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Original Article

Status of the oral environment in patients with digestive system tumors during the perioperative period

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Abstract: Background: Surgery is an important treatment modality for patients with digestive system tumors, and perioperative management is crucial for the patients' recovery and quality of life. During the perioperative period, significant changes can occur in the oral environment of patients, such as dry mouth, mucosal ulceration, and oral infections. These issues not only cause discomfort to the patients but may also affect postoperative recovery and treatment outcomes. Therefore, it is essential to investigate and analyze the oral environment during the perioperative period in patients with digestive system tumors. Aim: This study aims to investigate the oral health status in patients with digestive system tumors during the perioperative period and analyze the influencing factors. Methods: In this retrospective study, a total of 242 patients with digestive system tumors admitted to The Seventh Affiliated Hospital, Xinjiang Medical University from September 2021 to June 2023 were selected as the study population (patient group). During the same period, 245 healthy volunteers who received oral examinations were selected as the healthy group. The study compared the oral hygiene environment of the two groups, including the Dental Plaque Index (DI), Calculus Index (CI), and Periodontal Disease Index (PDI). Measurements were taken at admission (T0), 1 hour before surgery (T1), and 3 days after surgery (T2). Based on the PDI index, the patient group was divided into a periodontal disease group (PDI ≥ 3, n = 196) and a periodontal healthy group (PDI < 3, n = 46). The risk factors for the development of periodontal disease in digestive system tumor patients were analyzed, considering variables such as gender, age, BMI, smoking status, alcohol consumption frequency, monthly income, tumor type, oral self-care habits, low-grade inflammation, and nutritional status. Results: The DI, CI and PDI indexes in patient group were higher than those in healthy group (3.23±0.64 vs 1.46±0.43, 1.92±0.46 vs 1.21±0.41, 3.83±0.79 vs 2.65±0.69, all $P < 0.05$). DI index, CI index and PDI index at T1 and T2 were significantly lower than those at T0 ($P < 0.05$), and these indices at T2 were slightly higher than T1, but the difference was not statistically significant (all $P > 0.05$). Multivariate analyses identified high levels of high-sensitivity C-Reactive Protein [OR: 15.070 (1.611-140.951)], low levels of hemoglobin [OR: 0.239 (0.058-0.981)], and presence of dental caries [OR: 246.737 (1.160-52464.597)] as risk factors associated with periodontal disease in patients with digestive system tumors. Conclusion: It is important to enhance the attention and management of the oral environment during the perioperative period for patients with digestive system tumors.

Keywords: Digestive system tumor, perioperative management, oral environment, periodontal disease, risk factor

Introduction

For early, localized tumors of the digestive system, surgery can provide a high cure rate [1, 2]. As the start of the digestive tract, the oral cavity is directly connected with the gastrointestinal tract, and the changes of the oral environment may have an important impact on the surgical treatment and postoperative recovery of patients with digestive system tumors. An increase of bacteria and pathogens in the oral cavity may raise the risk of the surgical site infection [3], negatively affecting surgical treatment outcomes. Oral inflammation and infection can cause systemic inflammatory response [4], thereby interfering with the healing process after digestive system tumor surgery. Additionally, oral pain, chewing difficulties, and dysphagia may lead to reduced dietary intake after surgery, affecting nutritional intake [5] and hin-

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dering postoperative recovery. Periodontitis is currently one of the most extensively studied oral diseases associated with systemic health. Recent research has increasingly confirmed the relationship between periodontitis and various digestive system tumors. This correlation often involves microorganisms and inflammation, though the specific mechanisms are largely unclear.

At present, there are relatively few studies on the oral environment of patients with digestive system tumors during perioperative period. Therefore, the purpose of this study is to investigate and analyze the oral environment of patients with digestive system tumors. By understanding the status of oral health during the perioperative period, we can identify and address oral problems promptly, reduce complications, and improve the success rate of surgeries and patients' quality of life. Furthermore, the results of the study can also provide guidance for clinicians to develop personalized perioperative nursing programs to further improve the treatment effect and quality of life of patients.

Materials and methods

Patient characteristics

In this retrospective study, 242 patients with digestive system tumors treated in the Seventh Affiliated Hospital, Xinjiang Medical University from September 2021 to June 2023 were selected as the study subjects (patient group). During the same period, 245 healthy volunteers who underwent oral examination were selected as the healthy control group. This study was approved by the Ethics Committee of the Seventh Affiliated Hospital, Xinjiang Medical University.

Inclusion criteria for patient group: (1) Patients with confirmed digestive system tumors, including tumors in the oral cavity, esophagus, stomach, intestines, and other parts of the digestive system; (2) Patients aged 18-70 years old; (3) Patients scheduled for surgical treatment; Exclusion criteria: (1) Presence of other severe diseases such as heart, lung, brain, liver, or kidney damage, or acute/chronic infections; (2) Presence of severe psychological conditions; (3) Previous treatment by other means before enrollment; (4) Temporary exclusion of pregnant or lactating women due to potential effects of relevant treatments on the fetus or infant; (5) Patients with no teeth.

Inclusion criteria for the healthy group: (1) No history of digestive system tumors or other types of cancer. (2) No significant chronic diseases, such as heart disease, diabetes, or hypertension. (3) Willing to participate in the study and able to follow the study procedures. Exclusion criteria for the healthy control group: (1) Individuals with severe systemic diseases that may affect oral health or (2) Participants in other clinical trials or studies that may affect oral health. (3) Other factors affecting oral health, such as long-term use of medications that may affect the oral mucosa or gingival health.

Observation index

(1) We compared the DI index [6], CI index [7], and PDI index [8] between the healthy group and the diseased group. (2) We analyzed the DI index [6], CI index [7], and PDI index [8] of the patients at T0, T1, and T2 time points. (3) We collected patient information, including gender, age, BMI, smoking status, alcohol consumption frequency, monthly income, and type of neoplasms such as gastric cancer, colorectal cancer, liver cancer, pancreatic cancer, and cholangiocarcinoma. Additionally, we also gathered data on high-sensitivity C-Reactive Protein (hs-CRP), hemoglobin, and albumin levels. Furthermore, we assessed patients' oral hygiene habits, such as daily brushing frequency, brushing duration, gum bleeding during brushing, toothbrush replacement frequency, mouthwash usage, flossing, fluoride toothpaste usage, presence of dental caries, and regular dental cleaning.

Assessment criteria for DI index, CI index, and PDI

The oral health environment of the patient group was detected at the time of admission (T0), 1 hour before surgery (T1), and after surgery (T2).

(1) Debris Index (DI) [6]: Dentists or professional dental hygienists used an oral mirror and special tools to examine the presence of soft debris (also known as plaque) on the surfaces of patients' teeth. No visible debris or staining:

0; Scattered point-like debris on the tooth surface: 1 point; Thin and continuous band-like debris at the gingival margin, not exceeding 1 mm: 2 points; Visible debris covering less than one-third of the tooth surface: 3 points; Visible debris covering over one-third but less than two-thirds of the tooth surface: 4 points; and Visible debris covering over two-thirds of the tooth surface: 5 points. The DI for each tooth is added together and divided by the total number of teeth examined to obtain the Composite Index (CI) for the entire oral cavity.

(2) Calculus Index (CI) [7]: Each tooth was scored based on the thickness and extent of calculus using a scale of 0-3. 0 indicates no visible calculus; 1 indicates supra-gingival calculus covering less than 1/3 of the tooth surface; 2 indicates supra-gingival calculus covering 1/3-2/3 of the tooth surface; 3 indicates supra-gingival calculus covering 2/3 or more of the tooth surface. The CI was calculated for each tooth, and then the CI values for all teeth were added together. Finally, the sum was divided by the total number of teeth examined to obtain the Composite Index (CI) for the entire oral cavity.

(3) Periodontal Disease Index (PDI) [8]: A thorough examination of the oral cavity was conducted using an oral mirror and appropriate lighting equipment. The depth of gingival pockets was measured using a dental probe to assess the extent of destruction in the periodontal tissues. Each tooth was evaluated and scored based on factors such as gum inflammation and pocket depth. A score of 0 indicates no inflammation in the gums; 1 indicates mild to moderate gum inflammation with no involvement of the tooth surface; 2 indicates mild to moderate gum inflammation with involvement of the tooth surfaces; 3 indicates severe gum inflammation; 4 indicates pocket depth less than 3 mm; 5 indicates pocket depth between 3 to 6 mm; 6 indicates pocket depth greater than or equal to 6 mm. The PDI for the entire oral cavity was calculated based on the scores for each index. Based on the PDI, patients were categorized a periodontal disease subgroup (PDI $\geq$ 3, n = 196 (80.99%)) and a periodontal healthy subgroup (PDI < 3, n = 46 (19.01%)).

Perioperative oral care

(1) Preoperative: Patients were guided to brush their teeth at least twice a day using a soft-bristled toothbrush and gentle toothpaste to reduce irritation to the gums. When brushing, a gentle technique is best to employ, especially in cases with periodontal disease or bleeding tendencies, to avoid damaging sensitive oral tissues. In addition to brushing, patients use dental floss or interdental brushes to remove food debris and plaque between the teeth, further maintaining oral hygiene. Patients can rinse their mouths with fluoride mouthwash or saltwater to clean the oral cavity and reduce bacterial counts. When rinsing, ensure the mouthwash thoroughly wets the entire oral cavity and perform appropriate rinsing motions to maximize cleaning effectiveness. Preoperative patients can use oral sprays or mouth lubricants containing artificial saliva components to alleviate potential dryness, which is particularly important under preoperative stress.

(2) Intraoperative: Dryness of the mouth may occur during surgery. Healthcare providers should regularly check the moisture level of the patient's mouth and provide moistening measures as needed to prevent oral tissue damage and avoid injuries caused by prolonged mouth opening or surgical instruments.

(3) Postoperative: Patients may experience oral pain, ulcers, swelling, or bleeding after surgery. In such cases, consult a physician or dentist promptly for appropriate guidance and treatment. As the patient recovers postoperatively, encourage them to resume their daily oral hygiene habits such as brushing and flossing, but ensure gentle movements to avoid disturbing healing wounds.

Statistical analysis

SPSS 24.0 software was applied for data entry and analysis. Categorical data were described using frequency and percentage, while quantitative data were described using mean and standard deviation. For single-factor analysis, we employed chi-square test and t-test. Multifactorial analysis was conducted using the logistic regression method to explore the predictive factors for periodontal disease in patients with digestive tumors. Subsequently, we constructed a model based on the regression coefficients and plotted the receiver operating characteristic curve (ROC). The predictive efficacy of the predictive factors was evaluated through the area under the curve (AUC), sensi-

Table 1. General information of patients

Variables	Patient group (n = 242)	Healthy group (n = 245)	x^2/t	*P*
Gender			1.767	0.184
Male	138 (57.02)	125 (51.02)		
Female	104 (42.98)	120 (48.98)		
Age (years)	47.83±9.78	46.66±9.78	1.300	0.188
BMI (kg/m^2)	23.56±2.51	23.14±2.39	1.891	0.059
Smoking status			5.096	0.024
Former	157 (64.88)	182 (74.29)		
Current	85 (35.12)	63 (25.71)		
Frequency of drinking			10.969	0.004
None	108 (44.63)	146 (59.59)		
≤ Once/month	78 (32.23)	59 (24.08)		
≥ Twice/month	56 (23.14)	40 (16.33)		
Monthly household income (RMB)			2.331	0.312
< 3000	79 (32.64)	87 (35.51)		
3000-5000	106 (43.80)	114 (46.53)		
> 5000	57 (23.55)	44 (17.96)		

tivity, and specificity. The significance level was set at α = 0.05.

Results

Clinical characteristics

There were 138 males and 104 females in the patient group, with an average age of (47.83±9.78) years. There were 125 males and 120 females in the healthy group, with an average age of (46.66±9.78) years. There was no significant difference between the two groups in gender, age, BMI and family monthly income, and drinking frequency (all $P > 0.05$), but there was significant difference in smoking status ($P < 0.05$), as show in **Table 1**.

Analysis of oral health environment of patients and healthy subjects

The DI index, CI index and PDI index of the patient group were higher than those of the healthy group (all $P < 0.05$), as show in **Figure 1**.

Analysis of oral health environment at T0, T1, T2

Compared with T0, the DI, CI and PDI of patients at T1 and T2 were significantly lower (all $P < 0.05$). DI index, CI index and PDI index at T2 were slightly higher than T1, but the difference was not statistically significant (all $P > 0.05$), as show in **Figure 2**.

Single factor analysis of factors influencing preoperative periodontal disease in patients with digestive system tumors

The preoperative periodontal conditions of digestive system tumor patients showed significant correlations to smoking statuses, hs-CRP levels, hemoglobin levels, albumin levels, flossing habits, fluoride toothpaste usage, presence of dental caries, and regular dental cleanings (all $P < 0.05$), as show in **Table 2**.

Logistic regression analysis of factors influencing periodontal disease in patients with digestive system tumors before operation

After assigning values to the factors with statistical significance in single factors analysis, logistic regression analysis was conducted.

The results revealed that high levels of hs-CRP [OR = 15.070 (1.611-140.951)], low levels of hemoglobin [OR = 0.239 (0.058-0.981)], and the presence of dental caries [OR = 246.737 (1.160-52464.597)] were independent factors influencing periodontal disease in digestive system tumor patients (all $P < 0.05$), as show in **Tables 3** and **4**.

ROC curve

Using the regression coefficients analyzed in **Table 4**, a predictive model was built. The predicted probability values of the model served

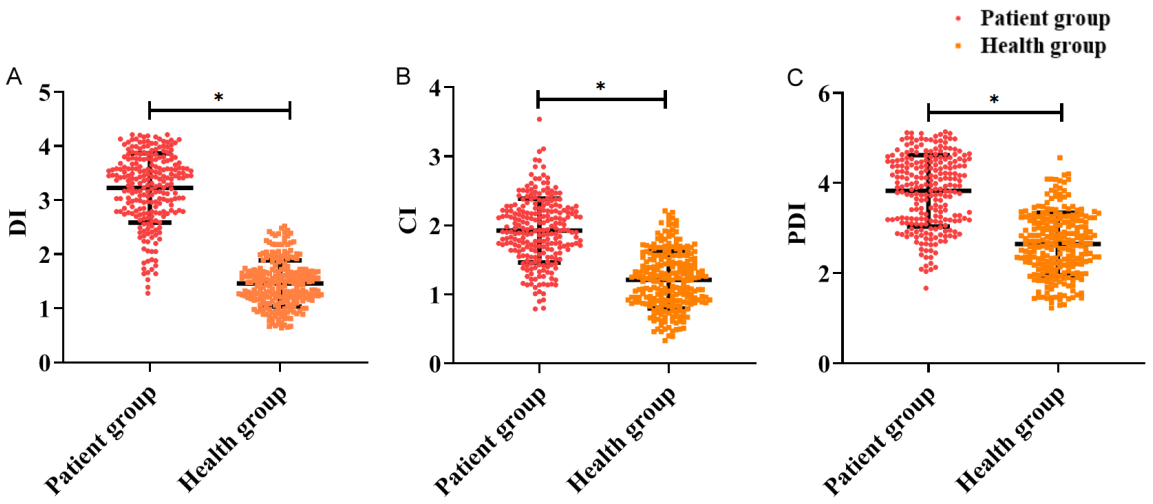

Figure 1. Analysis of oral health environment in the patient group and healthy group. A. Debris Index (DI). B. Calculus index (CI). C. Periodontal disease index (PDI). *, $P < 0.05$.

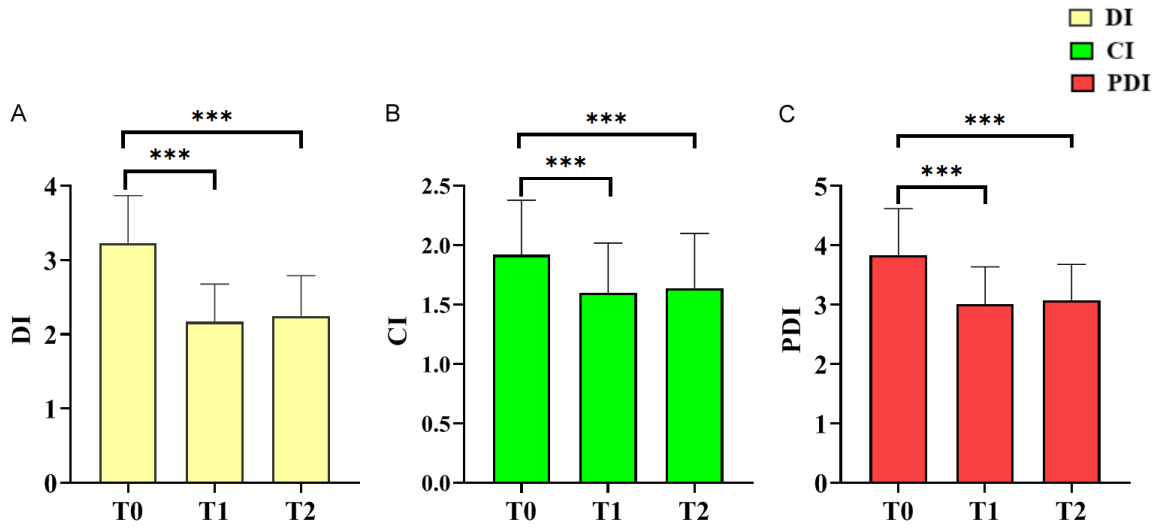

Figure 2. Analysis of oral health environment in T0, T1 and T2 of the patient group. A. Debris Index (DI). B. Calculus index (CI). C. Periodontal disease index (PDI). Notes: At admission (T0), 1 hour before surgery (T1), 3 days after surgery (T2). ***, $P < 0.001$.

as the test variable, and the occurrence of periodontal disease was the state variable. The ROC curve was plotted. The AUC of the predictive model was 0.954 (0.919, 0.989), with sensitivity and specificity of 93.4% and 87.0%, respectively. As show in **Figure 3**.

Discussion

Investigating and analyzing oral environment is a crucial research area that helps in understanding oral health status and related risk factors. Our study revealed that, compared with healthy volunteers, patients with digestive system tumors exhibited higher DI index, CI index and PDI index, indicating that there were some problems in the oral environment of tumor patients, including poor oral hygiene, high incidence of periodontal disease and increased risk of oral infection. The oral cavity is an environment with bacteria, including normal flora and conditional pathogenic flora. In healthy state, daily brushing, gargling and other activities prevent oral diseases. However, in conditions of illness, oral activity is reduced, immune system disorders, inflammatory response and

Table 2. Results of single factor analysis of preoperative periodontal disease in patients with digestive system tumors

Variables	Periodontal disease subgroup (n = 196)	Periodontal health subgroup (n = 46)	x^2/t	*P*
Gender			0.166	0.684
Male	113 (57.65)	25 (54.35)		
Female	83 (42.35)	21 (45.65)		
Age (years)	47.42±9.82	49.57±9.54	1.344	0.180
BMI (kg/m^2)	23.54±2.49	23.64±2.62	0.243	0.808
Smoking status			4.465	0.035
Former	121 (61.73)	36 (78.26)		
Current	75 (38.27)	10 (21.74)		
Frequency of drinking			1.056	0.590
None	80 (40.82)	28 (60.87)		
≤ Once/month	68 (34.69)	10 (21.74)		
≥ Twice/month	48 (24.49)	8 (17.39)		
Monthly household income (RMB)			1.510	0.470
< 3000	65 (33.16)	14 (30.43)		
3000-5000	88 (44.90)	18 (39.13)		
> 5000	43 (21.94)	14 (30.43)		
Type of neoplasms			1.352	0.852
Gastric cancer	69 (35.20)	18 (39.13)		
Colorectal cancer	34 (17.35)	8 (17.39)		
Liver cancer	47 (23.98)	9 (19.57)		
Pancreatic cancer	28 (14.29)	5 (10.87)		
Cholangiocarcinoma	18 (9.18)	6 (13.04)		
hs-CRP (mg/L)	6.38±1.15	3.85±0.74	14.233	< 0.001
Hemoglobin (g/L)	7.39±1.25	12.46±2.63	12.726	< 0.001
Albumin (g/dL)	2.47±0.31	3.21±0.41	11.488	< 0.001
Daily brushing frequency			3.035	0.386
0	21 (10.71)	2 (4.35)		
1 time	84 (42.86)	25 (54.35)		
2 times	57 (29.08)	11 (23.91)		
More	34 (17.35)	8 (17.39)		
Brushing time			3.478	0.175
< 1 min	61 (31.12)	8 (17.39)		
2 min	84 (42.86)	23 (50.00)		
More	51 (26.02)	15 (32.61)		
Gums bleed when brushing teeth			1.611	0.204
No	75 (38.27)	13 (28.26)		
Yes	121 (61.73)	33 (71.74)		
Frequency of toothbrush replacement			3.507	0.173
1-2 months	62 (31.63)	17 (36.96)		
3-6 months	68 (34.69)	20 (43.48)		
Over 6 months	66 (33.67)	9 (19.57)		
Use mouthwash			2.806	0.094
No	112 (57.14)	20 (43.48)		
Yes	84 (42.86)	26 (56.52)		
Use flossing			5.196	0.023
No	109 (55.61)	17 (36.96)		
Yes	87 (44.39)	29 (63.04)		

Use fluoride toothpaste			7.099	0.008
No	89 (45.41)	11 (23.91)		
Yes	107 (54.59)	35 (76.09)		
Whether there is caries			9.473	0.002
No	78 (39.80)	30 (65.22)		
Yes	118 (60.20)	16 (34.78)		
Regular dental cleaning			7.867	0.005
No	82 (41.84)	9 (19.57)		
Yes	114 (58.16)	37 (80.43)		
DI	3.19±0.65	3.39±0.56	1.925	0.055
CI	1.94±0.47	1.85±0.44	1.183	0.238

Notes: hs-CRP: High-Sensitivity C-Reactive Protein. DI: Debris Index. CI: Calculus index.

Table 3. Description of variable assignment

Variables	Assignment
Smoking status	0 = Former, 1 = Current
hs-CRP (mg/L)	Original value entry
Hemoglobin (g/L)	Original value entry
Albumin (g/dL)	Original value entry
Use flossing	0 = Yes, 1 = No
Use fluoride toothpaste	0 = Yes, 1 = No
Whether there is caries	0 = Yes, 1 = No
Regular dental cleaning	0 = Yes, 1 = No

a series of factors lead to weakened oral self-purification ability, which is conducive to the growth of anaerobic bacteria in the oral cavity, microbial reproduction and decomposition, causing dental plaque, dental calculus, destruction of periodontal tissue [9].

Long-duration surgeries performed under general anesthesia are highly invasive procedures. Surgical treatment for digestive system tumors may involve tissue incisions, organ removal, and structural repairs, thereby significantly impacting the patient's physiological functions and immune system. This can increase the risk of postoperative complications such as pneumonia or infections. Perioperative oral care has been shown to reduce the incidence of postoperative pneumonia or infections [10-12]. After propensity score analysis, Nobuhara H et al. [10] found that perioperative oral management intervention significantly reduced the risk of pneumonia or infection after colorectal cancer surgery, with an odds ratio of 0.484 (95% CI: 0.272-0.862). The management of perioperative oral environment in patients with digestive system tumors is very important for postoperative prognosis. We have also achieved significant results in perioperative oral care for patients with digestive system tumors. Compared with the admission, the DI index, CI index, and PDI index were improved 1 hour before and after surgery. This has a positive significance for reducing the risk of infection, improving the patient's nutritional intake, protecting dental health, and improving the patient's psychological state, thereby improving postoperative rehabilitation and treatment effects.

A large prospective cohort study with a sample size of more than 475,000 people [13] found that the risk of liver cancer in people with periodontitis was 1.32 times that of periodontally healthy people. In a cohort study conducted by Lo et al. [14] involving 98,000 women and 50,000 men with a follow-up of 22 to 28 years showed that the risk of esophageal cancer and gastric adenocarcinoma in people with a history of periodontal disease increased by 43% and 52%, respectively, compared with those without [14]. In our study, grouping patients based on the Periodontal Disease Index (PDI), we found that 80.99% of digestive system tumor patients had periodontal disease. This finding is consistent with the observation mentioned that periodontitis is associated with a 1.32-fold increased risk of liver cancer [13], and a significantly increased risk of esophageal cancer and gastric adenocarcinoma in individuals with a history of periodontal disease [14]. These study results suggest a potential link between periodontal health and the risk of digestive system tumors. One possible mechanism is that through the transfer of oral microbiota, periodontitis may promote a chronic inflammatory state that is related to cancer development. Additionally, periodontal pathogens may direct-

Table 4. Logistic regression analysis of factors influencing periodontal disease in patients with digestive system tumors before surgery

Variables	*β*	*SE*	Wald χ^2	*P*	*OR* (95% *CI*)
hs-CRP (mg/L)	2.713	1.141	5.656	0.017	15.070 (1.611-140.951)
Hemoglobin (g/L)	-1.433	0.722	3.945	0.047	0.239 (0.058-0.981)
Whether there is caries	5.508	2.735	4.058	0.044	246.737 (1.160-52464.597)
Constant	11.177	10.319	1.173	0.279	--

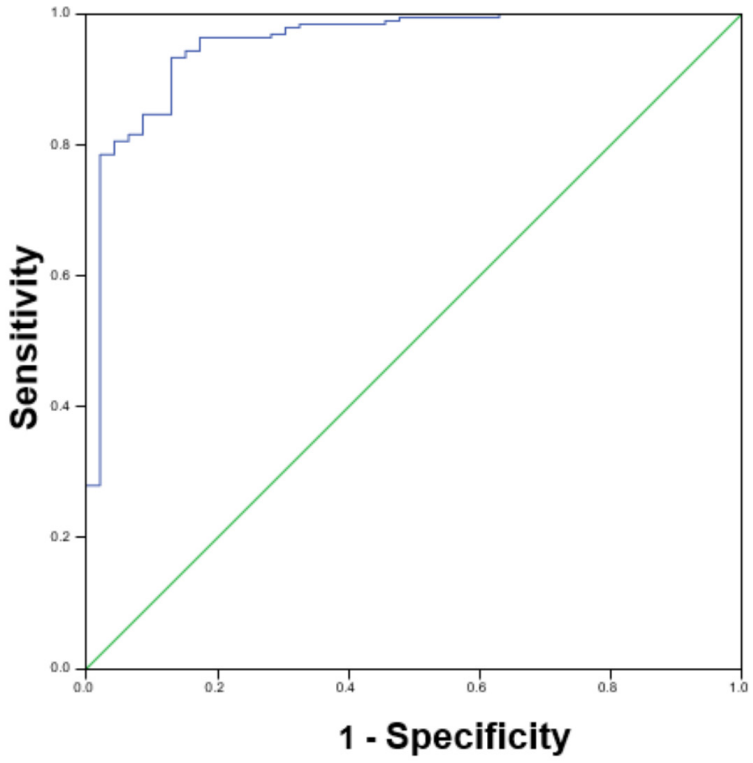

Figure 3. Receiver operating characteristic curve.

ly or through their metabolites affect the cellular function of distant organs, thereby increasing the risk of cancer. However, both our study and the referenced studies have certain limitations. For instance, our study was observational and analytical, unable to establish causality, while Lo et al.'s [14] cohort study, despite having a longer follow-up period, may still be influenced by unmeasured confounding factors.

Our research findings indicate that factors influencing the occurrence of periodontal disease in digestive system tumor patients include high levels of hs-CRP, low levels of hemoglobin, and dental caries. The hs-CRP level significantly increases in the body during inflammation or infection, indicating low-grade chronic inflammatory status in oral tissues. When dental plaque accumulates at the junction of teeth and gums and is not removed in a timely manner, the bacteria therein will release harmful substances that stimulate gingival tissues, resulting in a mild inflammatory reaction [15]. This inflammatory response is usually not apparent, and patients may not show any obvious symptoms. The state of micro-inflammation can be considered as an early stage of periodontal disease. Harmful substances released by bacteria in dental plaque can cause inflammation of the gingival tissues, leading to symptoms such as redness and bleeding of the gums. If dental plaque is not removed in time and appropriate oral hygiene measures are not taken, the state of micro-inflammation may further deteriorate, leading to periodontitis and damaging deeper tissues [16]. A long-standing state of micro-inflammation can cause the progression of gum disease, leading to the destruction of periodontal tissues and even bone loss, ultimately resulting in loose teeth and tooth loss [17]. Early detection and treatment of micro-inflammation can help prevent the progression of periodontal disease and the occurrence of complications. Therefore, we recommend visiting a professional dentist regularly for oral examinations and cleaning and following their oral care recommendations.

The level of hemoglobin in the blood can reflect the presence of anemia, which may be related to nutritional deficiencies. The quality of nutrition has a significant impact on both overall

health and oral health. Anemia can also lead to a weakened immune system, reducing the body's defense against oral bacteria and thus increasing the risk of developing periodontal disease [18, 19]. Therefore, we recommend incorporating foods rich in vitamin C, vitamin D, and protein into your diet, such as fruits, vegetables, fish, and legumes. At the same time, it is important to reduce the intake of sugar and limit the frequency and quantity of sweet foods.

In addition to perioperative oral care, it is recommended to remove the source of infection in the oral cavity before surgery, such as preoperative caries treatment and tooth extraction [20-23]. In this study, dental caries increased the risk of periodontal disease. Dental caries and periodontitis are both diseases caused by bacterial infections, and their occurrence and development involve bacterial invasion and inflammatory response [24]. If caries is not treated in time, bacteria and acid metabolites may corrode the tooth surface and lead to the formation of cavities [25]. These bacteria can also further infect the surrounding gums and alveolar bone, causing periodontitis. In addition, in some cases, dental caries and periodontitis may coexist in the same oral environment [24]. In addition, in this study, the incidence of periodontal disease was lower in patients with good oral hygiene habits, including brushing teeth, flossing, using fluoride toothpaste, regular tooth washing and regular examination. However, none of these were observed as risk factors. But it is very important for the prevention and management of dental caries and periodontitis.

There are still some limitations in this study. For example, the study subjects include patients with multiple digestive system tumors, and the operation time and blood loss may have an impact on the results. Secondly, there may be selection bias in the same hospital. Finally, there are many factors that affect individual oral health behavior.

Conclusion

There are some problems in the oral environment of patients with digestive system tumors. Perioperative oral care can effectively improve the oral health status, reduce the number of bacteria in the oral cavity, and reduce the risk of infection. However, it is not enough to rely solely on perioperative oral care. In daily life, more attention should be paid to oral health care.

Disclosure of conflict of interest

None.

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References

[1] Cillo U, Fondevila C, Donadon M, Gringeri E, Mocchegiani F, Schlitt HJ, Ijzermans JNM, Vivarelli M, Zieniewicz K, Olde Damink SWM and Groot Koerkamp B. Surgery for cholangiocarcinoma. Liver Int 2019; 39 Suppl 1: 143-155.

[2] Masiak-Segit W, Rawicz-Pruszyński K, Skórzewska M and Polkowski WP. Surgical treatment of pancreatic cancer. Pol Przegl Chir 2018; 90: 45-53.

[3] Isomura ET, Fujimoto Y, Matsukawa M, Yokota Y, Urakawa R and Tanaka S. General factors and dental-related risk factors for postoperative pneumonia or infectious complications: a retrospective study. J Clin Med 2023; 12: 3529.

[4] Lockhart PB, Brennan MT, Sasser HC, Fox PC, Paster BJ and Bahrani-Mougeot FK. Bacteremia associated with toothbrushing and dental extraction. Circulation 2008; 117: 3118-3125.

[5] Arigbede AO, Babatope BO and Bamidele MK. Periodontitis and systemic diseases: a literature review. J Indian Soc Periodontol 2012; 16: 487-491.

[6] Turesky S, Gilmore ND and Glickman I. Reduced plaque formation by the chloromethyl analogue of victamine C. J Periodontol 1970; 41: 41-43.

[7] Volpe AR, Manhold JH and Hazen SP. In vivo calculus assessment. I. A method and its examiner reproducibility. J Periodontol (1930) 1965; 36: 292-298.

[8] Eke PI, Page RC, Wei L, Thornton-Evans G and Genco RJ. Update of the case definitions for population-based surveillance of periodontitis. J Periodontol 2012; 83: 1449-1454.

[9] Wong HM. Oral complications and management strategies for patients undergoing cancer therapy. ScientificWorldJournal 2014; 2014: 581795.

[10] Nobuhara H, Yanamoto S, Funahara M, Matsugu Y, Hayashida S, Soutome S, Kawakita A, Ikeda S, Itamoto T and Umeda M. Effect of perioperative oral management on the prevention

of surgical site infection after colorectal cancer surgery: a multicenter retrospective analysis of 698 patients via analysis of covariance using propensity score. Medicine (Baltimore) 2018; 97: e12545.
[11] Ishimaru M, Matsui H, Ono S, Hagiwara Y, Morita K and Yasunaga H. Preoperative oral care and effect on postoperative complications after major cancer surgery. Br J Surg 2018; 105: 1688-1696.
[12] Soutome S, Hasegawa T, Yamguchi T, Aoki K, Kanamura N, Mukai T, Yamazoe J, Nishikawa M, Isomura E, Hoshi K and Umeda M; Joint Research Committee of Japanese Society of Oral Care. Prevention of postoperative pneumonia by perioperative oral care in patients with esophageal cancer undergoing surgery: a multicenter retrospective study of 775 patients. Support Care Cancer 2020; 28: 4155-4162.
[13] Jordão HW, McKenna G, McMenamin ÚC, Kunzmann AT, Murray LJ and Coleman HG. The association between self-reported poor oral health and gastrointestinal cancer risk in the UK Biobank: a large prospective cohort study. United European Gastroenterol J 2019; 7: 1241-1249.
[14] Lo CH, Kwon S, Wang L, Polychronidis G, Knudsen MD, Zhong R, Cao Y, Wu K, Ogino S, Giovannucci EL, Chan AT and Song M. Periodontal disease, tooth loss, and risk of oesophageal and gastric adenocarcinoma: a prospective study. Gut 2021; 70: 620-621.
[15] Gholizadeh P, Eslami H and Kafil HS. Carcinogenesis mechanisms of Fusobacterium nucleatum. Biomed Pharmacother 2017; 89: 918-925.
[16] Cecoro G, Annunziata M, Iuorio MT, Nastri L and Guida L. Periodontitis, low-grade inflammation and systemic health: a scoping review. Medicina (Kaunas) 2020; 56: 272.
[17] Hajishengallis G. Immunomicrobial pathogenesis of periodontitis: keystones, pathobionts, and host response. Trends Immunol 2014; 35: 3-11.
[18] Anumolu VN, Srikanth A and Paidi K. Evaluation of the relation between anemia and periodontitis by estimation of blood parameters: a cross-sectional study. J Indian Soc Periodontol 2016; 20: 265-272.
[19] Nibali L, Darbar U, Rakmanee T and Donos N. Anemia of inflammation associated with periodontitis: analysis of two clinical studies. J Periodontol 2019; 90: 1252-1259.
[20] Yamada SI, Soutome S, Hasegawa T, Tojyo I, Nakahara H, Kawakami M, Hirose M, Fujita S, Komori T, Kirita T, Shibuya Y, Umeda M and Kurita H. A multicenter retrospective investigation on the efficacy of perioperative oral management in cancer patients. Medicine (Baltimore) 2020; 99: e19129.
[21] Hong CHL, Hu S, Haverman T, Stokman M, Napeñas JJ, Braber JB, Gerber E, Geuke M, Vardas E, Waltimo T, Jensen SB and Saunders DP. A systematic review of dental disease management in cancer patients. Support Care Cancer 2018; 26: 155-174.
[22] Tsuji K, Shibuya Y, Akashi M, Furudoi S, Yakushijin K, Kawamoto S, Okamura A, Matsuoka H and Komori T. Prospective study of dental intervention for hematopoietic malignancy. J Dent Res 2015; 94: 289-296.
[23] Elad S, Thierer T, Bitan M, Shapira MY and Meyerowitz C. A decision analysis: the dental management of patients prior to hematology cytotoxic therapy or hematopoietic stem cell transplantation. Oral Oncol 2008; 44: 37-42.
[24] Lamont RJ, Koo H and Hajishengallis G. The oral microbiota: dynamic communities and host interactions. Nat Rev Microbiol 2018; 16: 745-759.
[25] Bowen WH, Burne RA, Wu H and Koo H. Oral biofilms: pathogens, matrix, and polymicrobial interactions in microenvironments. Trends Microbiol 2018; 26: 229-242.