Section: Miscellaneous

Original Research Article

ROLE OF THROMBOELASTOGRAPHY IN GUIDING APPROPRIATE UTILIZATION OF BLOOD COMPONENTS IN OBSTETRIC COMPLICATIONS AT A TERTIARY CARE CENTRE - A CROSS-SECTIONAL STUDY

Deepak J[1], Ruth Jenila A[3], Vijaya T[2]

[1]Assistant Professor, Govt. Vellore Medical College, Vellore, Tamil Nadu, India
[3]Assistant Professor, Govt. Stanley Medical College, Chennai, Tamil Nadu, India
[2]Assistant Professor, Govt. Villupuram Medical College, Villupuram, Tamil Nadu, India

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Corresponding Author:
Dr. Deepak J,
Email: dr.jothydeepak@gmail.com

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ABSTRACT

Background: Obstetric hemorrhage is the leading cause of maternal mortality in India. For effective management of critical cases, rapid assessment of coagulation status becomes essential. Routine coagulation tests are slow when compared to thromboelastography (TEG) which is a point-of-care viscoelastic test evaluating entire hemostatic process. While the utility of TEG is established well in surgical and trauma settings, evidence on TEG-guided blood component therapy across obstetric emergencies remains sparse in Indian setting. **Materials and Methods:** A longitudinal observational study was conducted over one year in a tertiary care obstetric centre in Tamil Nadu. Fifty-two patients presenting with obstetric hemorrhages were evaluated using both routine coagulation tests and thromboelastography. TEG parameters were measured before transfusion, immediately after transfusion, and 24 hours after transfusion. Blood component therapy was guided primarily by TEG findings. Association between TEG and Conventional indices were analysed using repeated measures ANOVA and Pearson's correlation coefficient. **Result:** Around 92.3% of the participants had PPH, with uterine atony as the predominant cause of PPH (63.4%). At baseline, marked coagulopathy was evident: R time 13.31 ± 5.52 min, K time 7.10 ± 4.58 min, alpha angle 42.31 ± 10.51°, and MA 47.45 ± 10.53 mm. PRBC were transfused in 94.2% of patients; cryoprecipitate—reflecting the high burden of fibrinogen deficiency—was the most frequently used plasma component (82.7%), followed by FFP (63.5%) and platelets (random donor, 69.2%; single donor, 59.6%). All TEG parameters and conventional coagulation tests improved significantly following TEG-guided transfusion and approached near-normalisation at 24 hours ($p = 0.0005$, repeated measures ANOVA). At baseline, strong correlations were observed between K time and PT ($r = 0.885$), alpha angle and fibrinogen ($r = 0.766$), MA and platelet count ($r = 0.613$), and LY30 and D-dimer ($r = 0.864$), all $p < 0.001$. By 24 hours, most correlations weakened with haemostatic recovery, with K time and LY30 retaining moderate associations. **Conclusion:** TEG effectively identified specific haemostatic deficits and guided targeted blood component therapy across obstetric emergencies, with significant and progressive normalisation of all coagulation parameters at 24 hours. Integration of TEG into obstetric transfusion protocols at tertiary care centres in resource-limited settings is recommended.

INTRODUCTION

Postpartum haemorrhage (PPH), which accounts for nearly one in four maternal deaths, remains the single largest cause of maternal death globally. PPH caused approximately 45,000 deaths in 2023 alone.[1,2] Low- and middle-income countries contribute to more than 80% of these deaths, with South Asia holding a disproportionate share.[3]

Despite a significant decline in the maternal mortality ratio (MMR) to 97 per 100,000 live births in India, haemorrhage continues to be the direct cause of 38% of maternal deaths.[4,5] Tamil Nadu has reduced its MMR from 380 in 1993 to 52 in 2022–23, which created a huge recognition for its maternal health reforms. It still records many preventable hemorrhage-related deaths annually, with tertiary

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care centres bearing the burden of the most compromised cases.[6,7]

Management of obstetric haemorrhage depends on routine laboratory tests such as PT, aPTT, INR, platelet count, and fibrinogen. These tests assess coagulation without taking platelet function and fibrinolysis into consideration and require long waiting hours for results.[8,9] This delay can lead to unfortunate circumstances in critical patients, and inappropriate blood transfusion adds to the problem.

Indian studies have reported that 3%-46% of obstetric blood component transfusions do not meet standard clinical criteria, indicating an absence of objective, real-time hemostatic guidance.[10,11]

Thromboelastography (TEG) provides a continuous, whole-blood assessment of clot formation, strength, and lysis at the point of care. It includes parameters such as R time, K time, alpha angle, maximum amplitude (MA), and LY30, which gives a complete haemostatic picture within minutes.[12] TEG-guided transfusion algorithms have reduced unnecessary blood product use in cardiac surgery, trauma, and liver transplantation,[13] and it has improved outcomes in severe PPH by early detection of hypofibrinogenaemia.[14,15] However, data from the tertiary care setting in our country on the whole spectrum of blood transfusion in obstetric emergencies remain sparse.[16,17]

Therefore, this study was planned to evaluate the role of TEG in guiding appropriate blood component therapy across obstetric complications at a tertiary care centre in Tamil Nadu.

MATERIALS AND METHODS

This longitudinal study was conducted at a tertiary care centre in Chennai for a duration of one year. The study included pregnant women with major obstetric hemorrhages who required appropriate transfusion support during the study period. Pregnant women with pre-existing renal disease, insulin-dependent diabetes, asthma requiring steroidal treatment, chronic hepatitis (with or without hepatic dysfunction), severe trauma history, anticoagulant drug-use history, oral contraceptive use history, smoking history, ITP (Idiopathic thrombocytopenic purpura), or any haematological diseases were excluded from the study.

The coagulation parameters that are taken into consideration are Prothrombin time (PT), PT INR, Activated Partial Thromboplastin Time (aPTT), serum fibrinogen and D-Dimer, along with Hemoglobin and platelet Count.

Thromboelastograph is a viscoelastic test for evaluating the coagulation defects by analyzing the physical properties of the clot. The blood sample collected is kept in the oscillating cup at 37ºc graph denoting R time, K time, Maximum amplitude, α angle, clot lysis index after 30 mins,EPL(estimated percent lysis) recorded along with the samples for routine coagulation tests such as platelet count, PT, aPTT, serum fibrinogen.

R time and K time correlate with PT/aPTT, Maximum amplitude, and alpha angle correlates well with platelets and fibrinogen, respectively.

After obtaining informed consent, data such as age, weight, BP, clinical diagnosis, and treatment history of the patient were collected from antenatal documents and inpatient records. Under aseptic precautions, blood samples were collected for both thromboelastography (TEG) and routine coagulation tests (RCoT). Coagulation samples were obtained at baseline - before transfusion, just after transfusion and 24 hours after transfusion. Samples for standard coagulation tests such as platelet count, PT&INR, aPTT, serum fibrinogen, and D-Dimer were also evaluated.

Interpretation of TEG guided transfusion therapy: prolonged R or K indicated coagulation factor deficiency requiring fresh frozen plasma, reduced α-angle suggested hypofibrinogenemia managed with cryoprecipitate, and reduced MA indicated platelet dysfunction requiring platelet transfusion.

The primary outcome was to evaluate the appropriateness of blood component utilization based on TEG findings. Secondary outcomes included changes in coagulation parameters over time and the correlation between TEG and routine tests.

Statistical analysis was carried out using IBM SPSS version 23. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequency and percentage. Repeated measures ANOVA with Bonferroni correction was used to compare parameters across time points, and Pearson's correlation coefficient to assess relationships between variables. A p-value <0.05 was considered statistically significant.

RESULTS

During the study period, 52 women with obstetric haemorrhage who fulfilled the eligibility criteria were enrolled. [Table 1] shows the baseline clinical and obstetric characteristics of the study population.

Half of the women were primigravida (50%), with majority at term gestation (75%) and normal vaginal delivery (67.3%) was the most common mode of delivery. Postpartum haemorrhage (PPH) was the predominant type (92.3%), with uterine atony being the most frequent cause (63.4%). Most patients were Rh positive (94.2%), and blood group O was the most common (36.5%) [Table 1].

Table 1: Baseline Clinical and Obstetric Characteristics of Study Participants (n = 52)

Variable	Category	n	%
Parity	Primigravida	26	50.0
	Multigravida	26	50.0
Gestational Age	Preterm	13	25.0

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	Term	39	75.0
Mode of Delivery	Normal vaginal delivery	35	67.3
	Caesarean section (LSCS)	17	32.7
Type of Hemorrhage	Postpartum hemorrhage (PPH)	48	92.3
	Antepartum hemorrhage (APH)	4	7.7
Diagnosis	Uterine atony	33	63.4
	Pre-eclampsia	5	9.6
	Retained placenta	5	9.6
	Vulvovaginal hematoma	5	9.6
	Placenta previa	2	3.8
	Placenta accreta	1	1.9
	Abruptio placentae	1	1.9
Blood Group	O	19	36.5
	B	18	34.6
	A	10	19.2
	AB	5	9.6
Rh Typing	Rh positive	49	94.2
	Rh negative	3	5.8

[Figure 1] presents the utilization of blood components guided by thromboelastography (TEG). To correct blood loss, packed red blood cells (PRBC) were transfused in 94.2% of patients, and cryoprecipitate (82.7%) was the most frequently administered plasma component, reflecting a high prevalence of fibrinogen deficiency and reduced alpha angle. FFP was transfused in 63.5% of participants to correct prolonged R time and K time. Based on reduced maximum amplitude (MA) values, platelet transfusion was administered with random donor platelets (69.2%) and single donor platelets (59.6%) commonly.

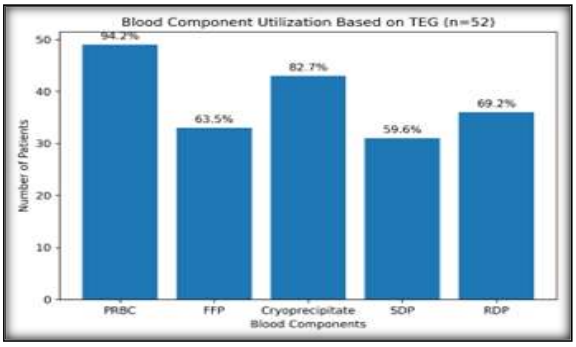

Figure 1: Distribution of blood component utilization based on thromboelastography findings among study participants (n = 52).

Table 2: Comparison of TEG Parameters and Routine Coagulation Tests at Three Time Points Using Repeated Measures ANOVA (n = 52)

Parameter	Before Transfusion Mean ± SD	Immediately After Transfusion Mean ± SD	24 Hours After Transfusion Mean ± SD	F value	p value
R Time (min)	13.31 ± 5.52	8.96 ± 2.43	7.61 ± 7.05	21.678	0.0005
K Time (min)	7.10 ± 4.58	3.64 ± 1.64	1.95 ± 0.68	73.976	0.0005
Alpha Angle (°)	42.31 ± 10.51	58.59 ± 5.59	65.11 ± 3.58	270.061	0.0005
Maximum Amplitude (mm)	47.45 ± 10.53	63.55 ± 5.32	72.25 ± 3.92	305.888	0.0005
LY30 (%)	5.69 ± 9.00	1.74 ± 3.00	0.70 ± 0.89	17.656	0.0005
Platelet Count (/µL)	55,028.85 ± 13,208.51	73,307.69 ± 17,487.01	117,230.77 ± 16,206.23	324.446	0.0005
Prothrombin Time (sec)	25.30 ± 7.83	18.15 ± 3.47	12.81 ± 1.85	130.853	0.0005
PT-INR	1.63 ± 0.25	1.25 ± 0.15	1.02 ± 0.08	282.722	0.0005
APTT (sec)	52.02 ± 8.44	40.61 ± 5.66	32.31 ± 3.18	254.085	0.0005
Fibrinogen (mg/dL)	149.38 ± 22.46	210.23 ± 51.79	324.56 ± 53.91	307.412	0.0005

The comparison of TEG parameters and routine coagulation tests at baseline, immediately after transfusion, and after 24 hours is shown in [Table 2]. At baseline, marked coagulopathy was noted with significantly prolonged R time (13.31 ± 5.52 min) and K time (7.10 ± 4.58 min), reduced alpha angle (42.31 ± 10.51°), and decreased maximum amplitude (47.45 ± 10.53 mm). Routine coagulation parameters also demonstrated abnormalities, including prolonged prothrombin time (25.30 ± 7.83 sec), elevated INR (1.63 ± 0.25), prolonged aPTT (52.02 ± 8.44 sec), reduced fibrinogen levels (149.38 ± 22.46 mg/dL), and low platelet counts.

There was a significant improvement in all coagulation parameters following TEG- guided transfusion. A decrease in R time and K time was noted immediately after transfusion, while alpha angle and MA increased, showing an improved clot formation and strength. Near normalization of TEG parameters was observed 24 hours after transfusion. Similar changes were seen in routine coagulation tests with normalization of PT, INR, aPTT, fibrinogen levels, and platelet counts.

Repeated measures ANOVA demonstrated a statistically significant improvement in all parameters across the three time points ($p = 0.0005$), confirming the effectiveness of targeted transfusion therapy guided by TEG [Table 2].

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Table 3: Correlation of TEG Parameters and Routine Coagulation Tests at baseline (n = 52)

Correlations at Baseline		PLC	PT	APTT	PT INR	Fibrinogen	DDIMER
R Time	r-value	-0.347	0.812	0.666	0.642	-0.289	0.668
	p-value	.012	0.0005 **	0.0005 **	0.0005 **	0.038 *	0.0005 **
K Time	r-value	-0.357	0.885	0.747	0.680	-0.396	.721**
	p-value	0.009 **	0.0005 **	0.0005 **	0.0005 **	0.004 **	0.0005 **
Angle	r-value	.116	-0.313	-.270	-.233	0.766	-0.446
	p-value	0.413 #	0.024 *	0.052 #	0.096 #	0.0005 **	0.001 **
MA	r-value	0.613	-0.283	-0.414	-0.282	.156	-0.403
	p-value	0.0005 **	0.042 *	0.002 **	0.043 *	0.270 #	0.003 **
LY30	r-value	-0.414	0.768	0.648	0.649	-0.446	0.864
	p-value	0.002 **	0.0005 **	0.0005 **	0.0005 **	0.001 **	0.0005 **
# No Statistical Significance at p > 0.05, * Statistically Significant at p<0.05, ** Highly Significant at p < 0.01							

Table 4: Correlation of TEG Parameters and Routine Coagulation Tests at 24 hours (n = 52)

Correlations at 24th hour		PLC	PT	APTT	PT INR	Fibrinogen	DDIMER
R Time	r-value	-.039	.047	.179	.001	.045	-.099
	p-value	0.782 #	0.740 #	0.205 #	0.994 #	0.752 #	0.487 #
K Time	r-value	-0.449	0.531	0.368	0.45	-0.339	0.361
	p-value	0.001 **	0.0005 **	0.007 **	0.001 **	0.014 *	0.008 **
Angle	r-value	0.399	-0.335	-.132	-0.331	.084	-0.305
	p-value	0.003 **	0.015 *	0.350 #	0.017 *	0.553 #	0.028 *
MA	r-value	.242	-0.404	-.234	-0.312	0.457	-0.396
	p-value	0.083 #	0.003 **	0.095 #	0.024 *	0.001 **	0.0005 **
LY30	r-value	-.224	.211	0.281	0.367	-.141	0.561
	p-value	0.110 #	0.133 #	0.044 *	0.007 **	0.320 #	0.0005 **
# No Statistical Significance at p > 0.05, * Statistically Significant at p<0.05, ** Highly Significant at p < 0.01							

At baseline, R time and K time showed strong positive correlations with PT, APTT, and INR ($p < 0.001$), indicating coagulation factor deficiency, while K time exhibited the strongest correlation with PT ($r = 0.885$) [Table 3]. A strong positive correlation was observed between alpha angle and fibrinogen ($r = 0.766$, $p < 0.001$), while maximum amplitude (MA) correlated significantly with platelet count ($r = 0.613$, $p < 0.001$). LY30 demonstrated the strongest correlation with D-dimer ($r = 0.864$, $p < 0.001$), indicating hyperfibrinolysis.

After the transfusion, there was a decrease in the strength of correlation; still, a significant correlation was noted with K time and LY30. At 24 hours, most correlations became non-significant, indicating normalization of coagulation parameters, although K time and LY30 retained moderate correlations [Table 4].

DISCUSSION

Obstetric hemorrhage accounts for a significant proportion of severe maternal outcomes. Among the 52 participants enrolled in our study, 92.3% had postpartum hemorrhage, with the major cause being uterine atony (63.4%). This is consistent with the global data, with atony as the reason for 70-80% of all PPH.[1,4] Cryoprecipitate (82.7%) was the most frequently administered plasma component, which indicates the high burden of fibrinogen depletion shown as reduced alpha angle and low MA on TEG. Similar studies have documented that fibrinogen reached critically low levels during a major hemorrhage, and early replacement of fibrinogen improved outcomes among the patients.[7,21] FFP was transfused in 63.5% of the participants, based on prolonged R and K times, followed by platelets in the majority due to reduced MA- each component was administered according to TEG, not empirically.[14,15] At baseline, the TEG profile reflected significant consumptive coagulopathy: prolonged R time (13.31 ± 5.52 min) and K time (7.10 ± 4.58 min) indicated factor deficiency; a reduced alpha angle (42.31 ± 10.51°) denoted impaired fibrin formation; and a low MA (47.45 ± 10.53 mm) pointed to combined platelet and fibrinogen insufficiency.[11,14] A significant and progressive improvement was noted in all TEG parameters, from baseline to 24 hours after transfusion ($p = 0.0005$, repeated measures ANOVA). It confirmed the biological effectiveness of TEG-guided utilization of blood components. A similar way of hemostatic normalization was reported by McNamara et al in obstetric haemorrhage.[15]

The correlation analysis at baseline between TEG and routine coagulation tests was consistent. R time and K time showed strong correlation with PT, aPTT, and INR (r up to 0.885, $p < 0.001$), confirming that TEG captures the same factor deficiency faster and from whole blood.18 Other strong correlations were noted between alpha angle and fibrinogen ($r = 0.766$, $p < 0.001$) and MA with platelet count ($r = 0.613$, $p < 0.001$). The strongest correlation in our study was between LY30 and D-dimer ($r = 0.864$, $p < 0.001$), which is consistent with similar studies reporting fibrinolytic activation and elevated D-dimer in severe PPH and acute obstetric coagulopathy.[10,17,20] As parameters normalised by 24 hours, most correlations weakened. Yet K time and LY30 retained moderate associations, indicating recovery of fibrinogen and

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fibrinolytic resolution remains longer than other indices, which is observed in studies relevant to post-haemorrhage monitoring.[3,19]

All the findings in our study support the use of TEG as a real-time, whole-blood guide to targeted blood component therapy in obstetric haemorrhage. A study by Prethika et al suggested that a goal-directed TEG-guided strategy reduced total blood consumption when compared with a fixed 1:1:1 ratio protocol useful in resource-limited settings.[24] A systematic review of TEG-guided transfusion in surgery and trauma by Dias et al indicated that it enhanced blood product management and improved clinical outcomes.[25] Kim et al suggested that TEG predicted the need for massive transfusion in Primary PPH, emphasizing their prognostic and therapeutic value.[17]

The study was conducted in a single tertiary care centre with a relatively small sample size, which limits its generalizability. Future prospective controlled trials from similar LMIC settings are required to quantify the benefit of TEG-guided protocols on transfusion volumes, adverse events, and maternal outcomes.

CONCLUSION

Our study demonstrated that thromboelastography provided a timely, comprehensive assessment of hemostatic derangement across all obstetric hemorrhages. The strong baseline correlations between TEG parameters and conventional indices, particularly the LY30–D-dimer relationship ($r = 0.864$), validate its biological accuracy, and the significant normalization of all parameters at 24 hours ($p = 0.0005$) confirms its therapeutic effectiveness. TEG offers a practical, valuable point-of-care solution in critical situations compared to the long waiting hours for routine coagulation tests. Wider adoption of TEG in obstetric centers may contribute to improved management of severe hemorrhage and better maternal outcomes.

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