Am J Transl Res 2024;16(12):7330-7342
www.ajtr.org /ISSN:1943-8141/AJTR0160525

Original Article

Comprehensive treatment focusing on transarterial chemoembolization for postoperative liver metastasis in gastric cancer patients

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Received September 13, 2024; Accepted November 11, 2024; Epub December 15, 2024; Published December 30, 2024

Abstract: Objective: To investigate the clinical efficacy of comprehensive treatment focusing on transarterial chemoembolization (TACE) for postoperative liver metastasis in patients with gastric cancer and analyze the factors influencing prognosis. Methods: A retrospective study was conducted on 116 patients who developed liver metastasis after gastric cancer surgery and were admitted to Gansu Provincial Cancer Hospital between January 2018 and February 2020. The observation group, consisting of 62 patients, received TACE with fluorouracil (FU) + irinotecan (CPT-11) + oxaliplatin (OXA) and moderate lipiodol embolization. The control group, consisting of 54 patients, received systemic S-1 and Oxaliplatin regimen (SOX) alone. The clinical efficacy and incidence of adverse reactions were compared between the two groups. Liver function indicators, tumor markers, and immunoglobulin changes were analyzed in both groups. The 2-year survival rate of patients was analyzed using the Kaplan-Meier (K-M) curve. Lasso-Cox regression was used to identify independent prognostic factors affecting the 2-year survival rate. A Nomogram model was constructed to predict outcomes. Results: The overall clinical efficacy ($P = 0.001$) and objective response rate (ORR) ($P = 0.001$) were significantly lower in the control group compared to the observation group. No significant differences were found in ALT and AST changes between the two groups ($P > 0.05$). Post-treatment, CEA and CA19-9 levels were significantly lower, and IgG and IgM levels were significantly higher in the observation group ($P < 0.001$). There was no significant difference in the incidence of adverse reactions ($P > 0.05$). Lasso-Cox regression identified treatment plan, pathological differentiation, degree of liver metastasis, and pre-treatment CEA as independent prognostic factors for 2-year survival. Based on these, a Nomogram model was constructed. In the training group, the model had AUC values over 0.8 for 1- and 2-year survival rates, and in the validation group, the AUC was 0.765 and 0.687, respectively, indicating good predictive performance. Conclusion: Compared to the conventional SOX regimen, comprehensive treatment focusing on TACE embolization for postoperative liver metastasis in gastric cancer is more effective and can improve survival rates.

Keywords: Transarterial chemoembolization (TACE), gastric cancer, liver metastasis, prognosis

Introduction

Gastric cancer, characterized by poor prognoses, remains one of the most prevalent and lethal malignancies worldwide, posing significant threats to global public health [1]. According to the International Agency for Research on Cancer, approximately 968,300 new cases of gastric cancer were diagnosed globally in 2022 alone, resulting in 659,800 deaths [2]. The distribution of gastric cancer varies markedly across regions, with East Asian countries, particularly China and Japan, exhibiting higher incidence and mortality rates compared to Europe and North America [3, 4]. In China, gastric cancer contributes to nearly half of the global incidence and mortality of gastric cancer, posing critical challenges to national public health [5]. In 2022, gastric cancer was the fifth most commonly diagnosed malignancy in China, accounting for 358,700 new cases and 188,400 deaths [6].

https://doi.org/10.62347/KWBT3893

Despite advancements in surgical techniques and multimodal treatments, the five-year survival rate of patients with advanced gastric cancer remains below 30% [7]. Notably, 20% to 25% of newly diagnosed gastric cancer cases in China are already in stage IV, with a subset of them developing liver metastasis [8]. Gastric cancer with liver metastasis (GCLM) refers to the dissemination of primary gastric tumor cells to the liver, a process observed in approximately 35% to 45% of gastric cancer patients during the disease course [9, 10]. Surgical resection remains the standard care for patients with resectable primary or metastatic tumors [11]. However, many GCLM patients are not eligible for surgery due to the extent of metastasis, making chemotherapy the mainstay of treatment [12]. Even with optimized first-line chemotherapy regimens, disease progression can occur within 6 to 7 months, with a median survival of 6 to 11 months and a five-year survival rate of only 5% to 10% [13].

In this context, transarterial chemoembolization (TACE) has emerged as a novel therapeutic approach. The mechanism of TACE involves two primary components: embolization of the tumor-feeding artery to induce ischemia and hypoxic necrosis of tumor tissues, and targeted delivery of chemotherapy drugs to increase their local concentration and prolong exposure of the tumor to cytotoxic agents [14, 15]. Several retrospective studies have demonstrated that the combination of TACE with systemic chemotherapy can significantly improve both local tumor control and overall survival in GCLM patients [16, 17].

This study aims to investigate effective treatment strategies for improving the survival and quality of life of GCLM patients. Specifically, by comparing the outcomes of the conventional SOX regimen with a comprehensive treatment approach that includes arterial catheterization via the femoral artery, arterial infusion chemotherapy, and lipiodol embolization, we sought to evaluate the potential benefits of this novel approach in enhancing local tumor control and prolonging patient survival.

Methods and materials

Sample size calculation

According to the study by Dang et al. [18], the overall survival (OS) rate of HER2 over-expressing gastric cancer patients with liver metastasis was approximately 20%. Based on this probability, we used the formula $N = Z^2 \times [P \times (1\text{-}P)]/E^2$ to calculate the required sample size. Using a 95% confidence level ($Z = 1.96$), a 5% margin of error ($E = 0.05$), and an estimated proportion of $P = 0.20$ (20%), the calculation yielded a required sample size of 246 participants. However, current clinical status and practical factors were taken into consideration when determining real sample size.

Clinical data

This retrospective study was conducted on patients with liver metastasis undergoing gastric cancer surgery at Gansu Provincial Cancer Hospital between January 2018 and February 2020. This study has been approved by the Ethics Committee of Gansu Provincial Cancer Hospital.

Inclusion and exclusion criteria

Inclusion Criteria: 1. Pathological diagnosis of gastric cancer confirmed by gastroscopy with evidence of liver metastasis through imaging [8]. 2. No surgical indications for radical resection based on patients' overall conditions, primary gastric cancer stage, the extent of liver metastasis, etc. 3. Karnofsky Performance Status (KPS) score ≥ 70, with an expected survival time ≥ 2 months, and good conditions in liver, kidney as well as bone marrow functions. 4. Measurable lesions for efficacy evaluation, with a tumor diameter ≥ 10 mm on CT or MRI, or ≥ 20 mm under other conditions, as indicated by gastroscopy, endoscopic ultrasonography, CT, MR, or ultrasound. 5. Complete clinical data.

Exclusion Criteria: 1. Severe diseases or dysfunction of vital organs including heart, lungs, or kidneys. 2. Systemic immune system diseases. Evidence of metastases in organs other than the liver, other primary tumors, or uncontrolled diseases, and a history of radiotherapy.

Patient grouping

A total of 116 cases meeting the criteria were selected. Among them, 54 patients who received the S-1 and Oxaliplatin regimen (SOX) were assigned to the control group. The remaining 62 patients underwent TACE with fluorouracil (FU) + irinotecan (CPT-11) + oxaliplatin (OXA)

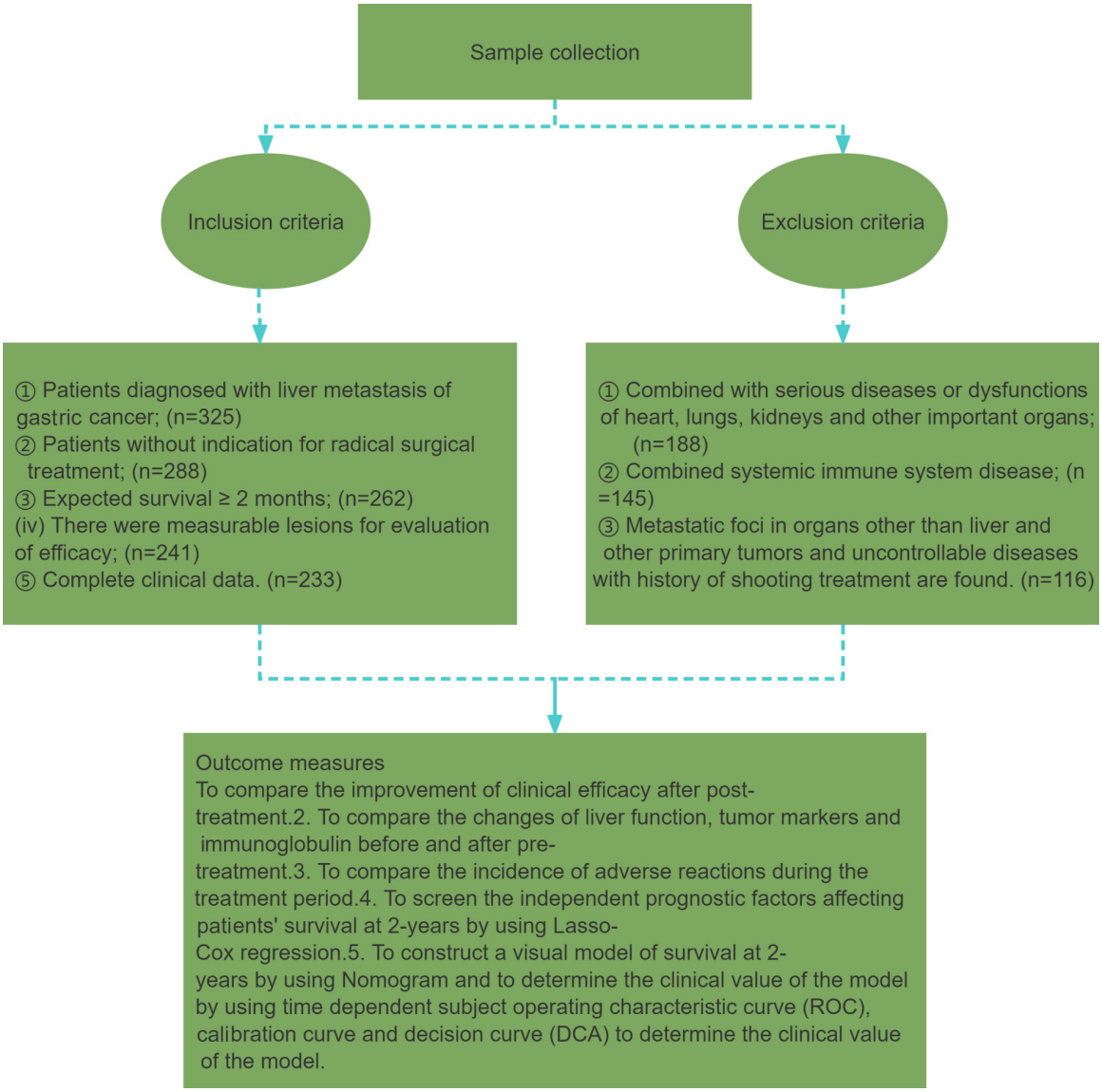

Figure 1. Study flowchart.

and moderate lipiodol embolization via the femoral artery with the Seldinger technique in the observation group. The flow chart is presented in **Figure 1**.

Treatment protocols

Control Group: Patients in this group received an intravenous infusion of oxaliplatin (130 mg/m^2) (manufacturer: Huadong Medicine Co., Ltd., Hangzhou, China; approval number: H2011-3457; drug specification: 50 mg) on the first day of each treatment cycle, diluted in 250 to 500 mL of 5% glucose solution and administered over 2 to 6 hours. From day 1 to day 14, patients took oral tegafur-gimeracil-oteracil capsules (manufacturer: Taiho Pharmaceutical Co., Ltd.; registration certificate number: H20090046; capsule specification: 25 mg), 50 mg each time, twice daily. The treatment cycle was repeated every 3 weeks, and all patients completed at least 2 cycles.

Observation Group: Using the Seldinger technique, arterial catheterization was performed through the femoral artery, followed by celiac artery and hepatic artery angiography to determine the tumor's size and blood supply. Catheterization was performed through the left or right hepatic artery, and hepatic artery che-

moembolization was administered with fluorouracil (FU) (manufacturer: Gisimei (Wuhan) Pharmaceutical Co., Ltd.; approval number: H20050465; drug specification: 500 mg), irinotecan hydrochloride injection (manufacturer: Jiangsu Hengrui Medicine Co., Ltd.; approval number: H20213373; drug specification: 40 mg/2 mL), and oxaliplatin (manufacturer: Huadong Medicine Co., Ltd.; approval number: H20113457; drug specification: 50 mg). The doses for the FU/CPT-11/OXA regimen were FU 400-500 mg/m^2, CPT-11 100-130 mg/m^2, and OXA 85-100 mg/m^2, along with moderate lipiodol embolization. Within one week after arterial infusion chemotherapy, patients took oral tegafur-gimeracil-oteracil (40 mg/m^2 for 14 days). This treatment was repeated every 21-28 days for a total of 2 cycles. For patients achieving complete response (CR), oral tegafur-gimeracil-oteracil was continued for maintenance. For partial response (PR), one additional cycle of chemoembolization was administered, followed by tegafur-gimeracil-oteracil maintenance. For stable disease (SD), SOX chemotherapy was continued, and for progressive disease (PD), docetaxel plus tegafur-gimeracil-oteracil chemotherapy was used. Postoperatively, intravenous plus oral chemotherapy was provided.

Clinical data collection

Data were obtained from patients' outpatient records, electronic medical records, and follow-up visits. Collected general data included sex, age, primary tumor location, pathological differentiation, number of liver metastases, lymph node metastasis, Eastern Cooperative Oncology Group Performance Status (ECOG PS) score [19], extent of liver metastasis, Child-Pugh classification, and clinical efficacy. Laboratory indicators included pre- and post-treatment levels of alanine transaminase (ALT), aspartate transaminase (AST), carcinoembryonic antigen (CEA), carbohydrate antigen 19-9 (CA19-9), immunoglobulin G (IgG), immunoglobulin A (IgA), and immunoglobulin M (IgM). Adverse reactions recorded during treatment included nausea, vomiting, oral mucositis, liver dysfunction, and leukopenia. ALT and AST levels were measured using an automated biochemical analyzer (Beckman Coulter, AU5800). CEA and CA19-9 were measured using an automated chemiluminescence immunoassay analyzer (Mindray, CL8000i), while immunoglobulins were measured using an automated protein analyzer (Siemens, BN II System).

Efficacy evaluation

The short-term clinical efficacy of patients was assessed according to the World Health Organization's criteria for evaluating solid tumors [20]. CR was defined as the disappearance of all lesions, sustained for at least one month; PR as a reduction of ≥ 50% in tumor size, maintained for at least four weeks; SD as a reduction of < 50% or an increase of < 25% in tumor size; PD as an increase of ≥ 25% in tumor size or the appearance of new malignant tumors. The overall response rate (ORR) was calculated as (CR + PR)/total cases × 100%.

Follow-up

Patients in both groups were followed for 24 months, either via telephone interviews or outpatient visits. The survival time was recorded for patients in both groups for subsequent analysis.

Statistical analysis

All data were analyzed using SPSS software (version 26.0). Continuous data were presented as mean ± standard deviation (Mean ± SD) and were compared between groups using independent sample t-tests or Mann-Whitney U tests, depending on their normality. For comparisons within groups before and after treatment, repeated measures ANOVA was applied, followed by Tukey's HSD post-hoc test for multiple comparisons. Categorical data were expressed as counts and percentages, with comparisons performed using Chi-square tests or Fisher's exact tests as appropriate. Lasso-Cox regression analysis was employed to identify independent prognostic factors. A Nomogram model predicting 1- and 2-year survival rates was constructed using the "rms" package in R software (version 4.3.2). The identified independent prognostic factors were incorporated into the Nomogram model. Calibration curves were generated to assess the agreement between predicted and observed outcomes, and time-dependent ROC curves were used to evaluate the model's predictive accuracy. Decision curve analysis (DCA) was conducted to determine the clinical utility of the Nomogram model. Statistical significance was defined as $P < 0.05$.

Table 1. Comparison of patients' general data between the two groups

Factors	Control Group (n = 54)	Observation Group (n = 62)	χ^2	P
Gender			0.449	0.503
Male	38	40		
Female	16	22		
Age			0.181	0.671
≥ 65 years	31	38		
< 65 years	23	24		
Gastric Cancer Site			0.438	0.803
Cardia	28	29		
Body	9	13		
Antrum	17	20		
Pathological Differentiation			0.501	0.479
Poorly Differentiated	39	41		
Moderately/Well Differentiated	15	21		
Number of Liver Metastases			0.388	0.533
Single	14	19		
Multiple	41	43		
Lymph Node Metastasis			1.046	0.307
Yes	42	43		
No	12	19		
ECOG PS Score			0.94	0.332
0-1	50	54		
2	4	8		
Degree of Liver Metastasis			0.729	0.694
H1	13	17		
H2	29	35		
H3	12	10		
Child Classification			0.181	0.671
A	46	51		
B	8	11		

Note: ECOG PS, Eastern Cooperative Oncology Group Performance Status.

Results

Comparison of patients' general data between the two groups

No statistically significant differences were found in patients' general data including gender, age, gastric cancer lesion site, pathological differentiation, number of liver metastases, lymph node metastasis, ECOG PS score, degree of liver metastasis, or Child-Pugh classification (P > 0.05). See **Table 1**.

Comparison of clinical efficacy between the two groups

Post-treatment evaluation showed that the overall clinical efficacy and ORR were significantly lower in the control group compared to the observation group (both P = 0.001). See **Table 2**.

Comparison of liver function changes between the two groups

The comparison of liver function showed no statistically significant differences in ALT and AST levels between the two groups both before and after treatment (P > 0.05). See **Figure 2**.

Comparison of CEA and CA19-9 changes between the two groups

Pre-treatment levels of CEA and CA19-9 showed no significant differences between the two groups (P > 0.05). However, post-treatment levels of both markers were significantly lower

Table 2. Comparison of clinical efficacy of patients between the two groups

Group	CR	PR	SD	PD	ORR
Control Group (n = 54)	0 (0.00%)	18 (33.33%)	19 (35.19%)	17 (31.48%)	18 (33.33%)
Observation Group (n = 62)	12 (19.35%)	28 (45.16%)	16 (25.80%)	6 (9.69%)	40 (64.51%)
χ^2		16.719			11.226
P		0.001			0.001

Note: CR, Complete Response; PR, Partial Response; SD, Stable Disease; PD, Progressive Disease; ORR, Objective Response Rate.

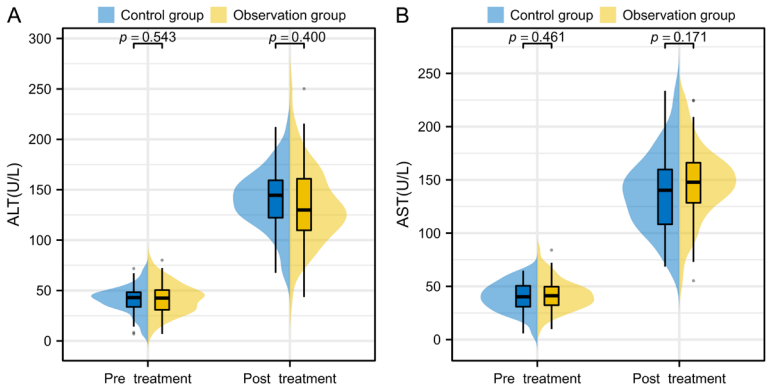

Figure 2. Changes in liver function indicators before and after treatment. A. Comparison of ALT levels before and after treatment in both groups. B. Comparison of AST levels before and after treatment in both groups. Note: ALT, Alanine Transaminase; AST, Aspartate Transaminase.

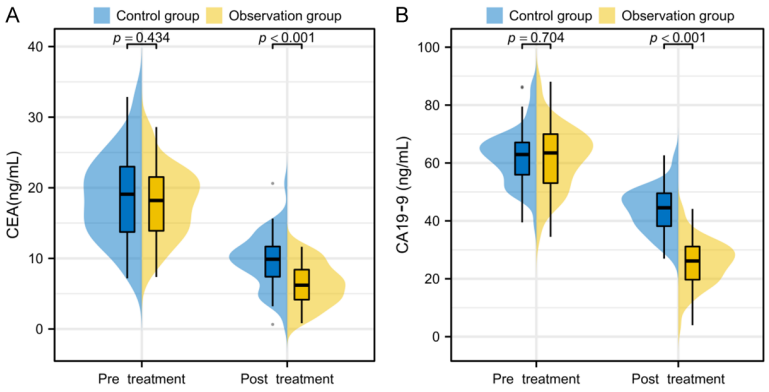

Figure 3. Changes in tumor markers before and after treatment. A. Comparison of CEA levels before and after treatment in both groups. B. Comparison of CA19-9 levels before and after treatment in both groups. Note: CEA, Carcinoembryonic Antigen; CA19-9, Carbohydrate Antigen 19-9.

in the observation group compared to the control group (P < 0.001). See **Figure 3**.

Comparison of immunoglobulin changes

No statistically significant differences were observed in IgG, IgA, or IgM levels between the groups before treatment (P > 0.05). Post-treatment, there were no significant differences in IgA levels between both groups (P > 0.05), but IgG and IgM levels were significantly higher in the observation group than those in the control group (P < 0.001). See **Figure 4**.

Comparison of incidence of adverse reactions between the two groups

The incidence of adverse reactions, including nausea, vomiting, oral mucositis, liver dysfunction, and leukopenia, did not significantly differ between the two groups (P > 0.05). See **Table 3**.

Screening of prognostic factors

The two-year survival data of patients were collected for initial identification of prognostic factors with the use of univariate analysis. Treatment plan, gastric cancer site, pathological differentiation, degree of liver metastasis, and pre-treatment CEA levels were identified in association with the two-year survival in GCLM patients (**Figure 5**). Lasso-Cox regression analysis further identified treatment plan, pathological differentiation, degree of liver metastasis, and pre-treatment CEA as independent prognostic factors influencing two-year survival. See **Figure 6**.

Construction and validation of the nomogram model

Based on the four independent prognostic factors identified through Lasso regression, we constructed a Nomogram model. The study

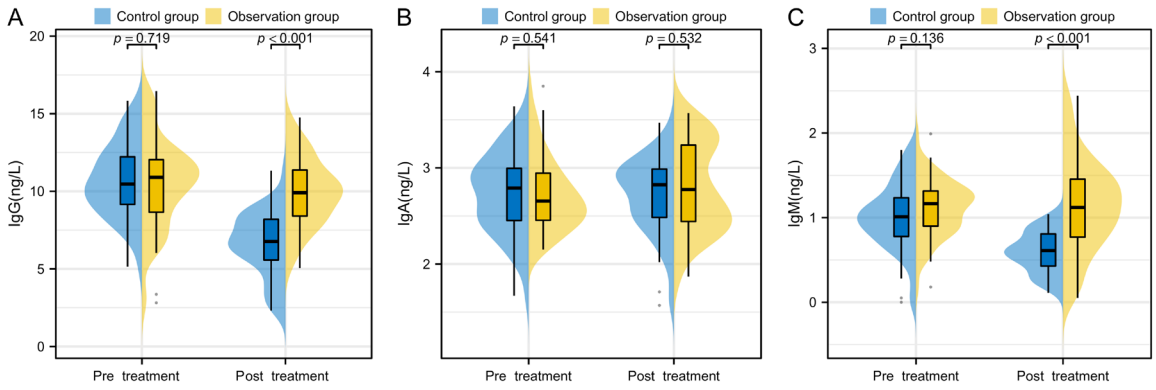

Figure 4. Changes in immunoglobulin levels before and after treatment. A. Comparison of IgG levels before and after treatment in both groups. B. Comparison of IgA levels before and after treatment in both groups. C. Comparison of IgM levels before and after treatment in both groups. Note: IgG, Immunoglobulin G; IgA, Immunoglobulin A; IgM, Immunoglobulin M.

Table 3. Comparison of the occurrence of adverse reactions between the two groups

Adverse Reaction	Control Group (n = 54)	Observation Group (n = 62)	χ^2	P
Nausea/Vomiting	48 (88.89%)	53 (85.48%)	0.297	0.586
Stomatitis	7 (12.96%)	10 (16.13%)	0.231	0.631
Hepatic Dysfunction	49 (90.74%)	53 (85.48%)	0.752	0.386
Leukopenia	24 (44.44%)	32 (51.61%)	0.594	0.441

cohort was split into a training group (n = 81) and a validation group (n = 35) in a 7:3 ratio. The Nomogram model was constructed using data from the training group (**Figure 7A**) and it showed an AUC greater than 0.8 for predicting both the 1-year and 2-year survival rates, indicating high predictive accuracy (**Figure 7B**). In the validation group, the AUCs for predicting the 1- and 2-year survival rates were 0.765 and 0.687, respectively, demonstrating reasonable stability. See **Figure 7C**.

Discussion

Gastric cancer is a common malignancy within the digestive tract. Due to the absence of specific early symptoms, approximately 50% of patients present with distant metastases at their initial diagnosis [21]. For unresectable GCLM, chemotherapy remains the primary treatment option. However, the long-term prognosis post chemotherapy is typically poor, largely due to the limited efficacy of the therapy on liver metastases [22].

Studies have shown that TACE combined with oxaliplatin and fluorouracil can promote spindle formation and increase apoptosis of tumor cells [23]. However, recent studies have indicated that TACE in combination with oxaliplatin and fluorouracil alone does not significantly reduce the number of liver metastases or prolong patients' survival [24]. Furthermore, arterial embolization during TACE may stimulate the formation of new blood vessels in the tumor, preventing complete obstruction of blood flow in tumor tissues [25]. The adjunctive use of S-1 (tegafur) has been shown to not only enhance apoptosis of tumor cells by inhibiting nucleic acid synthesis but also promote apoptosis of endothelial cells, thereby inhibiting neovascularization, reducing vessel density, and decreasing blood flow [26].

In this study, significantly improved clinical efficacy was identified in patients from the observation group. Several factors likely contribute to this: (1) The TACE regimen, which combines three drugs (fluorouracil, irinotecan, oxaliplatin), synergistically enhances antitumor activity through different mechanisms, making it particularly suitable for GCLM patients resistant to single-agent chemotherapy. (2) TACE delivers high concentrations of chemotherapeutic agents directly to the tumor vasculature, improving local drug concentrations and enhanc-

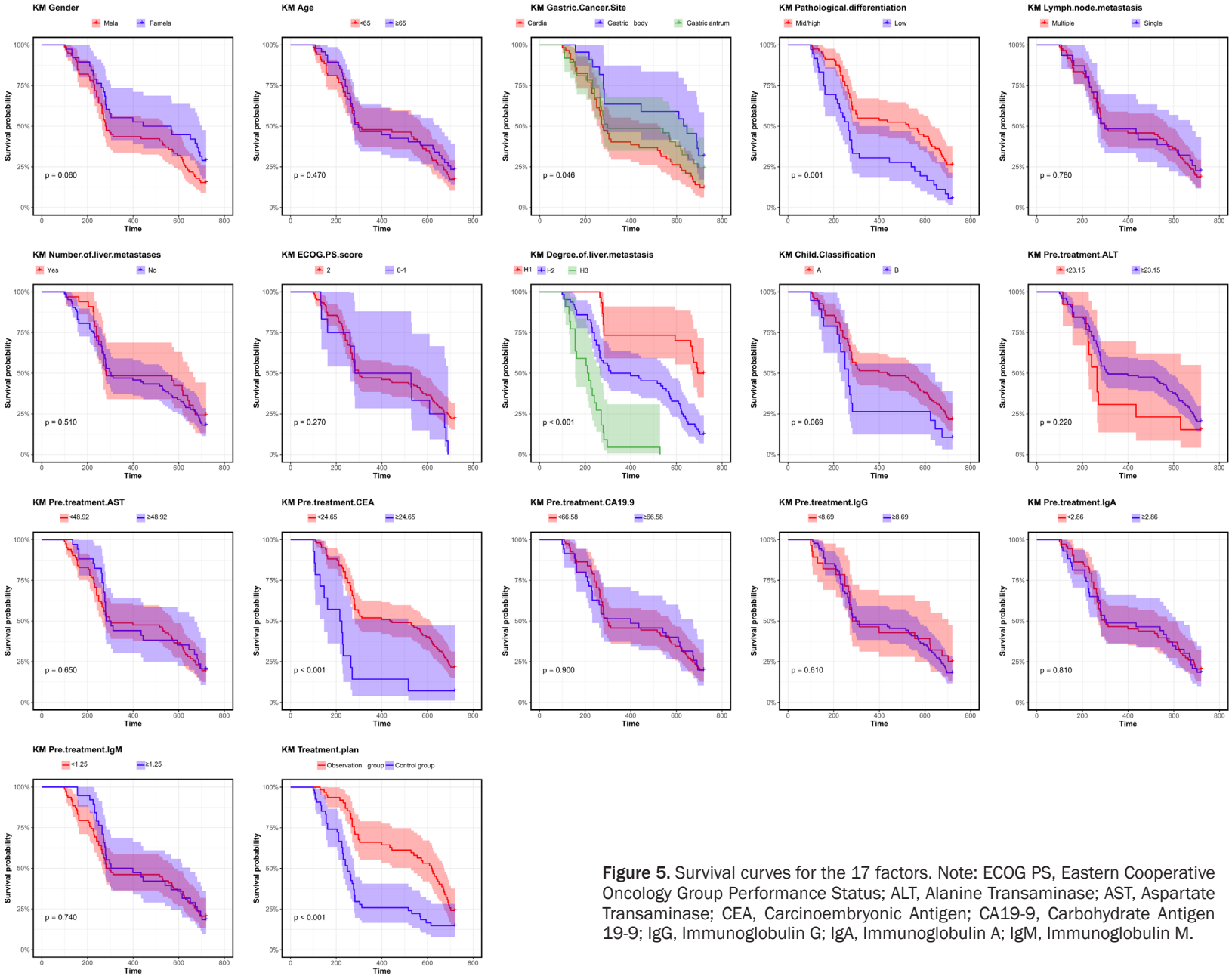

Figure 5. Survival curves for the 17 factors. Note: ECOG PS, Eastern Cooperative Oncology Group Performance Status; ALT, Alanine Transaminase; AST, Aspartate Transaminase; CEA, Carcinoembryonic Antigen; CA19-9, Carbohydrate Antigen 19-9; IgG, Immunoglobulin G; IgA, Immunoglobulin A; IgM, Immunoglobulin M.

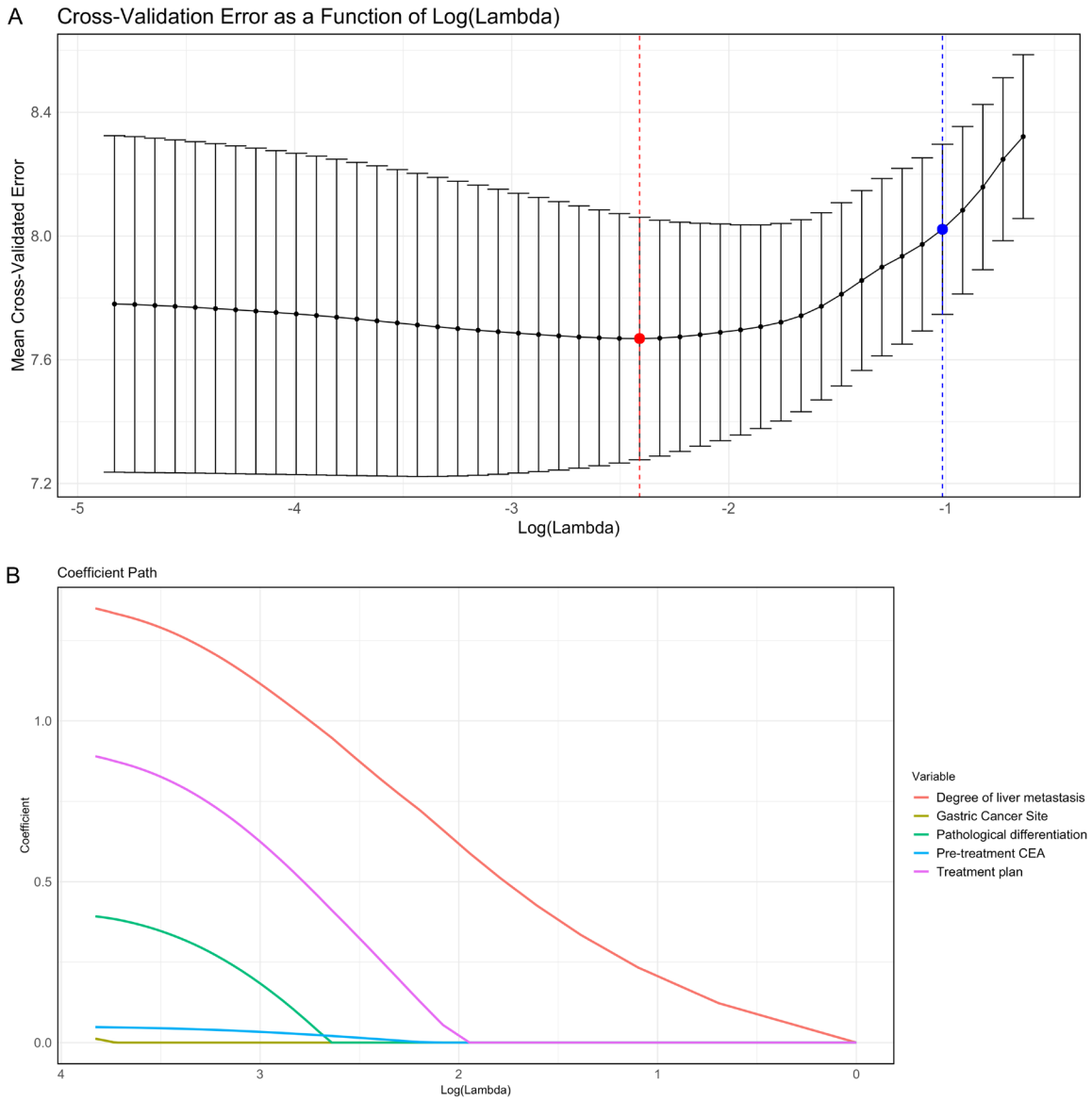

Figure 6. Lasso-cox regression screening for prognostic factors in GCLM. A. Regularization path of the Lasso model. B. Selection of Lasso feature coefficients. Note: GCLM, Gastric Cancer with Liver Metastasis.

ing treatment efficacy. (3) The addition of S-1 optimizes treatment outcomes by slowing tumor cell proliferation and disrupting endothelial integrity, enhancing the chemotherapeutic effects of oxaliplatin, which in turn improves clinical efficacy and reduces tumor marker levels in GCLM patients. These findings are supported by Polysalov et al. [27], who reported that gastric tumor chemoembolization and local chemotherapy effectively influenced primary tumor stages and lymph node metastases. Xu et al. [28] also demonstrated the safety profile of conventional TACE in treating GCLM.

Moreover, while patients in both groups experienced post-treatment liver function impairment, no significant differences were observed in their AST and ALT levels. The incidence of adverse reactions was also similar between the two groups. However, the observation group exhibited significantly higher IgG and IgM levels, suggesting a stronger immune response. These findings indicated that, compared to the SOX chemotherapy, the TACE embolization regimen was equally safe in terms of liver function impact, while potentially offering an immunostimulatory benefit. This supports the notion

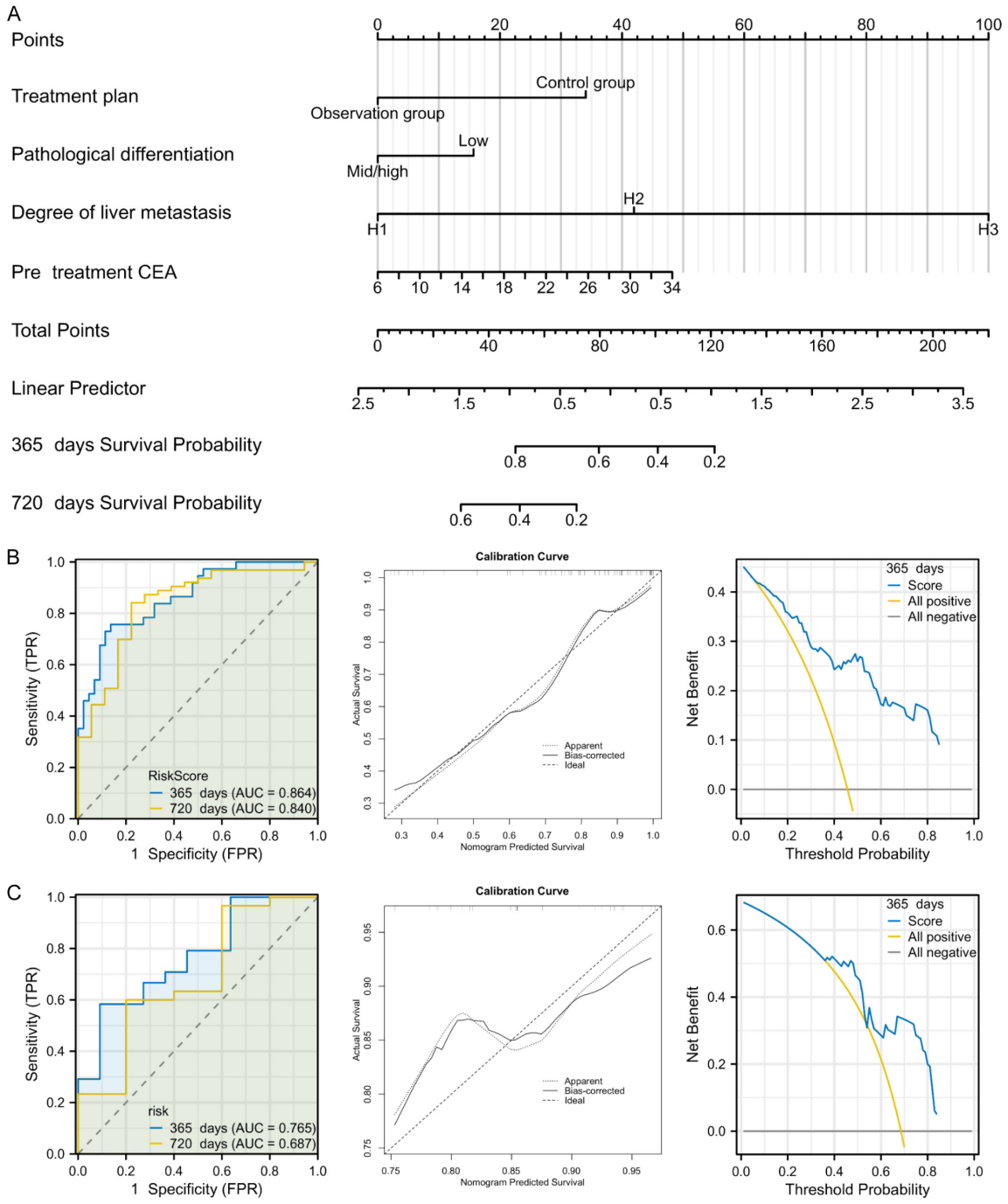

Figure 7. Construction and validation of the nomogram model. A. Nomogram model constructed using the four prognostic variables. B. Time-dependent ROC curves, calibration curves, and DCA curves in the training group. C. Time-dependent ROC curves, calibration curves, and DCA curves in the validation group. Note: CEA, Carcinoembryonic Antigen; ROC curve, Receiver Operating Characteristic; DCA, Decision Curve Analysis.

that the TACE regimen is not only effective but also enhances immune response, contributing to better overall outcomes.

In this study, Lasso-Cox regression identified several key prognostic factors, including treatment plan, gastric cancer site, pathological differentiation, degree of liver metastasis, and pre-treatment CEA levels. Patients with poorly differentiated tumors tend to have more aggressive tumors, faster tumor growth rates, and poorer responses to chemotherapy and

radiotherapy, leading to worse prognoses. Wu et al. [29] found that poorly differentiated GCLM patients had significantly shorter overall survival and disease-specific survival compared to those with moderately or well-differentiated tumors. The number and size of metastatic lesions are critical factors in the preservation of liver functions, which is closely linked to patients' survival. Extensive liver metastasis generally indicates a high tumor burden, complicating treatment and worsening prognosis. The study of Hori et al. on 412 GCLM patients [30] confirmed these findings, demonstrating significant survival differences between patients with H1, H2, and H3 stage liver metastases. High pre-treatment CEA levels, often reflective of a large tumor burden or advanced disease, are associated with poor treatment responses and outcomes. Song et al. [31] also noted that elevated CEA levels in GCLM patients after radical gastrectomy were linked to shorter survival time and a higher risk of liver metastasis.

The treatment plan is a crucial factor in the prognosis of GCLM patients, as different strategies target specific biological behaviors and dissemination patterns of the tumor, directly influencing the survival duration of patients. In this study, the TACE regimen effectively delivered high concentrations of chemotherapy and embolic materials directly to liver lesions, reducing tumor burden in the liver while minimizing toxicity to normal liver tissue, thus preserving liver function and extending survival of patients. Additionally, the TACE regimen treated small lesions and circulated tumor cells that were difficult to target, thereby reducing the risk of tumor recurrence and metastasis and improving the overall efficacy of chemotherapy. Zhao et al. [32] also demonstrated that the use of microsphere drug-eluting beads in TACE, combined with intra-arterial infusion for GCLM, significantly improved patients' overall survival rates.

Finally, we developed a Nomogram model based on the four prognostic factors identified through Lasso-Cox regression. Hopefully, this model will serve as a visual tool that allows clinicians to accurately predict the two-year survival probability of GCLM patients, thereby supporting personalized medical decision-making. Wu et al. [33] previously constructed a prediction model for all-cause mortality in GCLM patients using the SEER database, with an AUC of 0.718, while Huang et al. [34] developed a model to predict the occurrence of GCLM using logistic regression analysis, with an AUC of 0.851. In our study, the AUCs for predicting 1- and 2-year survival rates were 0.864 and 0.840, respectively, significantly higher than those in previous studies. Unlike Wu's and Huang's models, our Nomogram comprehensively has incorporated multiple key factors, including treatment plan, pathological differentiation, degree of liver metastasis, and pre-treatment CEA levels. This multidimensional analysis has provided a more robust assessment of survival rate, and the user-friendly format of the Nomogram has simplified the presentation of complex statistical data, facilitating its application in clinical practice. The model would enhance the ability of clinicians to make personalized, data-driven decisions with the potential to improve clinical outcomes.

This study does have several limitations. It is a single-center study with a relatively small sample size, which may limit the generalizability of the study results. Furthermore, the 24-month follow-up period may not fully capture the long-term effects of the treatment. As a retrospective study, it is also susceptible to information bias and limited control over confounding variables. Future research should involve larger, multi-center studies with longer follow-up periods and prospective, randomized controlled trials to validate and expand upon these findings.

Conclusion

In conclusion, the combination TACE therapy regimen significantly improves survival and quality of life in GCLM patients. By reducing tumor aggressiveness and extending disease-free survival, this treatment offers a valuable therapeutic option for clinical practice.

Acknowledgements

This work was supported by the Natural Science Foundation of Gansu Province Project (23JRRA1802).

Disclosure of conflict of interest

None.

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References

[1] Ozmen MM. The pandemic, statistics for 2020, journal targets and gastric cancer. Turk J Surg 2021; 37: aix.

[2] Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I and Jemal A. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2024; 74: 229-263.

[3] Li J, Xi H, Cui J, Zhang K, Gao Y, Liang W, Cai A, Wei B and Chen L. Minimally invasive surgery as a treatment option for gastric cancer with liver metastasis: a comparison with open surgery. Surg Endosc 2018; 32: 1422-1433.

[4] Tsunematsu M, Takahashi N, Murakami K, Misawa T, Akiba T and Yanaga K. Successful conversion surgery for gastric cancer with multiple liver metastases treated after S-1 plus cisplatin combination chemotherapy: a case report. Surg Case Rep 2017; 3: 95.

[5] Xia C, Dong X, Li H, Cao M, Sun D, He S, Yang F, Yan X, Zhang S, Li N and Chen W. Cancer statistics in China and United States, 2022: profiles, trends, and determinants. Chin Med J (Engl) 2022; 135: 584-590.

[6] Zheng RS, Chen R, Han BF, Wang SM, Li L, Sun KX, Zeng HM, Wei WW and He J. Cancer incidence and mortality in China, 2022. Zhonghua Zhong Liu Za Zhi 2024; 46: 221-231.

[7] Zhu Y, Chen J, Sun X, Lou Y, Fang M, Zhou F, Zhang L and Xin Y. Survival and complications after neoadjuvant chemoradiotherapy versus neoadjuvant chemotherapy for locally advanced gastric cancer: a systematic review and meta-analysis. Front Oncol 2023; 13: 1177557.

[8] Hu H, Li C, Cai S, Zhu C, Tian Y, Zheng J, Hu J, Chen C and Liu W. Increased expression of pleiotrophin is a prognostic marker for patients with gastric cancer. Hepatogastroenterology 2014; 61: 1478-1482.

[9] Zhang Y, Lin W, Yang Y, Zhu S, Chen Y, Wang H and Teng L. MEF2D facilitates liver metastasis of gastric cancer cells through directly inducing H1X under IL-13 stimulation. Cancer Lett 2024; 591: 216878.

[10] Fang YU, Wang L, Yang N, Gong X, Zhang YU and Qin S. Successful multimodal therapy for an α-fetoprotein-producing gastric cancer patient with simultaneous liver metastases. Oncol Lett 2015; 10: 3021-3025.

[11] Sonoda I, Suzuki D, Kawasaki K, Yoshitomi H, Furukawa K, Takayashiki T, Kuboki S, Takano S, Sakai N, Kagawa S, Nojima H, Mishima T and Ohtsuka M. Surgical treatment for liver metastases of gastric cancer. Gan To Kagaku Ryoho 2018; 45: 2270-2272.

[12] Yamauchi S, Hirata T and Tsuruhara Y. Effects of oral administration of UFT in unresectable gastric cancer with liver metastasis. Gan To Kagaku Ryoho 1986; 13: 384-388.

[13] Salati M, Di Emidio K, Tarantino V and Cascinu S. Second-line treatments: moving towards an opportunity to improve survival in advanced gastric cancer? ESMO Open 2017; 2: e000206.

[14] Kataoka K, Kinoshita T, Moehler M, Mauer M, Shitara K, Wagner AD, Schrauwen S, Yoshikawa T, Roviello F, Tokunaga M, Boku N, Ducreux M, Terashima M and Lordick F; EORTC GITCG Group and JCOG SCGC Group. Current management of liver metastases from gastric cancer: what is common practice? New challenge of EORTC and JCOG. Gastric Cancer 2017; 20: 904-912.

[15] Long J, Zhang X, Mi W, Shi J, Ren H and Wang Q. The predictive value of sarcopenia and myosteatosis in trans-arterial (chemo)-embolization treated HCC patients. Aging (Albany NY) 2024; 16: 389-401.

[16] Li J, Zhang K, Gao Y, Xi H, Cui J, Liang W, Cai A, Wei B and Chen L. Evaluation of hepatectomy and palliative local treatments for gastric cancer patients with liver metastases: a propensity score matching analysis. Oncotarget 2017; 8: 61861-61875.

[17] Tanigawa T, Hasuike Y, Akiyama Y, Higuchi I, Ishikawa A, Okada A and Miyamoto M. Preoperative treatment with transcatheter arterial chemoembolization (TACE) and hepatic arterial infusion (HAI) for liver metastasis from gastric cancer--a case report. Gan To Kagaku Ryoho 2015; 42: 1460-1462.

[18] Dang HZ, Yu Y and Jiao SC. Prognosis of HER2 over-expressing gastric cancer patients with liver metastasis. World J Gastroenterol 2012; 18: 2402-2407.

[19] Han CL, Tian BW, Yan LJ, Ding ZN, Liu H, Pan GQ, Zhang X, Mao XC, Tan SY, Li RZ, Wang DX, Dong ZR, Yan YC and Li T. The effect of age, sex, and eastern cooperative oncology group performance status on the efficacy and safety of immune checkpoint inhibitors in patients with hepatocellular carcinoma: a systematic review and meta-analysis. Expert Rev Anticancer Ther 2024; 24: 303-312.

[20] Karmakar A, Kumtakar A, Sehgal H, Kumar S and Kalyanpur A. Interobserver variation in response evaluation criteria in solid tumors 1.1. Acad Radiol 2019; 26: 489-501.

[21] Hirose Y, Aizawa M, Yabusaki H, Nomura T, Takano K, Kawasaki T, Watanabe G, Shimojima Y, Yuza K, Bamba T and Nakagawa S. Prognostic role of preoperative chemotherapy in liver-limited metastasis from gastric cancer. Ann Surg Oncol 2024; 31: 4213-4223.
[22] Namikawa T, Tsuda S, Fujisawa K, Iwabu J, Uemura S, Tsujii S, Maeda H, Kitagawa H, Kobayashi M and Hanazaki K. Conversion surgery after S-1 plus oxaliplatin combination chemotherapy for advanced gastric cancer with multiple liver metastases. Clin J Gastroenterol 2018; 11: 297-301.
[23] Hu J, Bao Q, Cao G, Zhu X, Yang R, Ji X, Xu L, Zheng K, Li W, Xing B and Wang X. Hepatic arterial infusion chemotherapy using oxaliplatin plus 5-fluorouracil versus transarterial chemoembolization/embolization for the treatment of advanced hepatocellular carcinoma with major portal vein tumor thrombosis. Cardiovasc Intervent Radiol 2020; 43: 996-1005.
[24] Fukami Y, Kaneoka Y, Maeda A, Takayama Y, Takahashi T, Uji M and Kumada T. Adjuvant hepatic artery infusion chemotherapy after hemihepatectomy for gastric cancer liver metastases. Int J Surg 2017; 46: 79-84.
[25] Cappelli A, Cucchetti A, Cabibbo G, Mosconi C, Maida M, Attardo S, Pettinari I, Pinna AD and Golfieri R. Refining prognosis after trans-arterial chemo-embolization for hepatocellular carcinoma. Liver Int 2016; 36: 729-736.
[26] Yen HH, Chen CN, Yeh CC and Lai IR. Adjuvant tegafur-uracil (UFT) or S-1 monotherapy for advanced gastric cancer: a single center experience. World J Surg Oncol 2021; 19: 124.
[27] Polysalov VN, Veriasova NN, Dolgikh SD and Gapbarov ACh. Regional chemotherapy in locally advanced and metastatic gastric cancer. Vopr Onkol 2012; 58: 762-767.
[28] Xu H, Min X, Ren Y, Yang L and Liu F. Comparative study of drug-eluting beads versus conventional transarterial chemoembolization for treating peculiar anatomical sites of gastric cancer liver metastasis. Med Sci Monit 2020; 26: e922988.
[29] Wu J, Yu J, Chen Z, Zhu H, Zhong C, Liang Y, Mai Z, Lin Z, Wan Y and Li G. Survival benefit of primary tumor resection for gastric cancer with liver metastasis: a propensity score-matched, population-based study. Front Oncol 2022; 12: 1039086.
[30] Hori S, Honda M, Kobayashi H, Kawamura H, Takiguchi K, Muto A, Yamazaki S, Teranishi Y, Shiraso S, Kono K, Kamiga T, Iwao T and Yamashita N. A grading system for predicting the prognosis of gastric cancer with liver metastasis. Jpn J Clin Oncol 2021; 51: 1601-1607.
[31] Song JC, Ding XL, Zhang Y, Zhang X and Sun XH. Prospective and prognostic factors for hepatic metastasis of gastric carcinoma: a retrospective analysis. J Cancer Res Ther 2019; 15: 298-304.
[32] Zhao GS, Song YX, Sun JB, Liu S, Xu F, Ma J, Li C, Gao F, Zhou J, Wang RY and Liang SN. Efficacy and safety of CalliSpheres® microspheres drug-eluting beads transarterial chemoembolization in GCLM combined trans-arterial infusion therapy for treating primary focus of gastric cancer: a multi-center retrospective study. Expert Rev Anticancer Ther 2023; 23: 1009-1016.
[33] Wu Y, Guo Y and Luo W. Prediction of all-cause death and specific causes of death in patients with gastric cancer with liver metastasis: a surveillance, epidemiology, and end results-based study. J Gastrointest Surg 2024; 28: 880-888.
[34] Huang F and Fang M. Prediction model of liver metastasis risk in patients with gastric cancer: a population-based study. Medicine (Baltimore) 2023; 102: e34702.