ORIGINAL RESEARCH

Correlating Serum Carcinoembryonic Antigen (CEA) levels with pathological grading and staging in colorectal malignancies

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ABSTRACT

Background: Colorectal cancer (CRC) represents a significant portion of cancer incidences globally, necessitating effective biomarkers for its diagnosis and management. Serum Carcinoembryonic Antigen (CEA) has been extensively studied as a potential marker for the diagnosis, staging, and monitoring of colorectal cancer. This study aims to elucidate the correlation between preoperative serum CEA levels and the pathological staging and grading of colorectal malignancies, providing insights into its utility as a prognostic marker. **Materials and Methods:** The study conducted a prospective analysis involving 50 patients diagnosed with colorectal cancer at King George Hospital, Visakhapatnam. Serum CEA levels were measured preoperatively and correlated with the TNM staging and histopathological grading of the tumors obtained postoperatively. Data analysis aimed to assess the sensitivity and specificity of CEA in predicting tumor burden and stage. **Results:** The results showed that elevated CEA levels were significantly associated with advanced disease stages and higher tumor grades. The majority of the patients with elevated CEA levels had tumors classified as T3 or T4, N1 or N2, and M1, indicating more advanced and aggressive disease. The sensitivity of CEA in detecting colorectal malignancies was found to be 88%. **Conclusion:** Serum CEA levels correlate with the severity of colorectal malignancies, with higher levels associated with advanced pathological stages and poorer differentiation of tumors. While CEA is not suitable as a standalone screening tool due to its moderate sensitivity, it proves valuable in conjunction with other diagnostic and monitoring techniques.

Keywords: Colorectal Cancer, Carcinoembryonic Antigen, Serum CEA, TNM Staging, Pathological Grading, Diagnostic Biomarker.

INTRODUCTION

Colorectal cancer (CRC) is the fourth most common malignancy worldwide, affecting approximately 2.3 million people annually and presenting an equal risk to both genders. It is particularly prevalent in developed countries such as the United States, Europe, and Australia. This disease is predominantly influenced by environmental factors, most notably dietary habits, which is supported by the differences observed in incidence rates among different ethnic groups and migrant studies (1). The majority of colorectal cancers are adenocarcinomas, often evolving from polypoidal masses that invade through the intestinal wall, with a clear preference for the left side of the colon, although right-sided incidence has been on the rise over the past two decades (1).The significance of carcinoembryonic antigen (CEA) as a tumor marker was recognized in 1965; it is now used predominantly to monitor colorectal cancer recurrence in patients post-treatment (2). Despite its widespread use, the predictive potential of preoperative CEA levels remains uncertain, with normal levels often seen in patients with early-stage CRC. This leads to challenges in using CEA as a sole predictor for tumor burden and recurrence, particularly when initial levels are elevated and do not return to normal following surgery (2, 3).

In the broader context of CRC management, the TNM staging system is integral, relying on tumor size, nodal involvement, and metastatic spread to categorize the disease severity. Historically, treatment strategies have been based on this staging system, emphasizing the importance of accurate diagnostic markers for effective management and prognosis prediction (4). Given the complexity of CRC pathology, markers like CEA are invaluable for enhancing diagnostic accuracy and treatment monitoring, despite their limitations in sensitivity and specificity.This study aims to elaborate on the correlation between preoperative serum CEA levels and the pathological grading and staging of colorectal malignancies, providing a clearer picture of its reliability and prognostic value in clinical practice. By understanding these dynamics, we can improve patient outcomes through more tailored and informed therapeutic approaches.

MATERIALS AND METHODS

Study Design: This prospective analytical study was conducted at King George Hospital, Visakhapatnam, from August 2020 to July 2022. The study aimed to explore the correlation between preoperative serum CEA levels and the pathological staging and grading of colorectal malignancies.

Study Participants: The study included 50 patients diagnosed with colorectal cancer based on clinical presentations and preliminary investigations. Patients were recruited according to the following inclusion criteria:

1. Patients showing signs and symptoms indicative of colorectal cancer.
2. Patients who consented to participate in the study and underwent the necessary diagnostic evaluations.
3. Patients who provided genuine informed consent.

Patients were excluded from the study if they had other types of cancer or refused to undergo the recommended diagnostic procedures.

Data Collection: Patients' serum CEA levels were measured preoperatively using standard immunoassay techniques. The TNM staging and histopathological grading of the tumors were determined postoperatively based on the surgical specimens.

Statistical Analysis: Data were analyzed to assess the relationship between serum CEA levels and tumor stage and grade. Statistical significance was determined using Pearson's correlation coefficient and multiple regression analysis, with p-values less than 0.05 considered statistically significant.

RESULTS

Table 1: Age Distribution

Age Group	Number of Patients
20-30	3
31-40	7
41-50	13
51-60	16
61-70	7
71-80	2
81-90	2

Table 2: Gender Distribution

Gender	Number of Patients
Male	31
Female	19

Table 3: TNM Staging

- **T Staging**

T-Stage	Number of Patients
T1	7
T2	14
T3	23
T4	6

- **N Staging**

N-Stage	Number of Patients
N0	34
N1	11
N2	5

- **M Staging**

M-Stage	Number of Patients
M0	47
M1	3

- **Overall TNM Staging**

Stage	Number of Patients
Stage I	19
Stage II	14
Stage III	14
Stage IV	3

Table 4: Differentiation of Tumor

Differentiation	Number of Patients
Well	21
Moderate	15
Poor	14
Undifferentiated	0

Table 5: CEA Levels by TNM Staging

TNM Stage	CEA Elevated	CEA Not Elevated
Stage I	16	3
Stage II	12	2
Stage III	13	1
Stage IV	3	0

Table 6: CEA Levels by Dukes Staging

Dukes Staging	CEA Elevated	CEA Not Elevated
Dukes A	6	1
Dukes B	21	4
Dukes C	14	1
Dukes D	3	0

Table 7: CEA Levels by Grade of the Tumor

Tumor Grade	CEA Elevated	CEA Not Elevated
Well	20	1
Moderate	13	2
Poor	11	3

The results of the study reveal a detailed distribution of age, gender, TNM staging, tumor differentiation, and carcinoembryonic antigen (CEA) levels among the 50 patients with colorectal cancer. The majority of patients fall within the 51-60 age bracket, with a higher prevalence among males (31) compared to females (19). TNM staging showed a significant portion of patients in the advanced T3 stage (23), while the majority exhibited no metastasis (M0, 47 patients). Tumor differentiation was mostly well-differentiated (21). CEA levels were elevated in the majority of cases, particularly in higher stages and poorer tumor differentiation, highlighting its potential as a marker for monitoring disease progression and severity in colorectal cancer patients. (Table 1-7)

DISCUSSION

The findings of this study highlight the significant relationship between serum CEA levels and the pathological grading and staging of colorectal malignancies. Elevated CEA levels were consistently associated with higher TNM staging and poorer tumor differentiation. This correlation aligns with the previously established role of CEA as a marker for tumor burden and disease progression in colorectal cancer (5).Interestingly, while CEA levels increased with advancing disease stages and grades, its sensitivity varied across different stages. This variability suggests that while CEA is a useful marker for disease monitoring and recurrence detection, it may have limitations in early disease detection. The study's findings support the use of CEA in conjunction with other diagnostic tools, enhancing overall prognosis and treatment strategies (6).The prospective design of the study allowed for real-time assessment of CEA levels in relation to tumor pathology, providing robust data that support its continued use in clinical practice. However, the study also underscores the need for further research into additional biomarkers that could complement CEA, particularly

in the detection of early-stage colorectal cancer where CEA's sensitivity is lower (7).

Moreover, the study contributes to the ongoing discussion about the role of biomarkers in cancer diagnostics. While CEA is an established marker for colorectal cancer, its application in routine screening has been debated. The findings suggest that CEA should not be used as a standalone screening tool but rather as part of a broader diagnostic and monitoring strategy (8).

CONCLUSION

The study conclusively demonstrates a significant correlation between elevated serum Carcinoembryonic Antigen (CEA) levels and higher stages and grades of colorectal cancer, affirming CEA's utility as a prognostic marker rather than a primary diagnostic tool. While CEA's sensitivity varies across different cancer stages, it is notably effective in monitoring disease progression and recurrence, particularly in advanced stages. These findings advocate for the integration of CEA measurement with other diagnostic methods to enhance overall accuracy in monitoring and managing colorectal cancer, highlighting the need for further research to explore additional biomarkers that could supplement CEA, especially in early detection.

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