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Associations Between Breast Cancer Stage, Surgical Treatment, and Adjuvant Therapy in a Resource-Limited Setting: A Descriptive Study from Al Bayda, Libya

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Abstract:
Breast cancer (BC) management in low-resource settings faces unique challenges due to limited diagnostic capacity, infrastructural constraints, and restricted access to adjuvant therapies. This retrospective descriptive study aimed to describe the clinical characteristics, surgical treatment patterns, and adjuvant therapy coverage among BC patients in Al Bayda, Libya, and to identify barriers affecting the delivery of standard care. Data were collected from 57 histopathologically confirmed BC patients treated between 2017 and 2019, including age, tumor stage, surgical intervention, and receipt of adjuvant therapy. Patients' ages ranged from 33 to 75 years, with a notable predominance of relatively younger women. Most patients (68.4%) were diagnosed at an early stage. Despite this, simple mastectomy with axillary clearance remained the predominant surgical approach, performed in 87.7% of cases, including a substantial proportion of early-stage patients. Postoperative radiotherapy (RT) was not available locally, and patients were referred to other cities for treatment, often resulting in inconsistent documentation. Chemotherapy (CHT) was administered to 94.7% of patients, irrespective of stage. Cancer stage did not significantly influence surgical or CHT decisions, whereas surgical procedure type was significantly associated with the likelihood of receiving postoperative RT ($p < 0.001$). These findings indicate that structural limitations, rather than clinical stage alone, strongly influence treatment decisions in Al Bayda. Establishing a dedicated local RT center would enhance access to breast-conserving surgery, reduce treatment burdens, and promote alignment with international standards.

Keywords: Breast Cancer, Mastectomy, Radiotherapy Access, Al Bayda, Libya.

Introduction

Breast cancer (BC) remains the most commonly diagnosed malignancy among women worldwide, accounting for approximately 2.3 million new cases annually (WHO, 2024). Despite substantial advances in early detection and treatment strategies, surgery continues to serve as the cornerstone of curative management, typically complemented by adjuvant therapies, including radiotherapy (RT), chemotherapy (CHT), and endocrine treatment. Nevertheless, over the past two decades, BC has claimed 670,000 lives worldwide, with 2022 alone accounting for 170,000 deaths (WHO, 2022). Cancer recurrence remains a major contributor to mortality, manifesting as regional disease in lymph nodes or chest wall, distant metastases, local recurrence, or a combination thereof. Although survival outcomes vary by subtype and period, recent studies indicate that post-recurrence survival remains limited, highlighting the poor prognosis associated with recurrent breast cancer (Lee *et al.,* 2023). Adjuvant therapy and tumor subtype significantly influence long-term recurrence risk in breast cancer, with substantial differences in 10-year recurrence rates observed between molecular subtypes (e.g.,

higher recurrence in triple-negative and HER2-positive tumors compared with luminal types (Ignatov *et al.,* 2018; van Maaren *et al.,* 2019). The incidence of BC is rising, particularly in emerging nations. Approximately one million women worldwide receive a new BC diagnosis annually, with over 400,000 deaths resulting from the disease. In many low- and middle-income countries, infrastructure and resources for routine screening mammography are limited, leading to frequent late-stage detection and suboptimal access to treatment and palliative care (Ferlay *et al.,* 2010; Tfayli *et al.,* 2010; WHO, 2025). Adjuvant RT after surgery improves overall survival and BC-specific survival while reducing locoregional recurrence (Kolářová *et al.,* 2024). According to NCCN guidelines and evidence from randomized controlled trials, adjuvant whole-breast radiotherapy is recommended for the majority of women undergoing breast-conserving surgery, as it significantly reduces locoregional recurrence and improves breast cancer-specific survival (Darby *et al.,* 2011; NCCN, 2025). Adjuvant chemotherapy improves disease-free survival in breast cancer patients and carries expected side effects, including fatigue, alopecia, and nausea (Spittle *et al.,* 1986; French Adjuvant Study Group, 2001). Although local registries suggest a doubling of BC rates over the past 40 years, it remains unclear whether this reflects a true increase or improved reporting across Africa (Adeloye *et al.,* 2018). In the Arab world, epidemiological data on BC remain sparse, with some countries maintaining cancer registries while others lack comprehensive population-based data. BC is the most prevalent malignancy among Arab women and tends to affect younger populations compared with Western countries (El Saghir et al., 2007; Najjar & Easson, 2010). In Libya, BC accounts for approximately 18% of female malignancies, with an estimated incidence of about 18–19 new cases per 100,000 women annually, representing a significant public health concern (Boder *et al.,* 2011). Ineffective data collection and the absence of comprehensive cancer registries have contributed to delayed diagnosis and advanced-stage presentation of gynecological malignancies, including BC, ultimately resulting in higher mortality rates, particularly in low- and middle-income countries (El Saghir *et al.,* 2007; WHO, 2014). Delays in diagnosis are associated with reduced survival and increased likelihood of aggressive therapies (Richards *et al.,* 1999; WHO, 2014; Kumilau *et al.,* 2025). In addition, BC patients often experience significant psychological morbidity, including anxiety and depression, along with diminished health-related quality of life, particularly in cases of delayed diagnosis or aggressive therapy (Mokhtari-Hessari & Montazeri, 2020). Choosing between mastectomy and breast-conserving surgery (BCS) represents a challenging decision for patients, influenced by both robust clinical evidence and individual preferences. Long-term trials have demonstrated that BCS followed by radiotherapy provides survival outcomes equivalent to mastectomy for early-stage BC (Fisher *et al.,* 2002). Simultaneously, growing emphasis on shared decision-making has underscored the importance of incorporating patient autonomy and preferences into treatment choices (Barry & Edgman-Levitan, 2012; NCCN, 2024). Accurate staging is essential for prognosis and treatment planning in BC. The 8th edition of the American Joint Committee on Cancer (AJCC) Cancer Staging Manual incorporated biological markers such as HER2, ER, PR, and multigene assays alongside traditional TNM parameters to enhance prognostic accuracy and guide therapy selection (Amin *et al.,* 2017; Kumilau *et al.,* 2025). Surgery remains the gold standard for localized breast cancer, often combined with adjuvant radiation, chemotherapy, or endocrine therapy to improve outcomes. However, published data from eastern Libya are limited, reflecting a scarcity of local studies on treatment patterns and survival (Boder *et al.,* 2011; Kolářová *et al.,* 2024). Recent studies from Benghazi, including analyses of patient presentations at the Medical Center Oncology Department (2020–2023) (Elsehati *et al.,* 2025) and investigations into histopathology and hormonal receptor biomarkers (2019–2024) (Elfrgani *et al.,* 2024), have begun to fill this knowledge gap. This study aimed to describe the stage distribution at diagnosis, explore associations between stage, surgical management, and adjuvant therapy, and identify healthcare barriers impacting BC care in Al Bayda.

Material and Methods

Study Population

This retrospective descriptive study used data from the Department of Pathology database at Al-Bayda Medical Center. Between January 2017 and December 2019, 1,900 women attended the Breast Clinic, of whom 57 were histopathologically confirmed to have BC.

Demographic and clinical variables included age, cancer stage (Giuliano *et al.,* 2018), type of surgery, and adjuvant therapy. The index date was defined as the date of surgical intervention. No survival analysis was conducted, as the study aimed primarily to describe treatment patterns.

Ethical approval was obtained, and patient confidentiality was maintained.

Statistical analysis
Analyses were conducted using SPSS version 17. Descriptive statistics summarized frequencies and percentages. Chi-square and Fisher's Exact tests were applied to examine associations between stage and treatment modalities. A p-value < 0.05 was considered statistically significant.

Results

The results comprise descriptive statistics to characterize the study cohort, followed by inferential analyses examining associations between cancer stage, surgical management, and adjuvant treatment.

Descriptive characteristics of the study population
The ages of the patients ranged from 33 to 75 years. Most patients (68.4%) were diagnosed at an early stage of disease, whereas 31.6% presented with advanced-stage BC. Simple mastectomy with axillary clearance was the predominant surgical procedure, performed in 87.7% of cases, including a substantial proportion of patients with early-stage disease.

Cancer stage
A total of 39 patients (68.4%) were diagnosed at an early stage, while 18 patients (31.6%) were diagnosed at a later stage (Figure 1).

Surgical management
Simple mastectomy with axillary clearance was the most frequently performed surgical intervention, accounting for 87.7% (n = 50) of all cases. Breast-conserving procedures, including lumpectomy with or without axillary clearance, were performed in 12.3% (n = 7) of patients (Figure 2).

Chemotherapy
The majority of patients received CHT as part of their treatment regimen, with 94.7% (n = 54) undergoing systemic therapy (Figure 3).

Radiotherapy
Postoperative RT was administered to 91.2% (n = 52) of patients. However, RT was not available locally, and treatment was delivered following referral to centers in other cities (Figure 4).

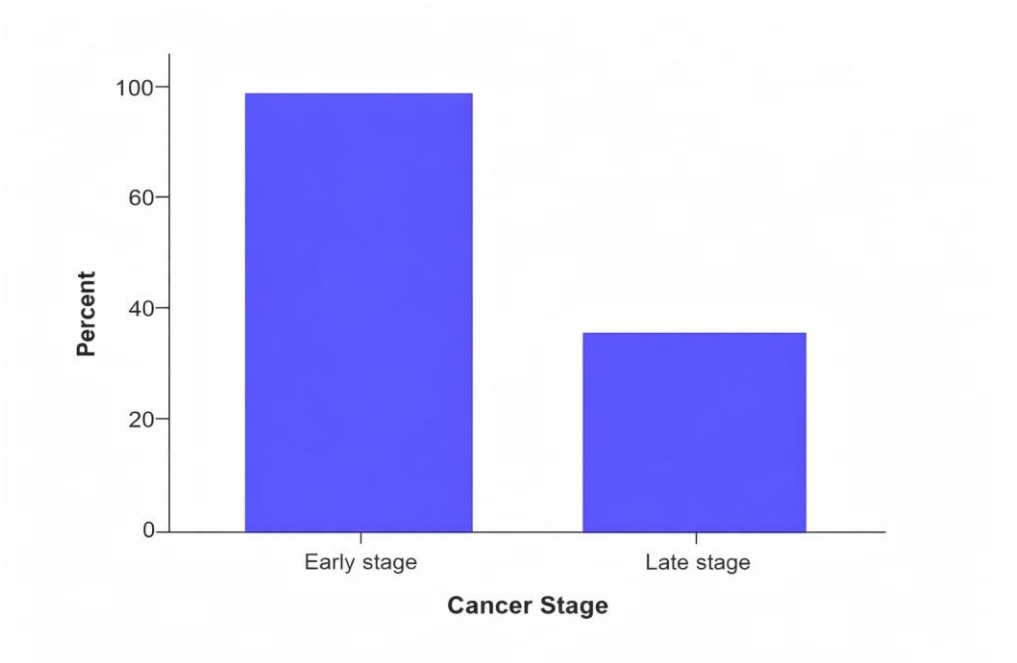

Figure 1: Cancer Stage

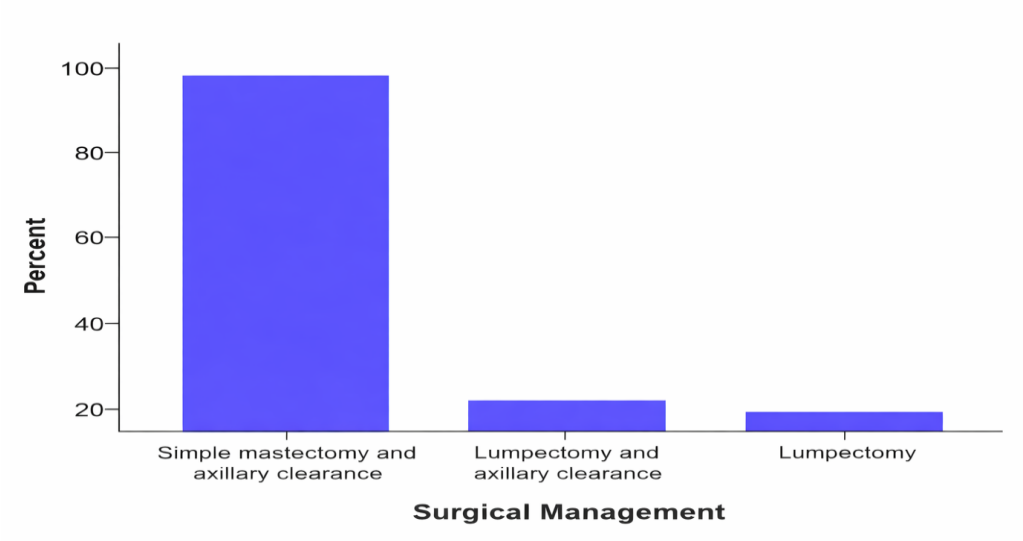

Figure 2: Surgical Management

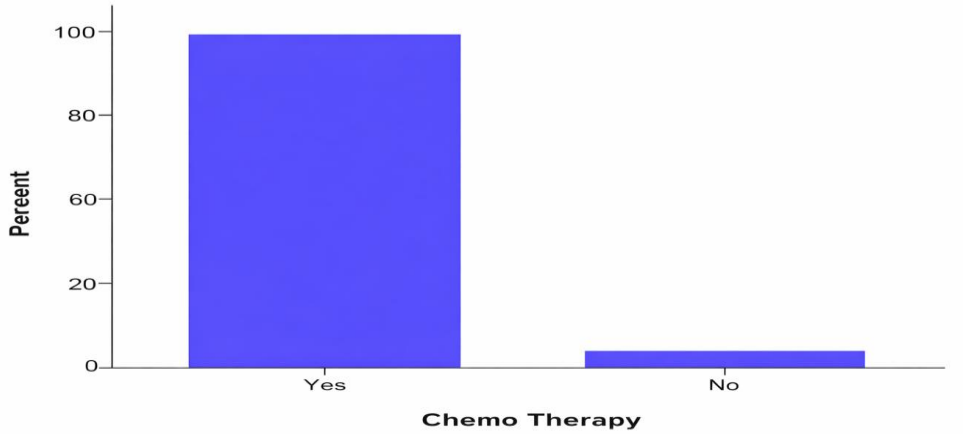

Figure 3: Chemotherapy

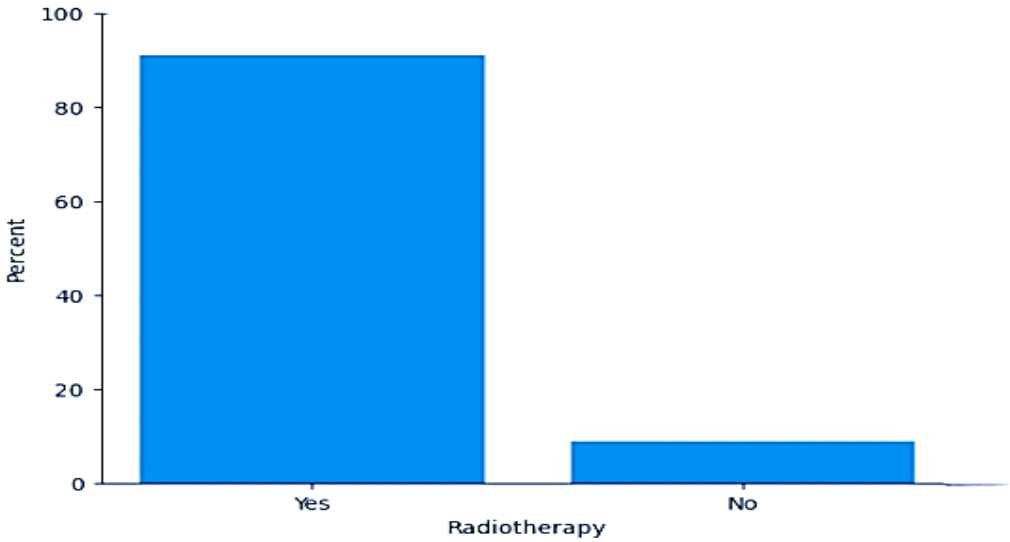

Figure 4: Radiotherapy

Cancer Stage and Treatment Method Relationship

Chi-square analysis and cross-tabulation were performed to examine the association between cancer stage and the type of surgical intervention. All patients with late-stage disease (100%) underwent simple mastectomy with axillary clearance, compared with 82.1% of patients diagnosed at an early stage. Despite this difference, the association between cancer stage and surgical management was not statistically significant.

Given the small sample size and the fact that 66.7% of cells had expected counts below five, Fisher's Exact Test was applied for statistical interpretation. The results demonstrated no significant association between cancer stage and the type of surgical intervention ($p = 0.275$).

Table 1: Association between BC stage and surgical management among patients treated in Al Bayda (2017–2019).

			Surgical Management			Total	X^2	P-value
			Simple mastectomy and axillary clearance	Lumpectomy and axillary clearance	Lumpectomy			
Cancer Stage	Early stage	Count	32	3	4	39	3.683	0.275
		% within Cancer Stage	82.1%	7.7%	10.3%	100.0%		
	Late stage	Count	18	0	0	18		
		% within Cancer Stage	100.0%	0.0%	0.0%	100.0%		
Total		Count	50	3	4	57		
		% within Cancer Stage	87.7%	5.3%	7.0%	100.0%		

Cancer stage and chemotherapy

The correlation between cancer stage and CHT administration was also examined in Table 2. All of the participants in the late-stage group (100%) and 92.3% of those in the early-stage group were administered CHT. This difference was determined to be statistically not significant based on Fisher's Exact Test (p =0 .544).

Table 2: Determining the association between cancer stage and Chemotherapy

			Chemotherapy		Total	X^2	P-Value
			Yes	No			
Cancer Stage	Early stage	Count	36	3	39	1.462	0.544
		% within Cancer Stage	92.3%	7.7%	100.0%		
	Late stage	Count	18	0	18		
		% within Cancer Stage	100.0%	0.0%	100.0%		
Total		Count	54	3	57		
		% within Cancer Stage	94.7%	5.3%	100.0%		

The relationship between surgical management and radiotherapy

A statistically significant association was observed between the type of surgical management and the administration of postoperative RT. Both the Chi-square test and Fisher's Exact Test demonstrated strong statistical significance ($p < 0.001$).

Cross-tabulation analysis revealed that RT was administered to 49 of 50 patients (98.0%) who underwent simple mastectomy with axillary clearance. In contrast, none of the three patients who underwent lumpectomy with axillary clearance received postoperative RT.

Among the four patients treated with lumpectomy alone, three (75.0%) received RT. These findings indicate that the type of surgical procedure significantly influenced the likelihood of receiving postoperative RT (Table 3).

Table 3: Investigate the relationship between the type of surgical management and the administration of postoperative RT.

			Radiotherapy		Total	X^2	P-Value
			Yes	No			
Surgical Management	Simple mastectomy and axillary clearance	Count	49	1	50	35.382	0.000
		% within Surgical Management	98.0%	2.0%	100.0%		
	Lumpectomy and axillary clearance	Count	0	3	3		
		% within Surgical Management	0.0%	100.0%	100.0%		
	Lumpectomy	Count	3	1	4		
		% within Surgical Management	75.0%	25.0%	100.0%		
Total		Count	52	5	57		
		% within Surgical Management	91.2%	8.8%	100.0%		

Discussion

This study evaluated the clinical profiles and treatment approaches of 57 patients diagnosed with BC, focusing on the relationships between cancer stage and key therapeutic options, including surgery, CHT, and RT. The findings provide valuable insight into local clinical practice and highlight the factors that influence treatment decision-making. Consistent with global trends, most patients in this research were diagnosed at an early stage, reflecting increased awareness and improved BC screening programs (WHO, 2024). Early detection of BC is typically associated with improved survival outcomes and allows a wider range of therapeutic options, including less aggressive surgery and tailored adjuvant therapies (Richards *et al.,* 1999; WHO, 2014). In accordance with recent clinical guidelines, patients with early-stage breast cancer generally undergo surgical treatment followed by adjuvant therapy, tailored according to tumor biology and nodal status (NCCN, 2024; Kumilau *et al.,* 2025). Nevertheless, simple mastectomy with axillary clearance remained the most frequently performed surgical procedure, accounting for nearly 88% of cases. This trend is influenced by factors such as tumor size relative to breast volume, patient preference, surgeon expertise, and resource limitations, which are commonly reported in low- and middle-income countries (Tfayli *et al.,* 2010; Boder *et al.,* 2011). Local evidence from Benghazi reinforces these findings. The National Cancer Center study reported that mastectomy was the predominant surgical approach, with limited use of BCS, reflecting both institutional practice and resource constraints (Elhawari *et al.,* 2025 b). The age-related prevalence study demonstrated that a substantial proportion of Libyan patients are diagnosed at younger ages, often below 50 years, which may influence surgical and systemic treatment decisions, including the use of hormone therapy for receptor-positive tumors (Ermiah *et al.,* 2022; Elhawari *et al.,* 2025 a). Furthermore, the BC Presentations at Benghazi Medical Center Oncology Department (2020–2023) highlighted the increasing number of cases presenting with diverse clinical features, while the histopathological and hormonal receptor biomarker study (2019–2024) provided critical insights into tumor biology, showing variability in receptor status that directly impacts therapeutic planning (Elsehati *et al.,* 2024; Elsehati *et al.,* 2025 b). Together, these studies emphasize that demographic realities, institutional practices, and biological characteristics strongly shape treatment pathways in Benghazi.

No statistically significant association was observed between cancer stage and surgical management. Although all late-stage patients underwent simple mastectomy with axillary clearance, this approach was also predominant among early-stage patients. This lack of association may be attributed to the small sample size and limited use of breast-conserving surgery (BCS), which reduced statistical power. Previous studies have demonstrated that surgical decision-making is influenced not only by disease stage but also by institutional practices, access to radiotherapy, and surgeon training, particularly in resource-restricted environments (Tfayli *et al.,* 2010; Boder *et al.,* 2011; Ermiah *et al.,* 2022). The Benghazi findings further support this interpretation, showing that institutional norms and histopathological realities strongly shape surgical choices. Similarly, cancer stage was

not significantly associated with CHT administration, as nearly all patients received systemic treatment regardless of stage. This pattern likely reflects standardized treatment protocols that emphasize CHT even in early-stage disease, especially where molecular subtyping is limited or unavailable (Tfayli *et al.,* 2010; Ermiah *et al.,* 2022; Elhawari *et al.,* 2025 b). Comparable findings have been reported in studies from low-resource healthcare systems, where CHT is frequently employed as a generalized strategy to reduce recurrence risk in the absence of tailored biological markers or targeted treatment options (Francies *et al.,* 2020; Ermiah *et al.,* 2022). The biomarker study from Benghazi adds nuance to this observation, showing that receptor variability may not always be fully integrated into treatment decisions, underscoring the need for improved diagnostic infrastructure. In contrast, a strong and statistically significant association was observed between surgical management and the use of postoperative radiotherapy. Patients who underwent lumpectomy were significantly more likely to receive RT, and nearly all patients treated with simple mastectomy and axillary clearance also received adjuvant RT. This finding aligns with established evidence demonstrating that BCS requires adjuvant RT to reduce local recurrence and improve survival outcomes (Darby *et al.,* 2011; Kolářová *et al.,* 2024). However, the absence of radiotherapy among patients who underwent lumpectomy with axillary clearance is remarkable and may reflect logistical challenges, margin assessment issues, patient-related contraindications, or limited RT availability, as reported in low-resource healthcare settings (Tfayli *et al.,* 2010; Francies *et al.,* 2020). These results emphasize that RT decisions are closely linked to surgical approach and are shaped by institutional treatment protocols. Overall, while cancer stage remains an important determinant of treatment selection, this study demonstrates that surgical practice patterns, access to adjuvant therapies, and prevailing clinical norms may exert a stronger influence on therapeutic decisions. The integration of local evidence from Benghazi highlights that demographic realities, particularly the younger age profile of patients, histopathological characteristics, and institutional practices significantly shape treatment pathways. Although the observed treatment patterns largely align with established principles of BC management, the variations identified highlight opportunities for improving guideline adherence, expanding biomarker testing, and standardizing care pathways, particularly in resource-limited environments (Francies *et al.,* 2020; Elsehati *et al.,* 2024; Elsehati *et al.,* 2025).

Conclusion

This study suggests that cancer stage on its own did not play a decisive role in guiding surgical or CHT decisions. Instead, the choice of surgical approach was closely linked to whether patients received postoperative RT. These findings highlight how local clinical practices and the availability of resources can strongly influence BC treatment in everyday practice. Larger patient groups, molecular tumor profiling, and long-term follow-up outcomes are important to gain a better understanding of these decision-making processes and to improve patient-centered care.

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