ref.) 1-2	1.27 (0.29-5.58)	0.750
Ki-67 index		
≤40 (Ref.) >40	1.45 (0.29-7.17)	0.647
Affected Breast Side		
Left (Ref.) Right	1.68 (0.44-6.45)	0.450
Carboplatin Administration		
No (Ref.) Yes	1.28 (0.25-6.69)	0.764
Pembrolizumab Administration		
No (Ref.) Yes	3.45 (0.31-39.04)	0.316

CI: Confidence Interval, IHC: Immunohistochemistry, OR: Odds ratio, *$p<0.05$

Discussion

In this single-center, real-world cohort, a pCR rate of 54.9% was observed, aligning closely with published data on TNBC. Age ≥60 years was significantly associated with a lower likelihood of achieving pCR (OR: 0.22; 95% CI: 0.05-0.98), consistent with previous multi-institutional and pooled analyses that report a negative correlation between increasing age and pCR outcomes [6, 8].

Verdial et al. [9] evaluated 1,383 breast cancer patients (29% with TNBC) and noted a progressive decline in pCR rates—from 52% in patients ≤40 years to 29% in those ≥61 years—after adjusting for subtype, grade, and BRCA status. Additionally, older patients frequently experience unplanned dose reductions, treatment delays, or therapy interruptions due to toxicity or comorbidities. Real-world data suggest that over 40% of women aged ≥70 years receive attenuated NAC, a practice linked to both reduced pCR rates and worse survival outcomes [9, 10]. These observations underscore the necessity for geriatric-adapted yet dose-intense treatment regimens.

Biological mechanisms proposed to explain diminished treatment response in older individuals include immunosenescence-related lymphocyte exhaustion, reduced DNA damage repair (DDR) capability, and age-related pharmacokinetic alterations that may result in subtherapeutic drug levels in tumor tissue [11].

In contrast to existing literature, the incorporation of carboplatin into NAC regimens did not yield a statistically significant benefit in our cohort. This finding diverges from studies such as the BrighTNess trial, which reported a 17% absolute improvement in pCR and a long-term event-free survival (EFS) benefit. Similarly, the CALGB 40603 study demonstrated a 13% increase in pCR with carboplatin [12, 13]. A meta-analysis of 11 randomized trials also reported a pooled pCR benefit of 13-19% [14]. The lack of significant findings in our analysis likely reflects the small sample size and resulting limited statistical power.

Only six patients (11.8%) in our cohort received pembrolizumab, precluding meaningful conclusions about its efficacy. In contrast, the KEYNOTE-522 trial showed a 15-18% improvement in pCR and a 37% reduction in EFS hazard with the addition of pembrolizumab to chemotherapy. A recent update also confirmed a 4.9% absolute improvement in overall survival in the pembrolizumab arm [6]. These results have led to its incorporation into current treatment guidelines.

This study has several limitations. Its retrospective nature, relatively small sample size, potential selection bias, and incomplete molecular profiling limit the generalizability of findings. Nevertheless, the study population likely reflects a typical TNBC cohort in middle-income countries where financial barriers limit the routine use of pembrolizumab.

In conclusion these findings partially align with prior research emphasizing the role of age as a determinant of treatment response in TNBC. The absence of statistically significant associations for carboplatin and pembrolizumab likely reflects sample size limitations and treatment heterogeneity. Our data highlight the importance of personalized strategies to optimize treatment compliance and outcomes in elderly patients. Such strategies may include the integration of geriatric assessments, prophylactic G-CSF support, and nutritional interventions.

Ultimately, precise identification of factors associated with pCR can facilitate individualized treatment planning, enhance outcomes, and inform clinical decision-making in the context of precision oncology.

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Conflict of interest: The authors declare that they have no conflict of interest.

References

1. Bianchini G, Balko JM, Mayer IA, Sanders ME, Gianni L. Triple-negative breast cancer: challenges and opportunities of a heterogeneous disease. *Nat Rev Clin Oncol*. 2016;13(11):674-690. doi:10.1038/nrclinonc.2016.66
2. Denkert C, Liedtke C, Tutt A, von Minckwitz G. Molecular alterations in triple-negative breast cancer-the road to new treatment strategies. *Lancet*. 2017;389(10087):2430-2442. doi:10.1016/S0140-6736(16)32454-0
3. Liedtke C, Mazouni C, Hess KR, et al. Response to neoadjuvant therapy and long-term survival in patients with triple-negative breast cancer. *J Clin Oncol*. 2008;26(8):1275-1281. doi:10.1200/JCO.2007.14.4147
4. Cortazar P, Zhang L, Untch M, et al. Pathological complete response and long-term clinical benefit in breast cancer: the CTNeoBC pooled analysis [published correction appears in Lancet. 2019;393(10175):986. doi:10.1016/S0140-6736(18)32772-7.]. *Lancet*. 2014;384(9938):164-172. doi:10.1016/S0140-6736(13)62422-8
5. Poggio F, Bruzzone M, Ceppi M, et al. Platinum-based neoadjuvant chemotherapy in triple-negative breast cancer: a systematic review and meta-analysis. *Ann Oncol*. 2018;29(7):1497-1508. doi:10.1093/annonc/mdy127
6. Schmid P, Cortes J, Dent R, et al. Event-free Survival with Pembrolizumab in Early Triple-Negative Breast Cancer. *N Engl J Med*. 2022;386(6):556-567. doi:10.1056/NEJMoa2112651
7. von Minckwitz G, Untch M, Blohmer JU, et al. Definition and impact of pathologic complete response on prognosis after neoadjuvant chemotherapy in various intrinsic breast cancer subtypes. *J Clin Oncol*. 2012;30(15):1796-1804. doi:10.1200/JCO.2011.38.8595
8. Gass P, Lux MP, Rauh C, et al. Prediction of pathological complete response and prognosis in patients with neoadjuvant treatment for triple-negative breast cancer. *BMC Cancer*. 2018;18(1):1051. doi:10.1186/s12885-018-4925-1
9. Verdial FC, Mamtani A, Pawloski KR, et al. The Effect of Age on Outcomes After Neoadjuvant Chemotherapy for Breast Cancer. *Ann Surg Oncol*. 2022;29(6):3810-3819. doi:10.1245/s10434-022-11367-w
10. Krishnan J, Patel A, Roy AM, et al. Detrimental Impact of Chemotherapy Dose Reduction or Discontinuation in Early Stage Triple-Negative Breast Cancer Treated With Pembrolizumab and Neoadjuvant Chemotherapy: A Multicenter Experience. *Clin Breast Cancer*. 2024;24(8):e701-e711.e2. doi:10.1016/j.clbc.2024.08.005
11. Pawelec G, Derhovanessian E, Larbi A. Immunosenescence and cancer. *Crit Rev Oncol Hematol*. 2010;75(2):165-172. doi:10.1016/j.critrevonc.2010.06.012
12. Shepherd JH, Ballman K, Polley MC, et al. CALGB 40603 (Alliance): Long-Term Outcomes and Genomic Correlates of Response and Survival After Neoadjuvant Chemotherapy With or Without Carboplatin and Bevacizumab in Triple-Negative Breast Cancer. *J Clin Oncol*. 2022;40(12):1323-1334. doi:10.1200/JCO.21.01506
13. Pandy JGP, Balolong Garcia JC, Cruz Ordinario MVB, Que FVF. Triple negative breast cancer and platinum-based systemic treatment: a meta-analysis and systematic review. *BMC Cancer*. 2019;19(1):1065. doi:10.1186/s12885-019-6253-5
14. Gianni L, Huang CS, Egle D, et al. Pathologic complete response (pCR) to neoadjuvant treatment with or without atezolizumab in triple-negative, early high-risk and locally advanced breast cancer: NeoTRIP Michelangelo randomized study. *Ann Oncol*. 2022;33(5):534-543. doi:10.1016/j.annonc.2022.02.004