International Journal of Women's Health

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Maternal Coagulation Profiles in Pregnant Women with Thalassemia: A Retrospective Observational Study in South China

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Purpose: Normal coagulation is essential for maternal safety during pregnancy and delivery. Thalassemia may influence coagulation parameters, however, its effects during pregnancy remain incompletely characterized. This study aimed to evaluate maternal coagulation profiles in pregnant women with thalassemia in South China.

Patients and Methods: This retrospective observational study included 53 pregnant women with thalassemia and 352 pregnant women without thalassemia who delivered at a tertiary medical center in South China. Singleton pregnancies with gestational age of ≥ 37 weeks were analyzed. Women with other hematological disorders, pregnancy complications affecting coagulation, or abnormal cardiac, liver, or renal function were excluded. Primary outcomes were maternal coagulation indices - activated partial thromboplastin time (APTT), prothrombin time (PT), thrombin time (TT), fibrinogen (FIB), international normalized ratio (INR), and platelet count (PLT) - and were assessed in early and late pregnancy. Perinatal outcomes were also evaluated as secondary outcomes.

Results: Women with thalassemia had lower TT in early pregnancy ($P = 0.007$) and higher PLT in both early and late pregnancy ($P < 0.001$) compared with women without thalassemia. From early to late pregnancy, APTT, PT, and INR decreased whereas TT and FIB increased in both groups ($P < 0.01$). PLT decreased only in the non-thalassemia group ($P < 0.001$). Changes in APTT ($P = 0.02$) and FIB ($P = 0.025$) were modestly more pronounced in the thalassemia group. Maternal anemia was more frequent among women with thalassemia ($P < 0.001$), while other perinatal outcomes were comparable between groups.

Conclusion: Pregnancy in women with thalassemia is associated with modest differences in coagulation parameters compared with women without thalassemia. Importantly, these variations remained within clinically acceptable ranges and were not associated with adverse perinatal outcomes. The findings provide reassuring information and contribute to a better understanding of physiological coagulation adaptation in pregnant women with thalassemia.

Plain Language Summary: Blood clotting helps prevent excessive bleeding during pregnancy and childbirth. Thalassemia is a common inherited blood disorder in South China and may influence blood clotting during pregnancy. This study compared routine blood clotting tests in pregnant women with and without thalassemia. Some clotting measurements differed between the two groups, but most values remained within normal ranges. Overall, the results provide reassuring information about blood clotting changes in pregnant women with thalassemia and help improve understanding of normal physiological adaptation during pregnancy.

Keywords: pregnancy, anemia, bleeding disorders & coagulopathies, anesthesia in obstetrics, observational study

Introduction

Thalassemia is a hereditary hemolytic anemia caused by mutations in globin genes that impair the synthesis of globin chains, leading to hemoglobin (Hb) imbalance and chronic anemia. The most common clinical forms are α-thalassemia and β-thalassemia.[1] China has a high prevalence of thalassemia, with carriers predominantly concentrated in South China, particularly in Guangdong and Guangxi provinces. A nationwide meta-analysis reported prevalences of 7.88% for

https://doi.org/10.2147/IJWH.S571929
Received: 17 December 2025
Accepted: 20 March 2026
Published: 25 March 2026

α-thalassemia, 2.21% for β-thalassemia, and 0.48% for αβ-thalassemia.[2] In Guangxi Province, the prevalence of α- and β-thalassemia reaches 17.55% and 6.43%, respectively, while corresponding rates in Guangdong Province are 12.03%, 3.80%, and 0.63%.[3,4] Given this high regional burden, understanding the physiological effects of thalassemia in pregnancy is of considerable clinical relevance.

Patients with thalassemia have been shown to exhibit a procoagulant tendency. Exposure of negatively charged phospholipids on the surface of red blood cells through a phospholipid flip-flop mechanism enhances prothrombin complex assembly and thrombin generation. Thrombin promotes fibrinogen (FIB) synthesis, platelet activation, and tissue factor expression, thereby amplifying coagulation.[5] Previous studies in non-pregnant populations with thalassemia have reported elevated fibrinogen levels, increased thrombin activity, and enhanced platelet activation.[6–8] However, how these alterations interact with the physiological changes of pregnancy remains unclear.

Normal coagulation function is essential for maternal safety during pregnancy and delivery.[9] Pregnancy itself is characterized by a well-recognized hypercoagulable state, marked by increased levels of coagulation factors, enhanced platelet activity, and reduced fibrinolysis.[10,11] These adaptations are essential for minimizing bleeding during delivery but may predispose to thrombotic or hemorrhagic complications if the coagulation balance is disturbed.[12] Moreover, acute obstetric complications such as placental abruption or amniotic fluid embolism may rapidly shift this hypercoagulable state toward consumptive coagulopathy, increasing the risk of severe maternal bleeding. In obstetric practice, coagulation abnormalities are closely linked to postpartum hemorrhage.[13] Women with postpartum hemorrhage exhibit prolonged coagulation times and reduced fibrinogen levels.[14–16] Inadequate coagulation during pregnancy also influences the safety of neuraxial anesthesia, including epidural hematoma, which are critical considerations in peripartum management.[17]

Despite extensive characterization of coagulation changes in normal pregnancy, data specifically addressing pregnant women with thalassemia are limited, particularly in regions with high disease prevalence. It remains uncertain whether the coexistence of thalassemia and pregnancy-related hypercoagulability results in clinically meaningful differences in routine coagulation profiles or perinatal outcomes. Therefore, in this retrospective observational study, we aimed to describe and compared dynamic changes in routine coagulation indices between pregnant women with and without thalassemia, and to examine associated perinatal outcomes in a high-prevalence setting in South China.

Patients and Methods

Study Design and Data Sources

This single-center retrospective observational study was conducted at the First Affiliated Hospital of Jinan University, a national tertiary medical center in South China. The study was approved by the Ethics Committee of the First Affiliated Hospital of Jinan University (Approval No. KY-2023-159). The Ethics Committee waived the requirement for informed consent due to the retrospective nature of the study and the use of anonymized data. The study was registered with the China Clinical Trial Registry (Registration number: ChiCTR2500111964).

All data were obtained anonymously from the hospital's integrated electronic medical record system. Extracted variables included hospitalization number, admission date, last menstrual period, delivery date, baseline demographic characteristics, discharge diagnoses, medication use, surgical and obstetric procedures, and laboratory test results. All data were anonymized and standardized prior to analysis.

Participants

A total of 638 pregnant women who delivered at our institution in 2023 were initially screened for eligibility. After applying the inclusion and exclusion criteria, 405 women were included in the final analysis, including 53 women with a confirmed diagnosis of thalassemia. The remaining 352 women without thalassemia were selected from the eligible population as a comparison group (Figure 1).

Inclusion criteria were: 1) singleton pregnancy and 2) gestational age ≥37 weeks. Exclusion criteria included: 1) other hematological disorders; 2) pregnancy-related complications affecting coagulation; 3) abnormal cardiac function; and 4) abnormal liver or kidney function. The detailed screening and exclusion process is illustrated in Figure 1.

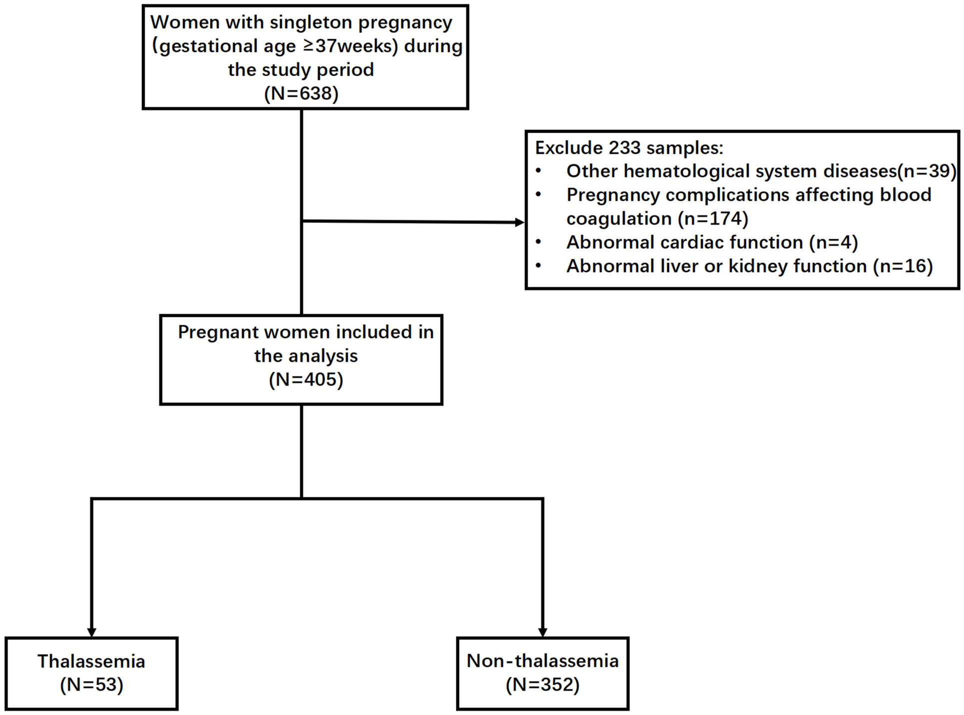

Figure 1 A flowchart of the study.

Outcome Variables and Definitions

Gestational age was categorized as early pregnancy (the first trimester) and late pregnancy (the third trimester). All participants underwent routine coagulation and complete blood count testing during both early and late pregnancy. Participants were divided into a thalassemia group and a non-thalassemia group. Thalassemia was diagnosed according to the 2018 revised Chinese expert consensus on the diagnosis and treatment of non-transfusion-dependent thalassemia issued by the Chinese Medical Association.

Baseline characteristics included nulliparity, gestational age, maternal age, body mass index (BMI), and medical history, including in vitro fertilization and embryo transfer (IVF-ET), hepatitis B carrier status, scarred uterus, uterine leiomyomas, thyroid dysfunction, and abnormal pregnancy history. BMI was calculated based on weight and height measured at hospital admission in late pregnancy. The comparison of the baseline data between the thalassemia group and non-thalassemia group was to identify any confounding factors and ensure comparability of the two sets of outcome variables.

Primary outcomes were maternal coagulation indices, including activated partial thromboplastin time (APTT), prothrombin time (PT), thrombin time (TT), fibrinogen (FIB), international normalized ratio (INR), and platelet count (PLT). Hemoglobin (Hb) and red blood cell distribution width (RDW) were also analyzed. Changes in these parameters from early to late pregnancy (ΔAPTT, ΔPT, ΔTT, ΔFIB, ΔINR, ΔPLT, ΔHb, and ΔRDW) were calculated.

Secondary outcomes included maternal and neonatal perinatal outcomes, such as delivery mode, neonatal birth weight, and the incidence of maternal anemia, low birth weight, fetal growth restriction (FGR), premature rupture of membranes (PROM), fetal distress, neonatal asphyxia, oligohydramnios, amniotic fluid opacity, and postpartum hemorrhage. Maternal anemia was defined as a hemoglobin concentration < 110 g/L during pregnancy, in accordance with World Health Organization criteria. Low birth weight was defined as a neonatal birth weight < 2500 g. Fetal growth restriction (FGR) was defined as failure to achieve the expected intrauterine growth potential. Premature rupture of membranes (PROM) was defined as rupture of the amniotic membranes before the onset of labor. Fetal distress was diagnosed when evidence of intrauterine hypoxia was present. Neonatal asphyxia was defined as failure to initiate spontaneous respiration at birth. Oligohydramnios was diagnosed when the amniotic fluid volume was < 300 mL.

Amniotic fluid opacity was defined as reduced clarity or abnormal coloration of the amniotic fluid. Postpartum hemorrhage was defined as blood loss ≥ 500 mL within 24 hours after delivery.

Statistical Analysis

Statistical analyses were performed using SPSS version 21.0 (IBM Corp., Armonk, NY, USA) and Microsoft Excel version 14.0 (Microsoft Corporation, Redmond, WA, USA). Sample size estimation indicated that approximately 400 participants were required to achieve 90% power at a two-sided α level of 0.05, allowing for a 20% rate of missing data. Patient characteristics were summarized using descriptive statistics. Continuous variables were tested for normality using the Shapiro–Wilk test. Normally distributed variables are presented as mean ± standard deviation (SD) and were compared using independent-samples t tests. Non-normally distributed variables are presented as median (interquartile range, IQR) and were compared using the Mann–Whitney *U*-test. Categorical variables were compared using the chi-square test. Logistic regression analysis was performed to calculate odds ratios (ORs) with 95% confidence intervals (CIs) for perinatal outcomes. A two-sided P value <0.05 was considered statistically significant.

Results

Participant Selection

A total of 638 singleton pregnancies with a gestational age ≥37 weeks were initially identified. Of these, 233 cases were excluded, including 39 patients with other hematological disorders, 174 with pregnancy complications affecting coagulation, 4 with abnormal cardiac function, and 16 with abnormal liver or kidney function. Ultimately, 405 pregnant women were included in the analysis, comprising 53 women with thalassemia and 352 women without thalassemia (Figure 1).

Baseline Characteristics

Baseline characteristics of the study population are summarized in Table 1. Approximately half of the participants in both groups were nulliparous. The median gestational age at delivery was 39 (38–39) weeks in the thalassemia group and 39 (38–40) weeks in the non-thalassemia group. Median maternal age was 28 (27–33) years and 29 (27–32) years, respectively, and the median body mass index was 25.2 kg/m^2 in both groups. No significant differences were observed between groups in nulliparity, gestational age, maternal age, or BMI. In addition, there were no significant differences in

Table 1 Baseline Clinical Characteristics of Pregnant Women with and without Thalassemia

Baseline Characteristics	Thalassemia (n=53)	Non-Thalassemia (n=352)	*P* values
Nulliparity (%)	28 (52.8%)	192 (54.5%)	0.815
Gestational week (IQR)	39 (38–39)	39 (38–40)	0.455
Age, years (IQR)	28 (27–33)	29 (27–32)	0.614
BMI, kg/m^2 (IQR)	25.2 (24.1–28.2)	25.2 (23.5–27.6)	0.514
IVF-ET (%)	0 (0%)	3 (0.9%)	1.000
Hepatitis B carriers (%)	4 (7.6%)	30 (8.5%)	1.000
Scarred uterus (%)	9 (17.0%)	62 (17.6%)	0.910
Uterine leiomyomas (%)	2 (3.8%)	16 (4.5%)	1.000
Hyperthyroidism (%)	1 (1.9%)	6 (1.7%)	1.000
Hypothyroidism (%)	3 (5.7%)	16 (4.5%)	0.992
Abnormal pregnancy histories (%)	0 (0%)	7 (2.0%)	0.601

Abbreviations: IQR, interquartile range; BMI, body mass index; IVF-ET, in vitro fertilization and embryo transfer.

https://doi.org/10.2147/IJWH.S571929

the rates of IVF-ET, abnormal pregnancy history, hepatitis B carriage, scarred uterus, uterine leiomyomas, hyperthyroidism, or hypothyroidism, indicating good baseline comparability.

Maternal Coagulation and Hematological Indices

Maternal coagulation and hematological parameters during early and late pregnancy are shown in Figure 2A–H. During early pregnancy, women with thalassemia had a significantly lower thrombin time (TT) compared with women without thalassemia (14.8 [14.4–15.3] s vs 15.1 [14.7–15.6] s). Platelet counts (PLT) were significantly higher in the thalassemia group during both early pregnancy (252 [218–296] $\times 10^9$/L vs 226 [193–255] $\times 10^9$/L) and late pregnancy (246 [208–292] $\times 10^9$/L vs 211 [181–245] $\times 10^9$/L). Hemoglobin (Hb) levels were significantly lower in the thalassemia group at both time points: early pregnancy (105 [96–114] g/L vs 120 [114–126] g/L) and late pregnancy (106 [99–114] g/L vs 117 [110–124] g/L), while red blood cell distribution width (RDW) was significantly higher in the thalassemia group at both time points. No significant differences were observed between groups in APTT, PT, FIB, or INR during early pregnancy, nor in APTT, PT, TT, FIB, or INR at either early or late pregnancy.

Changes in Laboratory Parameters Across Pregnancy

From early to late pregnancy, both groups demonstrated significant decreases in APTT, PT, and INR and significant increases in TT and FIB (all P<0.01). In the non-thalassemia group, Hb decreased, RDW increased, and PLT decreased significantly over time (all P<0.001). In contrast, Hb, RDW, and PLT did not change significantly across pregnancy in the thalassemia group.

Changes in coagulation and hematological parameters from early to late pregnancy (Δ values) are presented in Figure 3A–H. Compared with the non-thalassemia group, women with thalassemia exhibited a greater decrease in APTT (P=0.02) and a greater increase in FIB (P=0.025). In addition, ΔHb and ΔRDW differed significantly between groups, with a slight increase in Hb and a slight decrease in RDW observed in the thalassemia group, whereas Hb decreased and

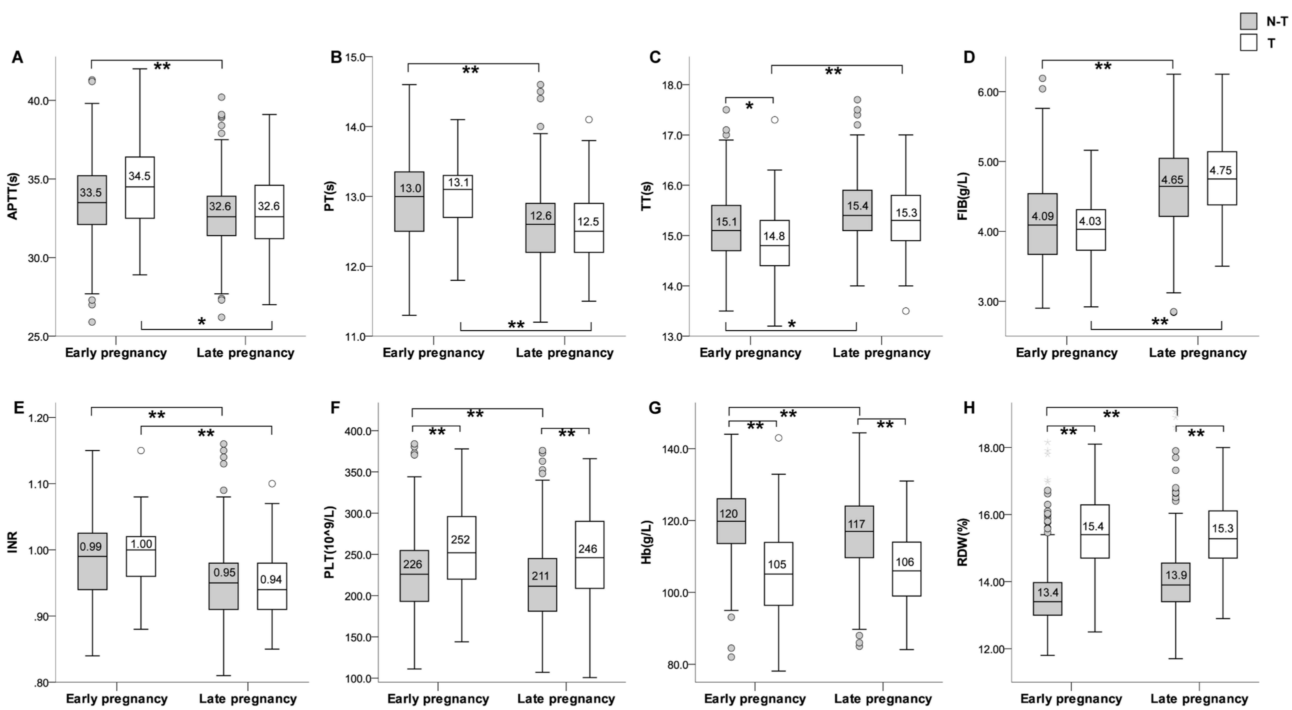

Figure 2 Analysis of APTT, PT, TT, FIB, INR, PLT, Hb and RDW from early to late pregnancy in thalassemia and non-thalassemia groups. (**A**) APTT; (**B**) PT; (**C**) TT; (**D**) FIB; (**E**) INR; (**F**) PLT; (**G**) Hb; (**H**) RDW. Comparisons are made between the thalassemia and non-thalassemia group from early pregnancy to late pregnancy. *P<0.05; **P<0.001.

Abbreviations: APTT, activated partial thromboplastin time; PT, prothrombin time; TT, thrombin time; FIB, fibrinogen; INR, international normalized ratio; PLT, platelet count; Hb, hemoglobin; RDW, red blood cell distribution width; T, the thalassemia group; N-T, the non-thalassemia group.

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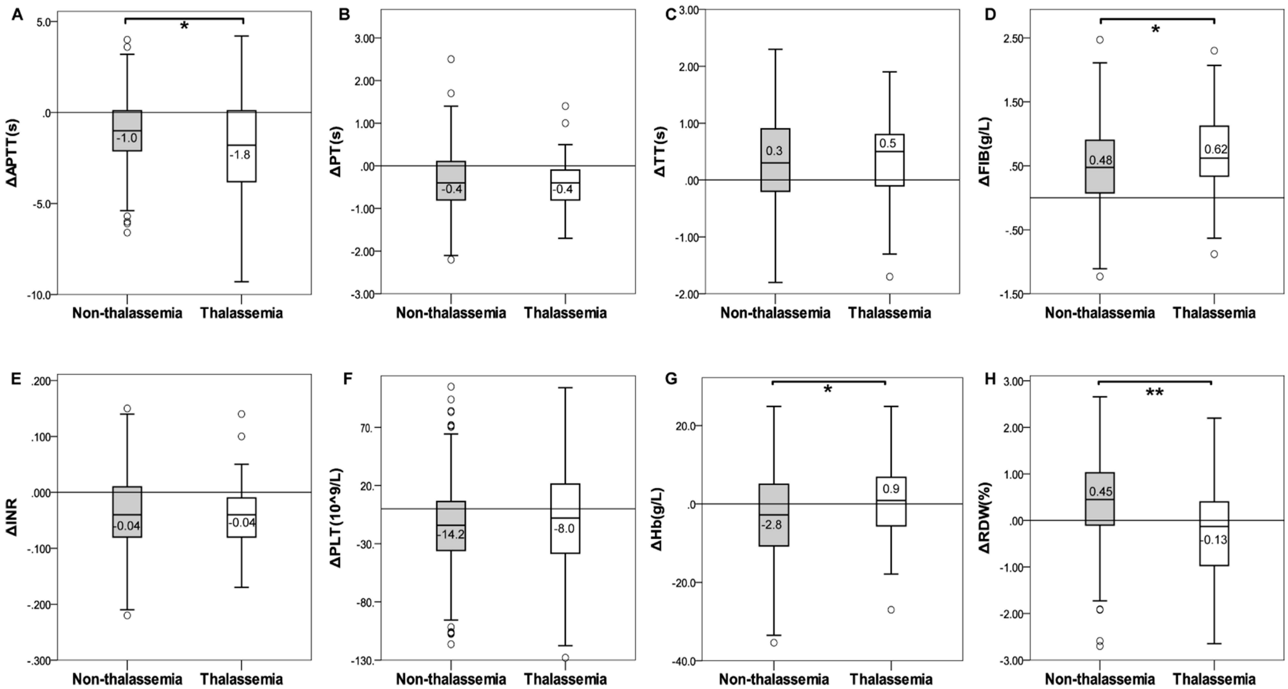

Figure 3 Analysis of changes in APTT, PT, TT, FIB, INR, PLT, Hb and RDW from early to late pregnancy in thalassemia and non-thalassemia groups. (**A**) APTT; (**B**) PT; (**C**) TT; (**D**) FIB; (**E**) INR; (**F**) PLT; (**G**) Hb; (**H**) RDW. Changes in APTT, PT, TT, FIB, INR, PLT, Hb and RDW from early to late pregnancy are presented as ΔAPTT, ΔPT, ΔTT, ΔFIB, ΔINR, ΔPLT, ΔHb, and ΔRDW. Comparisons are made between the non-thalassemia and the thalassemia group. Δ means the value change. *P<0.05; **P<0.001.
Abbreviations: APTT, activated partial thromboplastin time; PT, prothrombin time; TT, thrombin time; FIB, fibrinogen; INR, international normalized ratio; PLT, platelet count; Hb, hemoglobin; RDW, red blood cell distribution width; T, the thalassemia group; N-T, the non-thalassemia group.

RDW increased in the non-thalassemia group (ΔHb, P=0.012; ΔRDW, P<0.001). No significant between-group differences were found for ΔPT, ΔTT, ΔINR, or ΔPLT.

Perinatal Outcomes

Perinatal outcomes are summarized in Table 2. Mean neonatal birth weight was 3160 g in the thalassemia group and 3200 g in the non-thalassemia group, with no significant difference. Vaginal delivery was the predominant mode of delivery in

Table 2 Perinatal Outcomes in Pregnant Women with or without Thalassemia

Perinatal Outcomes	Thalassemia (n=53)	Non-Thalassemia (n=352)	OR (95% CI)	*P* values
Neonatal birth weight, g (±SD)	3160 (±390)	3200 (±390)	NA	0.450
Maternal anemia (%)	10 (18.9%)	20 (5.7%)	4.09 (1.73 to 9.67)	0.001**
Delivery mode			0.81 (0.41 to 1.61)	0.546
Vaginal delivery (%)	39 (73.6%)	232 (65.9%)		
Caesarean section (%)	14 (26.4%)	120 (34.1%)		
Low birth weight (%)	2 (3.8%)	6 (1.7%)	1.93 (0.30 to 12.52)	0.490
FGR (%)	1 (1.9%)	1 (0.3%)	2.08 (0.09 to 47.56)	0.646
PROM (%)	16 (30.2%)	69 (19.6%)	1.85 (0.95 to 3.62)	0.071
Fetal distress (%)	2 (3.8%)	23 (6.5%)	0.77 (0.17 to 3.60)	0.744
Neonatal asphyxia (%)	0 (0%)	3 (0.9%)	NA	0.999
Oligohydramnion (%)	0 (0%)	13 (3.7%)	NA	0.999
Amniotic fluid opacity (%)	2 (3.8%)	23 (6.5%)	0.67 (0.14 to 3.18)	0.613
Postpartum hemorrhage (%)	3 (5.7%)	16 (3.4%)	0.82 (0.18 to 3.80)	0.799

Notes: **P<0.01.
Abbreviations: SD, standard deviation; FGR, fetal growth restriction; PROM, premature rupture of membrane; OR, odds ratio; CI; confidence interval; NA, not applicable.

both groups (73.6% vs 65.9%). Maternal anemia occurred more frequently in the thalassemia group than in the non-thalassemia group (18.9% vs 5.7%). The incidence of postpartum hemorrhage did not differ significantly between the thalassemia and non-thalassemia groups (3.9% vs 3.4%). No significant differences were observed between the two groups in other perinatal outcomes, including low birth weight, FGR, PROM, fetal distress, neonatal asphyxia, oligohydramnios, and amniotic fluid opacity.

Discussion

In this retrospective observational study, maternal coagulation profiles were compared between pregnant women with and without thalassemia in a high-prevalence region of South China. Our findings indicate that pregnant women with thalassemia show modest differences in certain coagulation parameters compared with those without thalassemia, while the majority of values remained within clinically acceptable ranges and were not accompanied by increased adverse perinatal outcomes. Crucially, the intensified laboratory findings were not linked to increased perinatal complications in this cohort. These results suggest that although thalassemia distinctly alters maternal coagulation patterns, these changes should be viewed as a safe physiological adjustment rather than a sign of heightened danger.

Thrombin time (TT) reflects the conversion of fibrinogen to fibrin and may be prolonged in conditions such as fibrinogen deficiency, enhanced fibrinolysis, or the presence of anticoagulants.[18] In the present study, women with thalassemia had a lower TT during early pregnancy compared with those without thalassemia, while TT increased progressively across pregnancy in both groups. Although this difference reached statistical significance, TT values remained within clinically acceptable ranges, suggesting limited immediate clinical relevance. Previous studies in Northern Chinese populations have reported a decrease in TT from the first to the third trimester, which differs from our findings.[10] Such discrepancies may be explained by differences in study populations, regional characteristics, and sample size. Given the discrepancies in overall coagulation trends reported across different studies, this finding should be interpreted with caution and viewed as a descriptive observation rather than a definitive conclusion.

Prothrombin time (PT) and activated partial thromboplastin time (APTT) reflect the activity of the extrinsic and intrinsic coagulation pathways, respectively. In this study, both PT and APTT showed progressive and statistically significant shortening from early to late pregnancy, consistent with physiological hypercoagulability during gestation, likely driven by increased levels of coagulation factors such as VII, IX, XI, and XII. Concurrently, plasma fibrinogen (FIB) increased significantly with advancing gestational age, probably due to enhanced hepatic synthesis, indicating a gradual strengthening of coagulation function. Similar gestational trends in PT, APTT, and FIB have been reported by Hammerová et al and Liu et al, who also observed decreasing PT and APTT accompanied by increasing FIB levels as pregnancy progressed.[19,20] In contrast, another study reported stable APTT values comparable to nonpregnant levels throughout pregnancy and delivery; this discrepancy may be attributable to methodological differences, as frozen plasma samples were used, which have been shown to yield APTT values approximately 5–10% higher than those obtained from fresh samples.[21] Hemoglobin (Hb) concentration and red blood cell distribution width (RDW), key hematological markers for thalassemia, were also consistent with expected disease characteristics in this cohort, with lower Hb levels and higher RDW observed in pregnant women with thalassemia.[22]

Platelet counts were consistently higher in pregnant women with thalassemia than in those without thalassemia during both early and late pregnancy. Previous studies have suggested that platelet elevation in thalassemia may be related to platelet activation and altered platelet clearance, particularly in patients with splenic dysfunction.[23,24] However, in thalassemia patients, increased platelet activation rather than increased platelet production has been primarily demonstrated, which may partly explain the persistently higher platelet counts observed in this population.[25] In contrast, platelet counts in women without thalassemia declined progressively during pregnancy, a physiological change supported by a systematic review of 46 studies.[26] Consistent with this evidence, platelet counts decreased only in the non-thalassemia group in the present study, whereas no significant gestational decline was observed in women with thalassemia, suggesting that thalassemia-associated platelet elevation may partially offset pregnancy-related thrombocytopenia.

Notably, women with thalassemia demonstrated a greater decrease in APTT and a greater increase in fibrinogen from early to late pregnancy compared with women without thalassemia, indicating a more pronounced enhancement of coagulation activity as gestation progressed. While pregnancy itself is associated with a substantially increased risk of thrombosis, individuals with thalassemia are also recognized to have an elevated susceptibility to thromboembolic events.[12,27] Although no increase in thrombotic or hemorrhagic complications was observed in this cohort, the laboratory findings highlight physiological differences in coagulation profiles between pregnant women with and without thalassemia. These results primarily provide descriptive information that may help contextualize routine coagulation test findings in this population, rather than indicating a need for changes in standard clinical management.

To our knowledge, few studies have directly compared dynamic maternal coagulation profiles between pregnant women with and without thalassemia in a Chinese population. By focusing on South China, a region with a high prevalence of thalassemia, this study provides population-specific descriptive data that contribute to a better understanding of coagulation changes during pregnancy in this setting.

Several limitations of this study should be acknowledged. First, the single-center retrospective design may limit the generalizability of the findings and precludes causal inference. Multicenter prospective studies with larger and more diverse populations are therefore needed to confirm these results. Second, coagulation parameters were assessed at two predefined time points rather than continuously across all three trimesters, which may have limited the ability to fully characterize dynamic changes throughout pregnancy. Third, although no increase in thrombotic or hemorrhagic complications was observed, the sample size and observational design may not have been sufficient to detect rare clinical events, such as pregnancy-related thromboembolism. In addition, BMI was assessed in late pregnancy rather than prior to conception, which may reflect gestational weight gain and limit the generalizability of BMI-related comparisons. Finally, the analysis was limited to routinely measured coagulation and hematological indices, and more detailed assessments incorporating additional biomarkers or functional coagulation assays were not available. These limitations should be considered when interpreting the findings.

Conclusion

This retrospective study demonstrates that pregnant women with thalassemia exhibit coagulation profiles that differ modestly from those of women without thalassemia. Although physiological hypercoagulability increased from early to late pregnancy in both groups, women with thalassemia showed a greater reduction in APTT and a more pronounced increase in fibrinogen, while platelet counts remained consistently higher. Importantly, these laboratory differences largely remained within clinically acceptable ranges and were not associated with an increased incidence of adverse perinatal outcomes, except for a higher rate of maternal anemia. Overall, these findings indicate that pregnancy complicated by thalassemia is associated with physiological variations in coagulation profiles without evidence of clinically meaningful adverse perinatal or thrombotic outcomes. These findings also highlight the complexity of pregnancy-related hypercoagulability in the context of thalassemia and underscore the need for future studies to further explore the associations among thalassemia, physiological coagulation changes during pregnancy, and thromboembolic risk using larger, prospective cohorts with clinically relevant outcomes.

Data Sharing Statement

De-identified individual participant data are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the First Affiliated Hospital of Jinan University (KY-2023-159). The Ethics Committee waived the requirement for informed consent due to the retrospective nature of the study and the use of anonymized data. This study was registered with the China Clinical Trial Registry (Registration number: ChiCTR2500111964).

Acknowledgments

We thank all the staff who helped with the recording of this data in the Department of Anesthesiology and Department of Obstetrics of the First Affiliated Hospital of Jinan University.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This work was supported by the National Natural Science Foundation of China (No. 81503167); Science and Technology Projects in Guangzhou (No. 2023A03J0619); Foreign Expert Project of the Ministry of Science and Technology of China (No. DL2023199003L); National Innovation and Entrepreneurial Training Program for Undergraduate Students (No. 202310559035).

Disclosure

The authors report no conflicts of interest in this work.

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