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Observation on the efficacy of TPO receptor agonists and platelet transfusion in chemotherapy-induced thrombocytopenia in malignant tumors

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Abstract

Objective To observe the clinical efficacy of TPO receptor agonists and platelet transfusion in chemotherapy-induced thrombocytopenia in malignant tumors.

Methods Clinical data from 120 patients with malignant tumors who developed thrombocytopenia following chemotherapy at our hospital were retrospectively collected and randomly divided into three groups: A, B, and C, with 40 patients in each group. Group A was treated with a TPO receptor agonist (avatrombopag), group B received autologous platelet transfusion, and group C received a combination of both treatments. The clinical efficacy of the three groups was compared, including platelet levels at different time points during treatment, platelet recovery time (time to reach $<50\times10^9$/L, ≥75–100×10^9/L, and $\geq100\times10^9$/L), changes in serum cytokine levels (PF4, TPO, vWF) before and after treatment, and fluctuations in coagulation function indicators (APTT, PT, FIB) before and after treatment to analyze the effectiveness of each treatment regimen.

Results About clinical efficacy, the effectiveness in group A was comparable to that in group B ($P>0.05$), while the effective rate in group C was significantly higher than that in groups A and B ($P<0.05$). Regarding platelet counts, repeated measures analysis of variance showed significant differences in the time effect, group effect, and interaction effect for platelet counts (PLT) among the three groups ($P<0.05$). Concerning platelet recovery time, the time to reach PLT $<50\times10^9$/L, the time to recover to 75–100×10^9/L, and the time to recover to $\geq100\times10^9$/L were similar in groups A and B ($P>0.05$). However, the time for these parameters in group C was significantly shorter than in groups A and B ($P<0.05$). In terms of changes in platelet parameters, post-treatment levels of PF4, TPO, and vWF in all three groups were significantly higher than pre-treatment levels. The PF4, TPO, and vWF levels in groups A and B were similar ($P>0.05$), whereas group C had significantly higher levels compared to groups A and B ($P<0.05$). Regarding coagulation indices, post-treatment levels of APTT and PT decreased, while FIB levels increased in all three groups ($P<0.05$). There were no significant differences in APTT and FIB levels between groups A and B ($P>0.05$). However,

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group C had significantly lower APTT and higher FIB levels compared to groups A and B ($P < 0.05$). There were no significant differences in PT levels among the three groups post-treatment ($P > 0.05$).

Conclusion Autologous platelet transfusion and TPO receptor agonists are effective clinical methods for treating chemotherapy-induced thrombocytopenia. The combined use of both treatments yields better therapeutic results.

Keywords Malignant tumors, Chemotherapy-induced thrombocytopenia, TPO receptor agonist, Autologous platelet transfusion, Platelet count

Introduction

Cancer is the second leading cause of mortality globally. Despite advancements in diagnostic techniques and treatment modalities, over 50% of cancer patients ultimately succumb to the disease. Furthermore, survivors often contend with a spectrum of conditions directly attributable to the malignancy itself, in addition to the toxic effects of therapeutic interventions [1, 2]. Chemotherapy, as one of the common treatment methods for various malignant tumors, plays a crucial role in fighting cancer. However, it inevitably causes significant damage to the body, leading to a series of side effects, including chemotherapy-induced thrombocytopenia (CIT) [3, 4]. The presence of thrombocytopenia increases the bleeding risk in cancer patients, potentially leading to reduced chemotherapy doses or delayed chemotherapy cycles. This not only prolongs the treatment time but also increases the treatment costs, reduces the patients' quality of life, and in severe cases, poses a threat to the patients' life and increases their mortality risk [5].

In clinical practice, it is generally recommended to promptly manage patients with a platelet count (PLT) $< 75 \times 10^9$/L or those exhibiting bleeding symptoms, typically through platelet transfusion or drug therapy [6, 7]. Autologous platelet transfusion is widely used in the clinical treatment of thrombocytopenia caused by conditions such as leukemia, lymphoma, and post-operative or chemotherapy-induced thrombocytopenia due to its advantages of reducing rejection risk and eliminating the risk of infectious disease transmission [8, 9]. Thrombopoietic agents include recombinant human interleukin-11 (rhIL-11) [10] and thrombopoietin receptor agonists (TPO-RAs, TRAs) [11]. These agents are used to stimulate platelet production and are integral to the management of chemotherapy-induced thrombocytopenia.

There is substantial evidence that eltrombopag can cause hepatotoxicity [12, 13]. Avatrombopag, a second-generation TPO receptor agonist, increases platelet production by activating intracellular signaling pathways and promoting the generation of platelets and megakaryocytes from hematopoietic progenitor cells [14, 15]. Both autologous platelet transfusion and oral avatrombopag have shown favorable therapeutic effects for chemotherapy-induced thrombocytopenia, but comparative studies on their efficacy in treating thrombocytopenia post-chemotherapy in malignant tumors, as well as studies on the combined treatment effects, are still relatively rare. Based on the above reports, we believe that autologous platelet transfusion combined with TPO-RAs has favorable results in the treatment of chemotherapy-induced thrombocytopenia in malignant tumors. Platelet transfusions are a common emergency treatment in chemotherapy-induced severe thrombocytopenia. They are used to rapidly increase platelet levels and reduce the risk of bleeding. While transfusion alone provides rapid relief of thrombocytopenia, it is usually temporary and does not address the long-term platelet production problems caused by myelosuppression. Consequently, the combination of TPO agonists and platelet transfusion can have a "dual effect." On the one hand, platelets are rapidly replenished by transfusion. On the other hand, TPO agonists promote sustained platelet production and reduce the patient's dependence on platelet transfusion. This study aims to observe the efficacy of autologous platelet transfusion and TPO-RAs in chemotherapy-induced thrombocytopenia in malignant tumors.

Materials and methods

Study population

Patients with malignant tumors who developed thrombocytopenia following chemotherapy were collected from our hospital. This study was approved by the ethics committee of our hospital.

Inclusion criteria

1. Diagnosed with malignant tumors based on pathological or cytological evidence and treated with standardized chemotherapy regimens.
2. Met the diagnostic criteria for chemotherapy-related thrombocytopenia [16].
3. Had a platelet count (PLT) $< 75 \times 10^9$/L, indicating grade 2 or higher thrombocytopenia, approximately 10 days post-chemotherapy.
4. Estimated survival time of more than 3 months.
5. Complete clinical data.

Exclusion criteria

1. Age under 18 years.

2. Pregnant or breastfeeding patients.
3. Recent history of thrombosis.
4. Known allergy to avatrombopag.
5. Use of other thrombopoietic agents during the study period.
6. Thrombocytopenia caused by non-malignant tumor chemotherapy factors such as infection or coagulation disorders.

Clinical data

Complete clinical data were collected for each patient, including medical history, physical examination, laboratory tests, and imaging studies. Strict adherence to the inclusion criteria yielded 120 eligible patients, who were divided into three groups of 40 each. Group A was treated with a TPO receptor agonist (avatrombopag), group B received autologous platelet transfusion, and group C received a combination of both treatments.

Methods

Collection and storage of autologous platelets

Before platelet collection, patients' coagulation function and cardiac function (ECG) were tested. Once these indicators were normal and the patients' PLT was confirmed to be $\geq 120 \times 10^9$/L, autologous platelets were collected using the COBE Spectra cell separator (USA). The platelets were placed in specialized PVC collection bags, with a set target platelet collection amount of $\geq 3.0 \times 10^9$/L. Within 2 h post-collection, the platelet bags were placed in a class 100 clean room, and DMSO was injected into the collection bags at a rate of 1 mL/min to a final concentration of 5%. The collection bags were then placed horizontally in a -80 °C freezer for storage until needed [17].

Treatment methods

All patients underwent routine tests, including complete blood count, urinalysis, coagulation function, and electrocardiogram (ECG), before chemotherapy. Patients' daily post-treatment signs and symptoms, along with relevant auxiliary examinations, were recorded. Group A: When $PLT < 75 \times 10^9$/L post-chemotherapy, patients received oral avatrombopag (manufactured by Kawashima Plant Eisai Co., Japan, 20 mg/tablet, batch number: 85038). The initial and maintenance dose was 2 tablets once daily. Treatment was discontinued when the patient's PLT was normal ($\geq 100 \times 10^9$/L) for two consecutive days or increased by $\geq 50 \times 10^9$/L compared to pre-treatment levels. Autologous platelet transfusion was administered if the platelet count dropped below 10×10^9/L. Group B: Patients received transfusions of platelets collected before chemotherapy. The transfusion was performed when significant thrombocytopenia or bleeding symptoms occurred during or after chemotherapy. The frozen platelets were thawed in a 40 °C water bath for 2–3 min, irradiated with 20 Gy to kill leukocytes, and transfused at the fastest speed tolerable by the patient. PLT was measured 1 and 24 h post-transfusion to calculate the corrected count increment (CCI). Transfusion efficacy was defined as a 1-hour CCI > 7.5 and a 24-hour CCI > 4.5. Group C: Patients received a combination of the two treatment methods described above.

Observation indicators

Clinical efficacy

Significant efficacy is defined as a peripheral blood $PLT \geq 100 \times 10^9$/L after treatment; Effective is defined as a peripheral blood $PLT \geq 75 \times 10^9$/L, or an increase in PLT of at least 50×10^9/L compared to the original level; Ineffective is defined as not meeting the above criteria. The overall effective rate = (number of significantly effective cases + number of effective cases) / total number of cases × 100% [18].

Platelet count and platelet recovery time

Each group of patients undergoes daily blood routine examinations. The PLT count before treatment and on the 3rd, 7th, 10th, and 14th days of treatment is observed and compared among the three groups. The duration of PLT below 50×10^9/L, the time required for PLT to recover to 100×10^9/L > PLT ≥ 75×10^9/L, and the time required to recover to $PLT \geq 100 \times 10^9$/L are recorded and statistically analyzed for the three groups.

Serum cytokines

Collect 5 mL of fasting venous blood from patients in the morning, centrifuge at 4000 r/min for 10 min to extract 1.5 mL of the upper serum layer, and store it in a -80 °C freezer for later testing. Serum levels of platelet factor 4 (PF4), thrombopoietin (TPO), and von Willebrand factor (vWF) are measured using enzyme-linked immunosorbent assay (ELISA). The ELISA kits for PF4 (ab100628), TPO (ab277455), and vWF (ab108918) are all purchased from Abcam.

Coagulation indicators

Venous blood from the three groups of patients is collected before and after treatment. Using the PUN-2048 A fully automatic coagulation analyzer and associated reagents (Beijing Pulang New Technology Co., Ltd.), activated partial thromboplastin time (APTT), prothrombin time (PT), and fibrinogen (FIB) levels are measured by chemiluminescence.

Statistical methods

SPSS 19.0 statistical software was used. Normally distributed measurement data are expressed as Mean ± SD,

Table 1 Comparison of general data among three groups of patients [Mean ± SD, n]

Variable	Group A (*n* = 40)	Group B (*n* = 40)	Group C (*n* = 40)	χ^2/F/z	*P*
Gender				0.469	0.791
Male	23	20	21		
Female	17	20	19		
Age (years)	48.23 ± 10.20	47.50 ± 9.88	49.13 ± 10.39	0.257	0.774
BMI (kg/m^2)	22.00 ± 2.81	22.34 ± 2.91	21.58 ± 3.05	0.678	0.510
Tumor Type				3.682	0.961
Lung Cancer	12	13	13		
Stomach Cancer	6	4	7		
Ovarian Cancer	4	5	2		
Esophageal Cancer	6	7	5		
Colorectal Cancer	8	5	7		
Nasopharyngeal Cancer	4	6	6		
CIT Classification				0.068	0.967
Grade 2	17	18	16		
Grade 3	13	11	14		
Grade 4	10	11	10		
Cancer Staging				0.029	0.986
I	2	3	2		
II	4	5	6		
III	15	12	14		
IV	19	20	18		
Combined radiotherapy	8	10	7	0.707	0.702
Combined Targeted Therapy	7	6	4	0.959	0.619
Combined immunotherapy	5	6	8	0.875	0.646

while non-normally distributed measurement data are expressed as M (P25, P75). Analysis of repeated measurement efficacy indicators that conform to a normal distribution and homogeneity of variance was performed. If Mauchly's sphericity test assumption was met, a two-factor analysis of variance was used; if the sphericity assumption was not met, the Greenhouse-Geisser correction was applied. Count data are expressed as cases (%), and comparisons between groups were performed using Fisher's exact test. Rank data were analyzed using non-parametric tests. A Pvalue < 0.05 was considered statistically significant.

Table 2 Comparison of clinical efficacy among three groups (n, %)

Group	Significant Efficacy	Efficacy	Ineffective	Effective Rate (%)
Group A (*n* = 40)	22	10	8	32 (80.00)
Group B (*n* = 40)	20	11	9	31 (77.50)
Group C (*n* = 40)	34	5	1	39 (97.50)*#
χ^2	-	-	-	7.425
P	-	-	-	0.024

Note: * denotes comparison with Group A, # denotes comparison with Group B, $P < 0.05$

Results

Comparison of general data among three groups of patients

At baseline, there were no significant statistical differences ($P > 0.05$) in demographic characteristics such as gender, age, BMI, as well as clinical features including tumor type, CIT grading, cancer staging, and combined treatment regimens among the three groups of patients. This indicates comparability among the groups. Specific results are presented in Table 1.

Comparison of clinical efficacy among three groups

In this study, follow-ups were obtained for all of the patients, we compared the clinical efficacy among patients in Group A, Group B, and Group C. The results showed that the effective rate in Group C was the highest, reaching 97.50%, which was significantly higher than 80.00% in Group A and 77.50% in Group B. Specifically, in Group C, 34 patients achieved significant efficacy, 5 achieved efficacy, and 1 was ineffective; in Group A, 22 patients achieved significant efficacy, 10 achieved efficacy, and 8 were ineffective; in Group B, 20 patients achieved significant efficacy, 11 achieved efficacy, and 9 were ineffective. Statistical analysis results indicated that the effective rate in Group C was significantly higher than that in Group A and Group B ($P < 0.05$), suggesting that the treatment effect in Group C was superior to the other two groups. Specific results are presented in Table 2.

Table 3 Single effect test of PLT Level (Mean ± SD)

Group	Before Treatment	Day 3 of Treatment	Day 7 of Treatment	Day 10 of Treatment	Day 14 of Treatment	F	*P*
Group A (*n* = 40)	57.24 ± 9.79	64.34 ± 8.09[a]	72.55 ± 8.19[ab]	86.33 ± 10.54[abc]	96.25 ± 17.32[abcd]	82.583	*P* < 0.001
Group B (*n* = 40)	56.46 ± 10.08	65.21 ± 8.48[a]	72.77 ± 9.24[ab]	85.59 ± 10.29[abc]	97.49 ± 18.08[abcd]	83.073	*P* < 0.001
Group C (*n* = 40)	57.87 ± 8.25	68.24 ± 7.23[a]	80.54 ± 7.57[ab*#]	94.70 ± 8.46[abc*#]	109.54 ± 14.40[abcd*#]	138.750	*P* < 0.001
F	0.026	2.662	11.837	10.629	7.745	-	-
P	0.798	0.074	*P* < 0.001	*P* < 0.001	0.001	-	-

Note: a indicates comparisons with the same group before treatment, b indicates comparisons with the same group on day 3, c indicates comparisons with the same group on day 7, and d indicates comparisons with the same group on day 10, *P* < 0.05. * indicates comparisons with the same period of time as in group A, and # indicates comparisons with the same period of time as in group B, *P* < 0.05

Table 4 Comparison of platelet recovery related indices among three groups (Mean ± SD, days)

Group	Below 50 × 10^9/L	Recovery to 75–100 × 10^9/L	Recovery to ≥ 100 × 10^9/L
Group A (*n* = 40)	4.45 ± 1.34	8.30 ± 1.59	10.22 ± 1.65
Group B (*n* = 40)	4.55 ± 1.38	8.25 ± 1.50	10.38 ± 1.61
Group C (*n* = 40)	3.40 ± 1.03[*#]	5.45 ± 1.34[*#]	7.73 ± 1.26[*#]
F	10.244	48.681	38.317
P	< 0.001	< 0.001	< 0.001

Note: * indicates comparisons with the same period in Group A, # indicates comparisons with the same period in Group B, *P* < 0.05

PLT level single effect test

In the simple effect results of group membership, there were no significant differences in PLT levels between the three groups before treatment (F = 0.026, *P* = 0.798) and on the 3rd day of treatment (F = 2.662, *P* = 0.064). However, on the 7th day (F = 11.837, *P* < 0.001), 10th day (F = 10.629, *P* < 0.001), and 14th day (F = 7.745, *P* = 0.001) of treatment, there was no significant difference in PLT levels between Group A and Group B, but Group C was significantly higher than Group A and Group B. The simple effect of group membership was significant. The simple effect results of time showed that the PLT levels at different time points for Group A, Group B, and Group C were as follows: before treatment < 3rd day of treatment < 7th day of treatment < 10th day of treatment < 14th day of treatment (*P* < 0.05). Specific results are shown in Table 3.

Comparison of platelet recovery time among three groups

The platelet recovery status of patients in the three groups was observed and statistically analyzed. The results suggested that the durations of PLT remaining below 50×10^9/L, recovery to 75–100×10^9/L, and recovery to ≥ 100×10^9/L were similar between Groups A and B (*P* > 0.05). However, in Group C, the durations of PLT remaining below 50×10^9/L, recovery to 75–100×10^9/L, and recovery to ≥ 100×10^9/L were significantly shorter than those in Groups A and B (*P* < 0.05). Specific results are shown in Table 4.

Comparison of serum levels of cytokines before and after treatment among three groups

Comparison of serum levels of PF4, TPO, and vWF cytokines before and after treatment among the three groups revealed that before treatment, the levels of these indicators were similar among the three groups (*P* > 0.05). After treatment, the levels of PF4, TPO, and vWF in all three groups significantly decreased compared to before treatment. Furthermore, the levels of these indicators in Group C were significantly lower than those in Group A and Group B (*P* < 0.05), while the difference between Group A and Group B was not significant (*P* > 0.05). Specific results are shown in Table 5.

Comparison of coagulation indicator levels before and after treatment among three groups

Comparison of serum levels of APTT, PT, and FIB coagulation indicators before and after treatment among the three groups revealed that before treatment, the levels of these indicators were similar among the three groups (*P* > 0.05). After treatment, APTT significantly decreased in all three groups, with Group C significantly lower than Group A and Group B (*P* < 0.05). FIB levels significantly increased after treatment, with Group C significantly

Table 5 Comparison of serum levels of cytokines before and after treatment among three groups (Mean ± SD)

Group	PF4 (pg/mL)		TPO (pg/mL)		vWF (ng/mL)	
	Before Treatment	After Treatment	Before Treatment	After Treatment	Before Treatment	After Treatment
Group A (*n* = 40)	140.25 ± 13.36	125.54 ± 11.47[a]	358.54 ± 17.32	143.23 ± 12.55[a]	65.48 ± 6.12	51.33 ± 4.01[a]
Group B (*n* = 40)	141.33 ± 12.87	124.36 ± 11.29[a]	356.49 ± 17.59	138.29 ± 12.06[a]	65.24 ± 6.30	51.88 ± 4.13[a]
Group C (*n* = 40)	140.92 ± 13.10	114.28 ± 10.52[a*#]	358.02 ± 18.29	91.28 ± 10.12[a*#]	64.78 ± 6.40	43.25 ± 3.45[a*#]
F	0.068	12.414	0.144	243.193	0.130	62.249
P	0.934	< 0.001	0.866	< 0.001	0.878	< 0.001

Note: a indicates comparison with the same group before treatment, * indicates comparison with the same period in group A, and # indicates comparison with the same period in group B, *P* < 0.05

Table 6 Comparison of coagulation indicator levels before and after treatment among three groups (Mean ± SD)

Group	APTT (s)		PT (s)		FIB (g/L)	
	Before Treatment	After Treatment	Before Treatment	After Treatment	Before Treatment	After Treatment
Group A ($n=40$)	32.87 ± 3.34	29.54 ± 1.87[a]	13.25 ± 1.67	11.26 ± 1.70[a]	2.33 ± 0.51	2.97 ± 0.43[a]
Group B ($n=40$)	33.01 ± 3.14	29.63 ± 1.66[a]	13.44 ± 1.59	11.33 ± 1.74[a]	2.28 ± 0.49	2.91 ± 0.38[a]
Group C ($n=40$)	33.25 ± 2.99	27.23 ± 1.42[a*#]	13.18 ± 1.70	10.88 ± 1.63[a]	2.30 ± 0.48	3.21 ± 0.18[a*#]
F	0.140	26.701	0.272	0.820	0.125	8.500
P	0.869	< 0.001	0.762	0.443	0.883	< 0.001

Note: a indicates comparison with the same group before treatment, * indicates comparison with the same period in group A, and # indicates comparison with the same period in group B, $P<0.05$

higher than Group A and Group B ($P<0.05$). However, there was no significant difference in APTT and FIB levels between Group A and Group B after treatment ($P>0.05$). PT decreased after treatment in all three groups, but there was no significant difference in PT levels among the three groups ($P<0.05$). Specific results are shown in Table 6.

Discussion

Chemotherapy in cancer patients can lead to a decrease in platelet count, with the degree and duration of reduction mainly determined by the degree of bone marrow suppression and the time for hematopoietic function recovery [19]. Platelet reduction can induce severe bleeding, even leading to death. Currently, clinical interventions for CIT are very limited, mainly including platelet transfusion and administration of platelet growth factors, such as rhIL-11, rhTPO, and TPO-RA [20, 21]. rhIL-11 and rhTPO have favorable therapeutic effects on platelet reduction caused by surgeries, coagulation disorders, and regenerative anemia. However, each has its own drawbacks. Clinical observations of rhIL-11 have found adverse effects on patients' hearts, potentially leading to cardiovascular events such as atrial flutter and atrial fibrillation [22, 23]. On the other hand, rhTPO has a short duration of action in the human body and may cross-react with endogenous TPO, leading to the production of neutralizing antibodies and increasing the risk of resistance [24].

Platelet transfusion remains the primary approach in clinical management of CIT as it effectively addresses the coagulation dysfunction caused by platelet depletion. With further research, autologous platelet transfusion, due to its advantages such as avoidance of ineffective transfusion and reduced risk of bloodborne diseases transmission, gradually replaces allogeneic platelet transfusion and is widely applied in the clinical treatment of thrombocytopenia [25, 26]. In this study, patients in Group B were treated with cryopreserved autologous platelets collected before chemotherapy. The efficacy rate was 77.50%, and post-treatment PLT levels increased with prolonged treatment duration. Furthermore, significant improvements were observed in patients' levels of PF4, TPO, vWF, and other cell factors, as well as coagulation function indicators compared to pre-treatment levels. These findings once again confirm the feasibility and definite clinical efficacy of using cryopreserved autologous platelet transfusion in treating CIT [27, 28]. Existing literature suggests that avatrombopag has not been found to have significant liver toxicity and is generally safe [29]. Currently, there is limited research on the treatment of thrombocytopenia with avatrombopag, but all studies have achieved the expected therapeutic effects. Studies by Gabrail et al. [30] have found that avatrombopag can effectively treat thrombocytopenia caused by polyADP-ribose polymerase (PARP) inhibitors, allowing patients to continue targeted therapy and delay tumor progression. In this study, Group A was treated with oral avatrombopag after CIT diagnosis. The results showed an efficacy rate of 80.00%, and significant improvements were observed in PLT, PF4, TPO, vWF, and APTT levels after treatment. It is evident from the results that avatrombopag treatment for CIT can achieve favorable efficacy, with its ability to promote platelet recovery and improve coagulation function comparable to autologous platelet transfusion.

Additionally, the study observed the effect of combined use of platelet transfusion and avatrombopag. The results showed that in Group C, the duration of PLT < 50 × 10^9/L and the time for PLT recovery to ≥ 70 × 10^9/L and ≥ 100 × 10^9/L were significantly shorter compared to Groups A and B. This suggests that the combined application of platelet transfusion and avatrombopag is significantly more effective than either treatment alone. The reason for this may be attributed to avatrombopag's oral administration, which selectively binds to sites on endogenous TPO receptors, promoting the proliferation and differentiation of TPO receptor-dependent cell clones. This leads to the release of more platelets with normal functional structures into the peripheral blood circulation [31–33]. When used in conjunction with platelet transfusion, it further enhances synergistic effects, thus shortening the duration of PLT < 50 × 10^9/L and the time for PLT recovery. Moreover, significant improvements in PLT, PF4, TPO, vWF, and APTT levels were observed after treatment

in Group C compared to Groups A and B. This suggests that the combined application of platelet transfusion and avatrombopag can more effectively improve patients' platelet function impairment and coagulation function.

Chemotherapy is a common means of treating malignant tumors. However, its side effects, particularly thrombocytopenia, frequently result in significant complications for patients, increasing the risk of bleeding, delaying the treatment process, and even affecting the quality of life of patients. TPO receptor agonists have been employed in clinical settings to address conditions such as primary thrombocytopenia by stimulating platelet production in the bone marrow. These pharmaceutical agents, when administered in conjunction with platelet transfusion, have demonstrated efficacy in alleviating chemotherapy-induced thrombocytopenia, markedly elevating patients' platelet levels, and reducing the risk of bleeding. The advantage of combination therapy is that it not only relieves thrombocytopenia by promoting platelet production but also replenishes platelets through timely transfusion, rapidly corrects platelet levels, reduces bleeding events in patients, and improves the tolerance and efficacy of chemotherapy. Furthermore, long-term use of TPO receptor agonists may reduce patients' reliance on platelet transfusions and decrease transfusion-related risks. Nevertheless, while combination therapy offers clear clinical advantages, it is essential to consider the potential side effects of the drugs and the importance of individualized treatment. Some patients may experience excessive thrombocytosis or other adverse reactions, underscoring the necessity for close monitoring of platelet levels and related indicators in clinical practice to ensure safe and effective treatment. The combination of a TPO receptor agonist with a platelet transfusion represents a novel therapeutic approach for the treatment of thrombocytopenia induced by chemotherapy for malignant tumors. This strategy has the potential to reduce the economic burden of treatment and improve the quality of life of patients, while also offering significant clinical benefits.

There are some limitations to this study; it is a retrospective study with a small sample size and a single-center study, which has an impact on the representativeness of the results. In addition, this study observed short-term indicators after the combined intervention, and failed to explain the efficacy of the intervention for patients. Further prospective multicenter large-sample studies are needed in the future to provide a higher strength of evidence for the practical clinical application value of the combined intervention.

In summary, both autologous platelet transfusion and oral avatrombopag demonstrate effective treatment outcomes for malignant tumor patients with CIT, with the combination of both therapies yielding superior results. This combined approach proves more effective in alleviating platelet damage, promoting platelet recovery, and improving coagulation function. This study provides a reference basis for clinical diagnosis and treatment. With the development of medical technology, further research will be conducted on the prevention of chemotherapy complications of malignant tumors in the future.

Supplementary Information

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Supplementary Material 1

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Not Applicable.

Author contributions
Huan Hu wrote the main manuscript. Dongmei Leiprepared the data collection. Yan Liang prepared figures and tables. Huan Hu analyse and interpret of results. All authors reviewed the results and approved the final version of the manuscript. All authors would be informed each step of manuscript processing including submission, revision, revision reminder, etc.

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Data availability
The experimental data used to support the findings of this study are available from the corresponding author upon request.

Declarations

Ethics approval and consent to participate
This study did not involve any special intervention or handling of sensitive information, and therefore did not require ethical review. Chongqing University Cancer Hospital has agreed to exemption from review.

Consent for publication
Not Applicable.

Competing interests
The authors declare no competing interests.

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