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Characteristics and results of platelet count decrease after lower extremity arthroplasty in patients receiving low-molecular-weight heparin

Alikemal Yazici[1], Ahmet Serhat Genc[2]

[1]Samsun University, Faculty of Medicine, Department of Orthopedics and Traumatology, Samsun, Türkiye
[2]Samsun Training and Research Hospital, Department of Orthopedics and Traumatology, Samsun, Türkiye

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Abstract

This study aims to evaluate changes in platelet count and causes of thrombocytopenia in the postoperative period in patients undergoing lower extremity arthroplasty; to determine the frequency of heparin-induced non-immune thrombocytopenia (HIT Type I) and immune thrombocytopenia (HIT Type II); and to contribute to postoperative hemogram monitoring. The study retrospectively examined a total of 120 patients who underwent lower extremity arthroplasty and received routine low molecular weight heparin (LMWH) prophylaxis between December 2011 and December 2015. Platelet and hemoglobin values were recorded in the preoperative period and at 8 hours postoperatively, as well as on days 1, 2, 3, 4, 5, and 10. A platelet count of $<150\times10^9$/L was considered thrombocytopenia. The likelihood of HIT Type II was assessed based on a preoperative value of ≥50% platelet decrease and using the 4T scoring system. A decrease in platelet count was observed in 98.3% of patients during the postoperative period. The median decrease ratio between the baseline value and the lowest platelet value was calculated as 15.16%. Thrombocytopenia was observed in 24 (20%) patients. Thrombocytopenia due to hemodilution or increased platelet consumption was detected in 12 (10%) of these patients, while HIT Type I was detected in 12 (10%) of them. No HIT Type II was observed in any patient. The most significant decrease in platelet count was observed within the first four days postoperatively, while values recovered from day 5 onwards and exceeded baseline levels. Changes in platelet count following lower extremity arthroplasty generally occur within the first four days after surgery and are mostly observed as postoperative hemodilutional thrombocytopenia and thrombocytopenia associated with accelerated platelet destruction related to fluid replacement and surgical hemostasis. HIT Type I occurs at a significant rate but does not cause clinical problems. In contrast, HIT Type II is a life-threatening condition, although it is extremely rare, and therefore, clinical awareness is of great importance.

Keywords: Lower extremity arthroplasty, low molecular weight heparin, thrombocytopenia

Introduction

Postoperative fluid administration and blood product transfusion, medication use, comorbidities, and venous thromboembolism (VTE) prophylaxis routinely involve the use of low molecular weight heparins (LMWHs), which are associated with a decrease in platelet count and/or thrombocytopenia. This is a frequently encountered condition whose cause is often difficult to determine [1,2]. Changes in platelet count observed during this period are often due to transient causes, but in some cases may be associated with clinically significant conditions [1]. In particular, the timing, degree, and course of thrombocytopenia are indicative of the correct assessment of the underlying etiology [1,2].

Complications such as bleeding, allergic reactions, osteoporosis, and thrombocytopenia may be observed with low molecular weight heparin (LMWH) use [3]. Heparin-induced thrombocytopenia is classified into two subgroups based on its pathophysiological and clinical characteristics: non-immune (HIT Type I) and immune-mediated (HIT Type II) [3,4]. Type I HIT is characterized by a mild and transient decrease in platelet count, usually occurring early in heparin therapy; therefore, its clinical course is benign and generally does not require a change in the treatment procedure [2,3]. In contrast, HIT type II

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Corresponding Author: Alikemal Yazici, Samsun University, Faculty of Medicine, Department of Orthopedics and Traumatology, Samsun, Türkiye
Email: alikemal.yazici@samsun.edu.tr

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typically develops between 5 and 10 days after heparin exposure, is associated with a significantly increased risk of thrombosis, and may lead to serious clinical outcomes [4-7]. Therefore, the timing and severity of postoperative platelet count decreases must be accurately assessed, as this is critical for appropriate diagnostic approaches and patient management [1,8]. The normal platelet count in adults is 150–450×10^9/L, and thrombocytopenia is generally defined as a platelet count of <150×10^9/L [1,9–12]. However, some studies have indicated that this definition may not be sufficiently sensitive, particularly for patients developing HIT Type II, and it has been suggested that a decrease in platelet count of ≥50% compared to the preoperative value may be a more sensitive indicator [13–16]. In some studies, both criteria were used together [17]. Therefore, the timing, percentage change, and severity of postoperative platelet decline are critical in distinguishing the cause of thrombocytopenia. The causes of low platelet count and thrombocytopenia following lower extremity arthroplasty have been described in detail in the literature [1,9,12–14,18–20].

In this context, evaluating postoperative platelet count changes may contribute to distinguishing clinically significant conditions. Therefore, the aim of this study is to evaluate changes in postoperative platelet counts and causes of thrombocytopenia in patients receiving LMWH after lower extremity arthroplasty. The primary hypothesis of this study was that heparin exposure would be associated with clinically relevant reductions in platelet count. The secondary hypothesis was that such reductions would be related to an increased risk of thrombotic events and unfavorable clinical outcomes.

Material and Methods

Participants

The study retrospectively examined a total of 120 patients who underwent lower extremity arthroplasty between December 2011 and December 2015 and received routine LMWH VTE prophylaxis: 82 (68.3%) total knee arthroplasty (TKA), 29 (24.2%) total hip arthroplasty (THA), 7 (5.8%) TKA revision (rTKA), and 2 (1.7%) THA revision (rTHA). The median age of the patients was 66 (29–87) years, and 105 were female. Power analysis was performed using the G*Power (V3.1.9.7) program, and the sample size was calculated. The minimum number of cases required to be included in the study was determined to be 68, with 95% confidence (1-α) and 95% test power (1-β). A total of 120 cases were included in the study, and post hoc power analysis revealed a test power of 99.9% [9]. Inclusion criteria for the study were: planned THA or TKA (primary or revision); negative bilateral lower extremity venous Doppler ultrasound; absence of cognitive, linguistic, or mental impairment; and having signed an informed consent form.

Study Design and Procedures

This retrospective, observational study, designed to evaluate postoperative platelet count changes and causes of thrombocytopenia following lower extremity arthroplasty, was conducted as per the principles of the Helsinki Declaration. Ethics committee approval was obtained from the Samsun University Non-Interventional Clinical Research Ethics Committee (Approval No.: 2025/25/38, Date: December 31, 2025). Patients underwent a complete blood count (CBC) during the preoperative period and at 8 hours postoperatively, as well as on days 1, 2, 3, 4, 5, and 10. Patients were generally discharged on day 5 after receiving their blood count results. Patients were called in on day 10 for a follow-up visit, underwent a clinical evaluation, and had their blood count repeated. Platelet counts were repeated for confirmation in patients with detected thrombocytopenia. In accordance with the American College of Chest Physicians (ACCP) guidelines [21] for VTE prophylaxis in patients, LMWH (enoxaparin) was initiated subcutaneously 6–12 hours after surgery. LMWH use was continued for 10–14 days in TKA and rTKA cases and for 28–35 days in THA and rTHA cases. All patients received antibiotic prophylaxis with 2 g of intravenous cephalosporin during the preoperative period. General anesthesia was preferred in two patients, while spinal anesthesia was preferred in the other patients. Patients received a total of 3000 mL of fluid replacement during the operation and within the first 24 hours afterward. A platelet count of <150×10^9/L was considered thrombocytopenia. In the HIT Type II definition, it was accepted that using both criteria together; a platelet count of <150×10^9/L and a ≥50% decrease from the preoperative value—provided a more sensitive approach, and both criteria were evaluated together. Additionally, the 4T scoring system was used as a secondary evaluation criterion [19].

Statistical Analyses

Statistical analyses were performed using the SPSS program (SPSS for Windows, version 23.0, SPSS Inc., Chicago, Illinois, USA). Demographic data were summarized using descriptive statistics. The age variable was presented as mean±standard deviation and median (minimum–maximum, interquartile range), while the variables gender, comorbid disease, operation type, red blood cell transfusion, and bruising-leakage-bleeding were presented as frequency and percentage (%) (Table 1). The distribution of continuous variables was assessed using the Kolmogorov–Smirnov test. The relationships between categorical variables and the development of thrombocytopenia were analyzed using Pearson's Chi-Square Test with Yates Continuity Correction or Fisher's exact test when appropriate (Table 2). The Friedman test was used to compare platelet and hemoglobin values measured at different preoperative and postoperative time points for repeated measurements (Table 3). Bonferroni correction was applied in post-hoc pairwise comparisons. Postoperative platelet count changes, the presence of thrombocytopenia, and the frequency of thrombocytopenia were presented as frequency and percentage (%) using descriptive statistics (Tables 4-6). Statistical significance level was accepted as p<0.05.

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Result

Table 1 presents the baseline characteristics of the study population. The mean age was 64.9 years, most patients were female (87.5%), and comorbidities were present in 66.7%. Total knee arthroplasty was the most common procedure (68.3%), while postoperative bleeding-related complications occurred in 17.7% of patients.

The incidence of postoperative thrombocytopenia was 29.5% in patients over 65 years of age, while it was 10.2% in patients aged 65 years and younger. Postoperative thrombocytopenia was more common in patients over 65 years of age, and this difference was statistically significant (p=0.016). The incidence of postoperative thrombocytopenia was found to be 20% in both groups, and no statistically significant difference was found between the genders (p=1.000). Postoperative thrombocytopenia was observed in 21.3% of patients with comorbidities (hypertension, diabetes mellitus, atherosclerotic heart disease, chronic obstructive pulmonary disease, depression, anxiety), while this rate was determined to be 17.5% in patients without comorbidities. Although thrombocytopenia was observed more frequently in the group with additional diseases, the difference was not statistically significant (p=0.809). The rate of postoperative thrombocytopenia was 26.7% in patients who received red blood cell suspension, while this rate was 19% in patients who did not receive red blood cell suspension. Although thrombocytopenia was more common in the group receiving red blood cell suspension, this relationship was not statistically significant (p=0.497) (Table 2).

The median preoperative platelet count was 245 (150–498), while a decrease in platelet count was observed at the 8th postoperative hour and on days 1, 2, 3, and 4. The most significant decrease was observed on day 3. On day 5, platelet counts were found to have risen above baseline levels, and by day 10, they had reached approximately twice the baseline values (p<0.001). A decrease in hemoglobin levels was detected in all patients during the postoperative period, and the median change rate for hemoglobin was calculated as a 20.5% (8.3–34) decrease (Table 3).

A decrease in platelet count was observed in 98.3% of patients during the postoperative period, and the median decrease in platelet count between the baseline value and the lowest value was determined to be a 15.16% decrease in platelet count (−23.10: 42.99). In 2 patients (1.7%), an increase in platelet count was observed in the postoperative period (Table 4).

Thrombocytopenia was detected in 24 (20%) patients during the postoperative period. Thrombocytopenia was most commonly observed on day 2. On day 5, thrombocytopenia was observed in two patients, while on day 10, no thrombocytopenia was detected in any patient (0%). The lowest platelet count detected was 102×10^9/L (Table 5).

Thrombocytopenia due to hemodilution or increased platelet consumption was detected in 12 patients (10%), and HIT Type I was detected in 12 patients (10%). In 1 patient (0.8%), a>50% decrease in platelet count was observed at the 8th postoperative hour; however, no clinical or laboratory findings indicative of HIT Type II were detected in this case. No HIT Type II was detected in any patient (0%) (Table 6).

Table 1. Demographic data

Variables		Mean±SD	Median (min: max)	Q1	Q3
Age (year)		64.93±10.48	66 (29: 87)	58	73
Variables		**Frequency**		**Percentage**	
Gender	**Male**	15		12.5	
	Female	105		87.5	
Comorbid Disease	**Yes**	80		66.7	
	No	40		33.3	
Operation Type	**TKA**	82		68.3	
	rTKA	7		5.8	
	THA	29		24.2	
	rTHA	2		1.7	
Red Blood Cell Transfusion	**Yes**	15		12.5	
	No	105		87.5	
Bruising-Leakage-Bleeding	**Yes**	21		17.7	
	No	98		82.4	

SD, standard deviation; min, minimum; max, maximum; TKA, total knee arthroplasty; rTKA, revision total knee arthroplasty; THA, total hip arthroplasty; rTHA, revision total hip arthroplasty

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Table 2. Relationship between age, gender, comorbidities, and erythrocyte suspension transfusion with postoperative thrombocytopenia

Time point	65 years old and under	65 over	p	Male	Female	p	Comorbid Disease			Red Blood Cell Transfusion		
	(n=59, 49.2%)	(n=61, 50.8%)					Yes	No	p	No	Yes	p
PLT_8th hour	2 (3.4)	6 (9.8)	0.273x	1 (6.7)	7 (6.7)	1.000x	7 (8.8)	1 (2.5)	0.266x	8 (7.6)	0 (0)	0.594x
PLT_Day1	5 (8.5)	5 (8.2)	1.000x	1 (6.7)	9 (8.6)	1.000x	6 (7.5)	4 (10)	0.730x	9 (8.6)	1 (6.7)	1.000x
PLT_Day2	2 (3.4)	12 (19.7)	0.013y	3 (20)	11 (10.5)	0.381x	11 (13.8)	3 (7.5)	0.381x	13 (12.4)	1 (6.7)	1.000x
PLT_Day3	1 (1.7)	10 (16.4)	0.013y	2 (13.3)	9 (8.6)	0.627x	9 (11.3)	2 (5)	0.333x	11 (10.5)	0 (0)	0.355x
PLT_Day4	3 (5.1)	6 (9.8)	0.491x	1 (6.7)	8 (7.6)	1.000x	5 (6.3)	4 (10)	0.479x	7 (6.7)	2 (13.3)	0.313x
PLT_Day5	1 (1.7)	1 (1.6)	1.000x	0 (0)	2 (1.9)	1.000x	2 (2.5)	0 (0)	0.552x	2 (1.9)	0 (0)	1.000x
General	6 (10.2)	18 (29.5)	0.016x	3 (20)	21 (20)	1.000x	17 (21.3)	7 (17.5)	0.809x	20 (19.1)	4 (26.7)	0.497x

p<0.05; PLT: platelet; x fisher's exact test; y pearson's chi-squared test with yates continuity correction; n(%)

Table 3. Examination of the temporal changes in preoperative platelet and hemoglobin values after surgery

Time point	PLT	HGB
Preoperative	245 (150: 498) a	12.9 (10.4: 16.1) a
8th hour	210.5 (127: 361) bc	11.05 (7.1: 15.3) b
Day1	206 (105: 367) b	10.7 (8.7: 14.6) c
Day2	200.5 (114: 401) d	10.2 (7.8: 13.2) d
Day3	198.5 (102: 371) d	9.7 (7.5: 12.7) e
Day4	214 (107: 427) c	9.5 (7.2: 12) f
Day5	258.5 (136: 465) a	9.25 (7.4: 11.5) g
Day10	452.5 (212: 796) e	9.7 (8.3: 11.5) e
p	< 0.001x	< 0.001x

x Friedman Test; a-e There is no difference between times with the same letter; median (min:max); PLT, platelet; HGB, hemoglobin

Table 4. Postoperative platelet count change

Time point	Change direction	Frequency	Percentage
PLT 8th hour change situation	Increased	19	15.8
	Decreased	101	84.2
PLT Day1 change situation	Increased	10	8.3
	Decreased	110	91.7
PLT Day2 change situation	Increased	9	75
	Decreased	111	92.5
PLT Day3 change situation	Increased	14	11.7
	Decreased	106	88.3
PLT Day4 change situation	Increased	28	23.3
	Decreased	92	76.7
PLT Day4 end overall change	Increased	2	1.7
	Decreased	118	98.3
PLT Day5 change situation	Increased	68	56.7
	Decreased	52	43.3
PLT Day10 change situation	Increased	120	100
General	Increased	2	1.7
	Decreased	118	98.3

PLT: platelet

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Table 5. Presence of postoperative thrombocytopenia

Time point	Thrombocytopenia	Frequency	Percentage
PLT 8th hour	Yes	8	6.7
	No	112	93.3
PLT Day1	Yes	10	8.3
	No	110	91.7
PLT Day2	Yes	14	11.7
	No	106	88.3
PLT Day3	Yes	11	9.2
	No	109	90.8
PLT Day4	Yes	9	7.5
	No	111	92.5
PLT Day5	Yes	2	1.7
	No	118	98.3
PLT Day10	No	120	100
General	Yes	24	20
	No	96	80

PLT: platelet

Table 6. Postoperative thrombocytopenia frequency (Hemodilutional, HIT Type I, HIT Type II)

Time point	Type of Thrombocytopenia	Frequency	Percentage
8th hour	Hemodilutional	3	2.5
	HIT Type I	4	3.3
Day1	Hemodilutional	5	4.2
	HIT Type I	5	4.2
Day2	Hemodilutional	9	7.5
	HIT Type I	5	4.2
Day3	Hemodilutional	5	4.2
	HIT Type I	6	5
Day4	Hemodilutional	5	4.2
	HIT Type I	4	3.3
Day5 and 10	HIT Type II	0	0
General	Hemodilutional	12	10
	HIT Type I	12	10
	HIT Type II	0	0

HIT: heparin-induced thrombocytopenia

Discussion

Our study evaluated time-dependent changes in postoperative platelet counts and the frequency of HIT subtypes in patients undergoing lower extremity arthroplasty. The main findings of the study are as follows: A decrease in platelet count was observed in the postoperative period in the vast majority of patients (98.3%), with a median platelet decrease of 15.16% between the baseline value and the lowest value. Thrombocytopenia developed in 20% of patients; in half of these cases, thrombocytopenia was due to hemodilution or increased platelet consumption, while HIT Type I was detected in the other half. No HIT Type II was observed in any patient.

The most significant change in platelet count in the early postoperative period occurred within the first four days, during which platelet values decreased by up to 42.99% and increased by up to 23.10% compared to baseline values. The lowest median platelet count was recorded on day 3, and from day 5 onwards, the platelet count rose above preoperative values, reaching approximately twice the initial values by day 10. In patients undergoing lower extremity arthroplasty, perioperative administration of fluids and blood products may lead to a decrease in platelet count, primarily due to surgery-related hemodilution, increased platelet consumption, and temporary bone marrow suppression [22]. Hemodilutional thrombocytopenia, which develops as a result of accelerated platelet destruction associated with surgical hemostasis during fluid replacement administered during surgery and in the postoperative period, occurs minutes

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to hours after surgery and may persist for 1–3 days. During this period, increased production of thrombopoietin stimulates the bone marrow and increases platelet production. In the literature, a 20–30% decrease in platelet count within the first 3–4 days postoperatively is considered normal, and it is reported that it generally returns to baseline levels by day 5 and increases to 2–3 times the baseline level by days 10–14 [22-24].

Thrombocytopenia was detected in 24 (20%) of our patients in our study. Thrombocytopenia was most commonly observed on day 2, persisted in only two patients on day 5, and was not observed in any patients on day 10. The lowest platelet count recorded was 102×10^9/L. Only one patient showed a decrease of >50% compared to the preoperative value, but in this case, the platelet count recovered rapidly and did not meet the criteria for HIT Type II. Therefore, in patients suspected of having hemodilutional thrombocytopenia or HIT Type I, LMWH was not discontinued; only close monitoring was performed [23,24]. The prevalence of HIT Type I is reported in the literature to be between 10–30%, while the incidence of HIT Type II is reported to be quite low, at 0–0.04% [23–27]. Zacharia et al. detected a decrease in platelets in the early postoperative period in more than 90% of patients undergoing orthopedic surgery and reported a thrombocytopenia rate of 28% [28]. Warkentin et al. reported that HIT Type I developed in 28.8% of elective TKA patients receiving LMWH prophylaxis, but no HIT Type II was observed in any patient [9]. The HIT Type I and Type II rates obtained in our study show a high degree of consistency with these studies. In a study conducted on 3,515 patients receiving LMWH prophylaxis for TDA and TKA, relative thrombocytopenia was reported in 13 patients (0.37%). Thrombosis was observed in only one patient (0.0284%); however, a definitive association with HIT type II could not be established [29]. Haughton et al., however, reported that in 1361 patients who underwent lower extremity arthroplasty and received enoxaparin prophylaxis, no cases of HIT Type II were detected in evaluations performed between postoperative days 8 and 10, and therefore advanced laboratory testing with the 4T score was not required [16]. Ren et al. reported an incidence of Type II HIT of 0.01–0.03% in a 10-year follow-up of total knee arthroplasty and revision cases [8]. Similarly, Dhakal et al. reported HIT Type II in 0.04% of THA patients and 0.02% of TKA patients [6]. In our study, the incidence of postoperative thrombocytopenia was found to be significantly higher in patients over 65 years of age. The literature reports that HIT Type II is more common in patients over 60–65 years of age receiving LMWH, whereas it is extremely rare in patients under 40 years of age [23,27,30]. Studies involving lower extremity surgery patients not receiving LMWH have also shown a higher incidence of thrombocytopenia in patients over 65 years of age [31]. No significant difference was found in the incidence of postoperative thrombocytopenia between female and male patients. The literature presents conflicting results regarding the relationship between gender and HIT risk, indicating a need for studies with more balanced samples [23,27,30]. Although thrombocytopenia was observed more frequently in patients with comorbidities and those receiving red blood cell transfusions, these associations were not found to be statistically significant. The fact that the amount of red blood cell suspension used in our study was mostly limited to 1 unit may explain why thrombocytopenia associated with massive transfusion did not develop. The literature reports a strong association between massive transfusions and postoperative thrombocytopenia [22,32].

There are differing opinions in the literature regarding the necessity of routine platelet monitoring in patients receiving LMWH for VTE prophylaxis after lower extremity arthroplasty. While some studies recommend routine platelet monitoring [21,30,33-35], others argue that it is not necessary in low-risk patients [9,16]. Some studies also state that follow-up should be performed according to the patient's risk status [18,19]. As per the ACCP guidelines, monitoring platelet counts every 2–3 days between days 4 and 14 is recommended in patients with a Type II HIT risk above 1% (patients receiving prophylactic or therapeutic doses of UFH after surgery) (Grade 2C) [19]. Instead, routine platelet monitoring is not recommended in patients with a HIT Type II risk below 1% (medical and obstetric patients receiving UFH and LMWH, patients receiving LMWH after surgery). It is also recommended that a baseline platelet count be performed prior to treatment in patients who have been exposed to heparin within the last 100 days and, if possible, repeated 24 hours later [19]. To prevent HIT Type II, routine monitoring of platelet counts at least every other day between days 4 and 14 of heparin exposure or until heparin is discontinued is generally recommended [25]. Our study suggests that platelet and hemoglobin median values generally remain within safe limits, indicating that routine daily monitoring may not be necessary for every patient with low risk. However, considering that platelet and hemoglobin levels may fall below clinical thresholds individually, it has been concluded that close monitoring of blood counts during the first five days postoperatively is appropriate in high-risk patient groups.

This study has some limitations. The fact that the number of female patients is significantly higher than that of male patients may have limited the generalizability of gender-based evaluations. Furthermore, the single-center nature of the study and the limited sample size restrict the generalizability of the results to broader populations.

Conclusion

Changes in platelet counts in patients undergoing lower extremity arthroplasty are frequently seen as postoperative hemodilutional thrombocytopenia and thrombocytopenia due to accelerated platelet destruction associated with fluid replacement and surgical hemostasis. HIT Type I occurs with considerable frequency but does not pose a clinical problem. Although HIT type II is extremely rare, it is a life-threatening condition; therefore, awareness and adequate knowledge of this entity are of great importance. Whereas routine monitoring of platelet levels is not required in patients receiving LMWH after lower extremity arthroplasty, it should be noted that daily monitoring of blood counts (platelet count and hemoglobin level) may be

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necessary during the first five days postoperatively in patients with a bleeding tendency and those at high risk.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
This study was approved by the Samsun University Non-Interventional Clinical Research Ethics Committee (Approval No: 2025/25/38, Date: 31.12.2025).

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