RJNMSR
Review Journal of Neurological & Medical Sciences Review

Volume 3, Issue 8, 2025

SERUM TUMOR MARKER PROFILES IN PATIENTS FROM QUETTA, BALOCHISTAN: A RETROSPECTIVE ANALYSIS OF CA 19-9, CEA, AFP, AND CA-125

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DOI: https://doi.org/10.5281/zenodo.18152066

Received	Accepted	Published
30 October 2025	18 December 2025	31 December 2025

ABSTRACT

Background: *Serum tumor markers are widely utilized in clinical practice for the diagnosis, prognosis, treatment monitoring, and surveillance of various malignancies. Among these, carbohydrate antigen 19-9 (CA 19-9), carcinoembryonic antigen (CEA), alpha-fetoprotein (AFP), and cancer antigen 125 (CA-125) are commonly employed to aid in the evaluation of different cancer types.*

Objective: *This study aimed to retrospectively analyze serum tumor marker profiles in patients admitted to a tertiary care hospital in Quetta, Balochistan, and to assess variations in marker levels with ,Medical diagnosis across different demographic groups.*

Methods: *A retrospective analysis was conducted on laboratory data collected from patients evaluated for tumor markers at a tertiary care hospital in Quetta. Serum levels of CA 19-9, CEA, AFP, and CA-125 were analyzed in relation to demographic characteristics and clinical indications.*

Results: *The majority of patients demonstrated markedly elevated CA 19-9 levels, ranging from 70–300 U/mL to extremely high concentrations (>10,000 U/mL), showing a strong association with pancreatic malignancies. Moderately elevated levels of CEA, CA-125, and CA 15-3 were observed in a subset of patients, suggesting multi-organ involvement. Significantly increased CEA levels, reaching up to >1,000 ng/mL, were predominantly observed in older patients and were indicative of advanced tumor burden.*

Conclusion: *The findings highlight the clinical significance of serum tumor markers in the diagnosis and management of malignancies. Tumor marker profiling plays a vital role in disease monitoring,*

prognostication, therapeutic decision-making, and long-term surveillance, particularly in resource-limited settings such as Balochistan.

Keywords: *Tumor markers, CA 19-9, CEA, AFP, CA-125, malignancy, retrospective study, Quetta, Balochistan*

INTRODUCTION

Tumor markers are biochemical substances produced either by malignant cells or by normal tissues in response to malignancy. These markers are detectable in blood or serum and are widely used in oncology for disease detection, monitoring of treatment response, prognostication, and surveillance of disease recurrence. Despite their clinical utility, tumor markers generally require correlation with radiological imaging and histopathological findings to achieve diagnostic accuracy.**(1,2)**

Carbohydrate antigen 19-9 (CA 19-9) is one of the most frequently utilized tumor markers, particularly in pancreatic adenocarcinoma and other gastrointestinal malignancies. Elevated CA 19-9 levels are often associated with tumor burden and disease progression. However, false elevations may occur in non-malignant conditions such as hepatobiliary disease, pancreatitis, and obstructive jaundice. Notably, markedly elevated CA 19-9 levels (>1,000 U/mL) are strongly suggestive of malignancy and are typically associated with advanced disease and poor prognosis.**(3,4)**

Carcinoembryonic antigen (CEA) is a glycoprotein involved in cell adhesion and is primarily used in the management and follow-up of colorectal carcinoma. It also has clinical relevance in gastric, pancreatic, lung, and breast malignancies. Although CEA lacks sufficient specificity for primary cancer diagnosis, significantly elevated levels are often indicative of advanced disease and metastatic spread. Mild to moderate elevations may also be observed in smokers and in certain benign inflammatory conditions.**(5,6)**

Alpha-fetoprotein (AFP) is a well-established tumor marker for hepatocellular carcinoma and germ cell tumors, while cancer antigen 125 (CA-125) is predominantly associated with epithelial ovarian carcinoma. Elevated CA-125 levels may also be observed in peritoneal involvement, gastrointestinal malignancies, and various benign gynecological conditions. Similarly, cancer antigen 15-3 (CA 15-3) is commonly employed in the monitoring of breast cancer, particularly in advanced and metastatic disease.**(7)**

Given the overlapping elevations of tumor markers in both malignant and non-malignant conditions, the combined interpretation of multiple markers enhances diagnostic accuracy and clinical decision-making. Patterns of tumor marker expression such as isolated elevations or concurrent increases (e.g., CA 19-9 with CEA or CA-125) provide valuable insights into tumor origin, disease extent, and progression. This retrospective study presents a classification-based analysis of commonly requested tumor markers, evaluating their distribution across age and gender groups, and underscores their practical interpretive value in routine laboratory and clinical practice.**(8,9)**

In addition to global evidence, regional data from Balochistan highlight the growing burden of malignancies, chronic liver disease, and related biochemical abnormalities, underscoring the need for reliable laboratory-based diagnostic tools. Previous studies from this region have demonstrated significant associations between abnormal liver function parameters, viral hepatitis prevalence, and oncologic risk profiles across both adult and pediatric populations. Similarly, elevated prostate-specific antigen levels and incidental detection of prostatic adenocarcinoma in routine surgical specimens emphasize the role of tumor markers in early detection and disease stratification. Genetic susceptibility and immune-mediated disorders, such as coeliac disease, further illustrate the complexity of disease presentation in this population and the importance of supportive laboratory investigations .**(10)** Moreover, the broader impact of systemic illnesses and public health crises on disease outcomes and patient management has been documented locally, reinforcing the value of integrated diagnostic and monitoring strategies in resource-limited settings.

Within this context, the present study provides region-specific insight into serum tumor marker patterns and their clinical interpretive significance in routine practice.**(11,12)**

Methodology

Study Design and Setting

This retrospective observational study was conducted at a tertiary care hospital in Quetta, Balochistan, Pakistan. Laboratory records of patients who underwent serum tumor marker testing were reviewed over a defined study period. The hospital serves as a major referral center for both urban and rural populations of the province.

Study Population

All patients for whom serum tumor marker analysis was requested during the study period were eligible for inclusion. Patients of both genders and all age groups were included. Cases with incomplete demographic data or missing laboratory results were excluded from the analysis.

Data Collection

Data were retrieved from the laboratory information system and patient medical records. The collected variables included age, gender, clinical indication for testing, and serum levels of tumor markers. The tumor markers evaluated in this study included carbohydrate antigen 19-9 (CA 19-9), carcinoembryonic antigen (CEA), alpha-fetoprotein (AFP), cancer antigen 125 (CA-125), and cancer antigen 15-3 (CA 15-3), where available.

Laboratory Analysis

Venous blood samples were collected following standard aseptic procedures. Serum was separated by centrifugation and analyzed according to manufacturer instructions. Tumor marker assays were performed using standardized immunoassay techniques on automated analyzers routinely used in the hospital laboratory. Internal quality control procedures were applied daily, and external quality assurance programs were followed to ensure analytical accuracy and precision.

Reference Ranges and Interpretation

Tumor marker results were interpreted using laboratory-defined reference ranges. Marker levels were categorized as normal, moderately elevated, or markedly elevated based on established clinical thresholds. Markedly elevated values (e.g., CA 19-9 >1,000 U/mL, CEA >100 ng/mL) were considered highly suggestive of malignant pathology.

Data Analysis

Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 2021. Continuous variables were expressed as mean ± standard deviation or median with interquartile range, while categorical variables were presented as frequencies and percentages. Associations between tumor marker levels and demographic variables were assessed where applicable. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of the Bolan Medical College ,Hospital. Patient confidentiality was strictly maintained by anonymizing all data prior to analysis. As this was a retrospective study based on existing laboratory records, informed consent was waived in accordance with institutional ethical guidelines.

Results:

A total of **33 patients** were included in the analysis, with ages ranging from **30 to 80 years** (mean age approximately **58 years**). The study population showed a **slight male predominance** (approximately **55% males**). **CA 19-9** was the most frequently requested tumor marker and demonstrated the **highest rate and magnitude of elevation** among all markers analyzed. A substantial proportion of patients exhibited **markedly elevated CA 19-9 levels**, with several values exceeding **1,000 U/ml** and reaching up to **12,000 U/ml**, particularly among patients aged **≥60 years**.Elevated **CEA** levels were observed in multiple cases, including **extremely high concentrations (>100 ng/ml)**, often in combination with raised CA 19-9 levels, suggesting

advanced gastrointestinal malignancy. **CA-125** elevation was observed mainly in female patients, either alone or in combination with CA 19-9 and/or CEA, indicating possible gynecologic or peritoneal involvement. **AFP levels were predominantly within normal limits**, even in patients with significantly elevated CA 19-9, suggesting that hepatocellular carcinoma was unlikely in most cases. Rare elevation of **CA 15-3**, observed in combination with markedly raised CEA and CA-125, was consistent with advanced metastatic disease.Overall, **combined tumor marker elevation** was more informative than isolated marker abnormalities, with the **CA 19-9 and CEA combination** representing the most frequent high-risk pattern. Gender-based analysis demonstrated **greater variability and higher extreme values of CA 19-9 in male patients**. These findings indicate a predominance of **advanced-stage malignancy at presentation** and highlight the diagnostic value of **multi-marker assessment** in routine oncological practice.

Demographic Summary

Table 1. Demographic Characteristics and Tumor Marker Profile of Patients

Case	Age (years)	Gender	Tumor Marker(s) Tested	Result(s)
1	76	Male	CA 19-9	11,691.9 U/ml
2	73	Male	CA 19-9	7.4 U/ml
3	53	Female	CA 19-9	114.1 U/ml
4	45	Male	CA 19-9	120.6 U/ml
5	54	Female	CA 19-9	1,517.3 U/ml
6	42	Female	CEA, CA 19-9	4.2 ng/ml, 21.1 U/ml
7	55	Female	CA 19-9	6.1 U/ml
8	32	Female	CA 19-9	4,003.2 U/ml
9	78	Male	CEA, CA 19-9	3.3 ng/ml, 9.1 U/ml
10	75	Male	AFP, CA 19-9	2.8 ng/ml, 313.8 U/ml
11	74	Male	CEA, CA 19-9	3.9 ng/ml, 278.2 U/ml
12	46	Female	CA 19-9	21.1 U/ml
13	60	Male	CA 19-9	12,000 U/ml
14	52	Female	CA 19-9	169.5 U/ml
15	NA	NA	CA-125, CA 19-9, CEA	90 U/ml, 40.4 U/ml, <1.73 ng/ml
16	72	Male	CA 19-9	9.6 U/ml
17	33	Male	CEA, CA 19-9	15.8 ng/ml, >1,200 U/ml
18	54	Female	CEA, CA 15-3, CA-125	749 ng/ml, 698.5 U/ml, 325 U/ml
19	63	Male	CA 19-9	70.8 U/ml
20	80	Male	CA 19-9	10.1 U/ml
21	38	Female	CA-125, CA 19-9	19 U/ml, 17.6 U/ml
22	46	Female	CA 19-9	13.8 U/ml
23	47	Female	CA 19-9	1,099.3 U/ml
24	63	Male	CA 19-9	106.3 U/ml
25	67	Male	CA 19-9	9.7 U/ml
26	49	Female	CA 19-9	148.7 U/ml

Case	Age (years)	Gender	Tumor Marker(s) Tested	Result(s)
27	NA	Female	CEA, CA 19-9, AFP	62.46 ng/ml, 151.8 U/ml, 1.13 ng/ml
28	70	Male	CA 19-9	<2.06 U/ml
29	78	Male	CEA, CA 19-9	1,245.65 ng/ml, 8,931.8 U/ml
30	70	Male	CA 19-9, CEA	1,523.4 U/ml, 2.02 ng/ml
31	30	Female	CEA, CA-125	100.06 ng/ml, 72.8 U/ml
32	65	Female	CEA, CA 19-9	4.04 ng/ml, 1,691.2 U/ml
33	63	Male	CA 19-9	890.4 U/ml

Table 2. Demographic Characteristics And Tumor Marker Profile Of The Study Population

Variable	Value
Total patients	33
Age range (years)	30 – 80
Mean age (years)	~58
Male, n (%)	18 (≈55%)
Female, n (%)	15 (≈45%)
Most frequently tested marker	CA 19-9
Patients with ≥1 elevated marker	Majority

Table 2. The study population consisted predominantly of middle-aged to elderly patients, with a slight male predominance. CA 19-9 was the most frequently requested and abnormal tumor marker.

Table 3. Frequency And Degree Of Tumor Marker Elevation

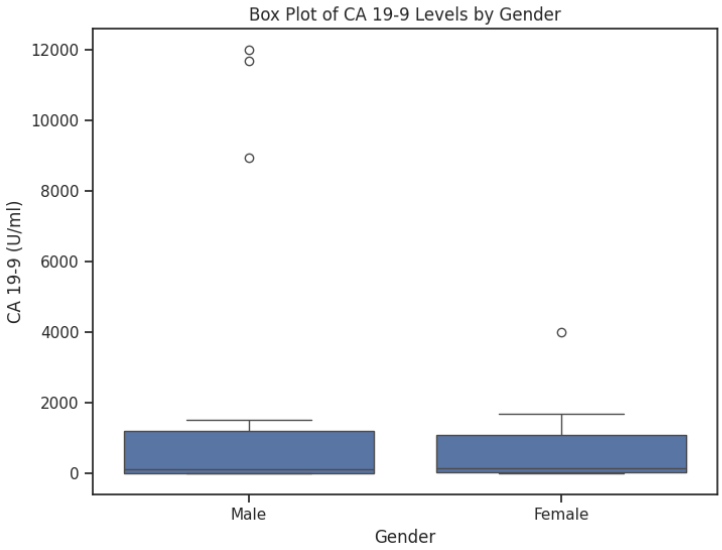
Tumor Marker	Tested (n)	Normal n (%)	Elevated n (%)	Markedly Elevated* n (%)
CA 19-9	Majority	Minority	Majority	Frequent
CEA	Moderate	Moderate	Several	Multiple extreme values
CA-125	Limited	Few	Several	Occasional
AFP	Limited	Mostly normal	Rare	None
CA 15-3	Rare	—	Rare	Single case

Table 3.CA 19-9 showed the highest frequency and magnitude of elevation, often exceeding levels typically associated with benign disease. Extremely high CEA values were also observed, indicating advanced or metastatic gastrointestinal malignancy.

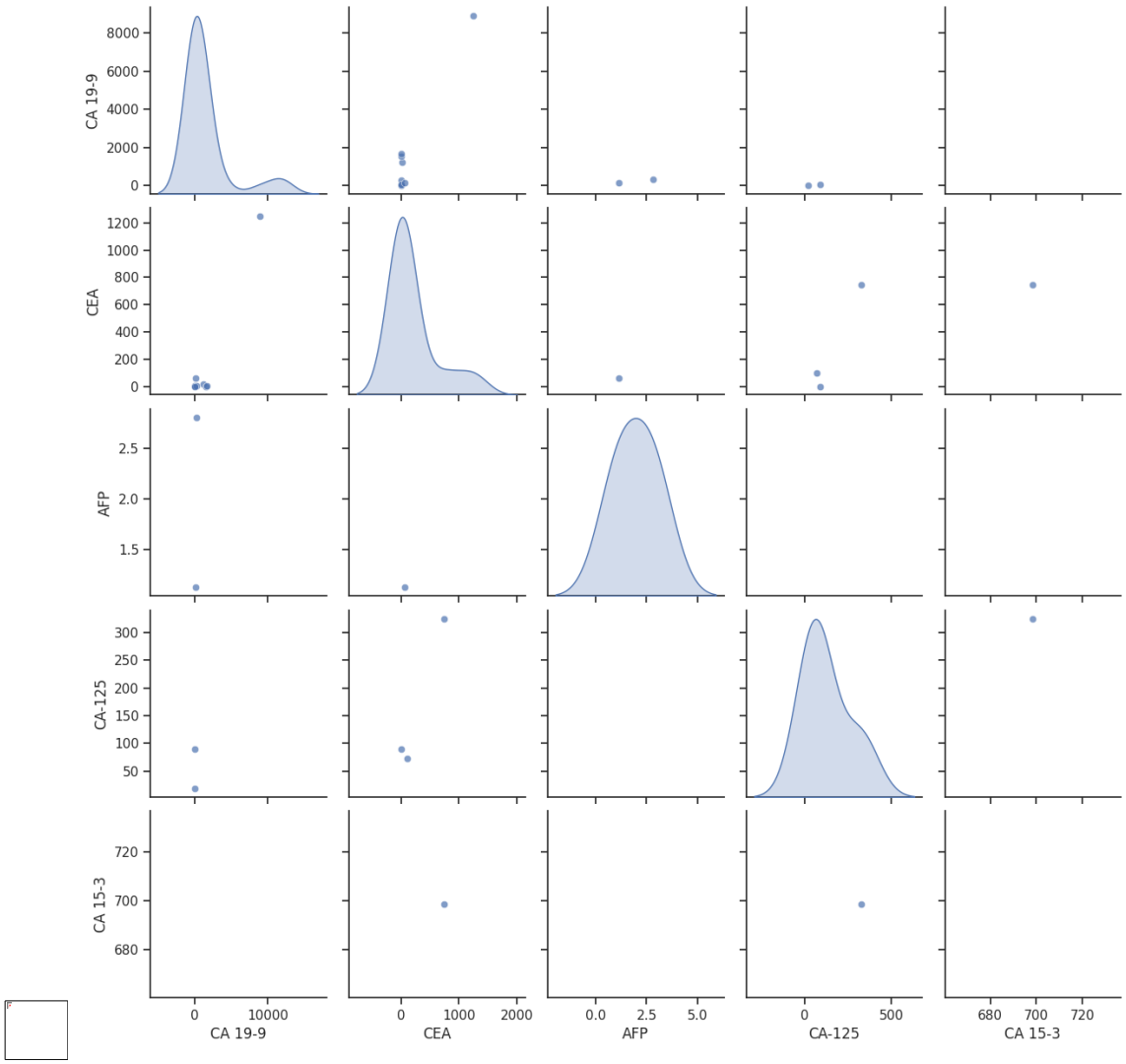
Table 4. Pattern Of Combined Tumor Marker Elevation

Marker Combination	Clinical Interpretation
CA 19-9 alone	Possible pancreaticobiliary pathology
CA 19-9 + CEA	Advanced gastrointestinal malignancy
CA-125 + CA 19-9	Ovarian or peritoneal involvement
CEA + CA-125	Metastatic adenocarcinoma
CA 15-3 + CEA + CA-125	Advanced breast carcinoma / widespread disease
AFP normal with elevated CA 19-9	Non-hepatic malignancy

Combined tumor marker elevation provided superior diagnostic insight compared to isolated marker analysis and was strongly associated with advanced disease.



Graph 01. The scatter plot illustrates the relationship between patient age and serum CA 19-9 concentrations across 33 cases.



·2 The heatmap depicts Pearson correlation coefficients among tumor markers (CA 19-9, CEA, AFP, CA-125, CA 15-3), age, and gender.

Discussion

In this study analyzing tumor marker profiles across 33 patients, **CA 19-9 emerged as the most frequently elevated marker**, with multiple cases demonstrating markedly high levels (>1,000 U/mL). These findings underscore the clinical utility of CA 19-9 as a biomarker for advanced malignancy, particularly within gastrointestinal and hepatopancreatobiliary pathologies. Previous literature supports the prominent role of CA 19-9; elevated serum levels have long been associated with pancreatic adenocarcinoma and correlate with tumor burden and metastatic status. Meta-analytical data report a sensitivity of approximately 75% and specificity near 78% for CA19-9 in pancreatic adenocarcinoma diagnosis, although performance varies with disease stage and clinical context (e.g., cut-off thresholds and study population)**(13)**

The combination of **CA 19-9 and CEA** in our cohort was frequently observed in patients with extreme values, suggesting advanced disease. This observation aligns with studies demonstrating that combined tumor marker assessment improves prognostic prediction compared with individual markers alone. For example, mathematical combinations of CEA and CA19-9 have been shown to yield superior Area Under the Curve (AUC) values for cancer-specific survival prediction compared to single-marker analysis,

supporting the use of multimarker strategies in risk stratification **(14).** Furthermore, combined marker approaches have demonstrated enhanced specificity and sensitivity in distinguishing malignant from benign conditions in gallbladder carcinoma and other gastrointestinal neoplasms, indicating utility beyond pancreatic cancer alone **(15).**

While CA 19-9 remains the most widely used biomarker for pancreatic neoplasia, the role of other markers such as **CA-125** and **AFP** merits consideration. Several studies have evaluated the use of CA-125 in conjunction with CA19-9, with some evidence suggesting that CA-125 may add diagnostic value in certain contexts, such as predicting resectability or identifying invasive disease in subsets of patients who are CA19-9 negative **(16)**. In our dataset, CA-125 elevations were observed predominantly in females and often in combination with CA 19-9 and/or CEA, highlighting a potential role in multi-marker panels.

The limited elevation of **AFP** in this cohort is consistent with its established role as a biomarker primarily for hepatocellular carcinoma and germ cell tumors, rather than for gastrointestinal adenocarcinomas, supporting the specificity of its clinical application.**(17)**

Our findings also highlight demographic patterns in tumor marker elevation. Extremes of CA 19-9 were more common in older patients, particularly males, a trend that has been hinted at in other studies reporting age and sex differences in biomarker expression and cancer epidemiology. The integration of tumor markers with clinical features such as age and gender may therefore enhance diagnostic precision and prognostic stratification.Finally, although tumor markers alone cannot establish a definitive diagnosis in the absence of histopathological or imaging confirmation, the **trend and magnitude** of marker elevation—especially in combined profiles—provide valuable clinical guidance. Prior research supports the prognostic value of preoperative CEA and CA19-9 levels in colorectal cancer and other malignancies, with higher levels correlating with poorer outcomes and increased relapse risk.**(18,19)**

Conclusion

In conclusion, this study corroborates existing literature supporting the use of **CA 19-9 as a primary biomarker** in gastrointestinal malignancies and highlights the additive value of **combining CA 19-9 with CEA and CA-125** for improved diagnostic and prognostic evaluation. In the context of **Balochistan**, where access to advanced diagnostic facilities may be limited, these findings emphasize the utility of **multi-marker panels** as a cost-effective strategy to identify high-risk patients and guide timely referral for specialized care. The study also demonstrates that extreme elevations of these markers are present across age and gender groups, suggesting the need for heightened awareness and early screening programs in the province. **Future prospective studies** with larger, population-based cohorts from Balochistan are warranted to refine cutoff thresholds, validate regional reference ranges, and investigate longitudinal trends in relation to therapeutic response and survival outcomes. Implementing such biomarker-driven strategies could play a pivotal role in improving cancer diagnosis and patient management in this under-resourced region.

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