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Original Research Article

A Comparative Study of Platelet Count, Prothrombin Time, Activated Partial Thromboplastin Time, and D-Dimer in Normotensive Pregnant Women, and Women with Pre-Eclampsia & Eclampsia in Third Trimester

Ravi Ranjan Singh[1], Vikas Kumar[2], Nandini Raghav[3]

[1]Associate Professor, Department of Pathology, Autonomous State Medical College (ASMC), Kaushambi, Uttar Pradesh, India.

[2]Associate Professor, Department of Pathology, Autonomous State Medical College (ASMC), Kaushambi, Uttar Pradesh, India.

[3]Assistant Professor, Department of Pathology, Autonomous State Medical College (ASMC), Kaushambi, Uttar Pradesh, India.

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Corresponding Author: Dr. Nandini Raghav

Conflict of interest: Nil

Abstract:

Background: Preeclampsia and eclampsia are major causes of maternal and neonatal morbidity and mortality. These conditions exaggerate the normal hypercoagulable state associated with pregnancy, and they may result in disseminated intravascular coagulation. Inexpensive hemostatic screening tests could aid in the identification of those women who are predisposed to such problems.

Aim: To compare the platelets count, Prothrombin Time (PT), Activated Partial Thromboplastin Time (aPTT), and D-dimer in normal pregnant women, Pre-Eclampsia, and Eclampsia in the third trimester of pregnancy and correlate them with the severity of the disease.

Methodology: An observational study design was carried out in the Department of Pathology, Bharati Vidyapeeth Deemed University and Hospital,Sangli,Maharashtra,India for a duration of one year. A sample size of 120 females in the third trimester of pregnancy was included in this study, where there were 60 age-matched females with normal blood pressure (normotensive pregnant females – Group NP) and 60 females with hypertensive disorders, 46 pre-eclamptic and 14 with eclampsia (Group PE and Group E respectively). Platelet count, PT, aPTT and D-dimer were measured, along with bleeding time and clotting time. Data were analyzed by using SPSS version 22.0 with Chi-square and ANOVA.

Results: Mean platelet count decreased steadily from Group NP (2.55 ± 0.88 lakh/mm³) to Group PE (2.21 ± 0.82 lakh/mm³) and Group E (1.49 ± 0.80 lakh/mm³) ($p<0.001$). Platelet count of ≤1.5 lakh/mm³ was observed in 10.00%, 19.57% and 57.14% of patients in three different groups, respectively. Mean prothrombin time (PT) (14.1 ± 0.69, 14.9 ± 1.24 and 15.1 ± 1.26 s) and mean activated partial thromboplastin time (aPTT) (30.8 ± 2.6, 34.5 ± 3.7 and 37.6 ± 5.3 s) were increased with increasing severity of disease ($p<0.001$ for both), and aPTT>35 s was seen in 1.67%, 39.13% and 64.29% of women, respectively. Mean D-dimer concentration increased from 1.09 ± 0.41 mg/L in Group NP to 2.50 ± 1.66 mg/L in Group PE and 5.65 ± 4.77 mg/L in Group E ($p<0.001$). More than half of eclamptic women had high D-dimer concentrations of ≥4.0 mg/L.

Conclusion: There is progressive decrease in platelets with increase in PT, aPTT and D-Dimer in pre-eclampsia and eclampsia. These parameters can be considered as early simple markers for coagulation disturbances in cases of hypertension during pregnancy, specifically in third trimester.

Keywords: Pre-eclampsia, eclampsia, platelet count, prothrombin time, activated partial thromboplastin time, D-dimer, coagulation profile.

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Introduction

Pregnancy is associated with significant but reversible changes in metabolism, hematologic, immune, and hemostasis systems. In the case of complex pregnancies, these physiological changes may lead to adverse consequences [1]. The rate of maternal death is unacceptably high in many developing countries such as India; according to various statistics, about 830 women die each day in the world because of complications of pregnancy and delivery, which are mostly preventable. Hypertension-related diseases are one of the most common medical complications of pregnancy, and

they affect 7–15% of pregnancies, and they account for a substantial share of antenatal admissions, maternal disability and perinatal loss [2].

Pregnancy-induced hypertension is described by systolic blood pressure at least 140 mmHg or higher or/and diastolic blood pressure at least 90 mmHg or higher, documented by two measurements done several hours apart [3]. Hypertensive disorders include gestational hypertension, pre-eclampsia/eclampsia, chronic hypertension, and pre-eclampsia with chronic hypertension [4]. Pre-eclampsia is a state of new-onset hypertension after 20 weeks of gestation with proteinuria or with organ dysfunction indicators, such as thrombocytopenia, liver dysfunction, kidney dysfunction, pulmonary edema or brain and visual disturbances in case of absence of proteinuria. Eclampsia refers to new onset of generalized seizures in a woman with pre-eclampsia not caused by any other condition [4]. Pre-eclampsia is a multi-system disorder, which may affect the fetus causing growth restriction, preterm birth or intrauterine death and the mother by pulmonary edema, stroke, liver and kidney dysfunction, and cardiovascular or renal disease [5].

Normal pregnancy is an inherently hypercoagulable condition. The levels of several clotting factors and fibrinogen increase, whereas there is a slight decrease in the platelet levels due to hemodilution and consumption, and there is a decrease in fibrinolysis, which is mainly attributed to the inhibition of plasminogen activators such as PAI-2 [6], which is a placentally-derived protein. All these physiological changes assist in handling the challenges of the separation of the placenta. Pre-eclampsia and eclampsia conditions cause an exaggerated pro-coagulation state due to endothelial dysfunction, vasospasm, and activation of platelets, which may lead to development of DIC and HELLP syndrome (hemolysis, elevated liver enzymes and thrombocytopenia) [7]. Thrombocytopenia is the common hematological abnormality in such cases.

Tests that may be used to evaluate the function of the coagulation cascade include simple laboratory investigations. Prothrombin time measures the activation of the extrinsic and common pathway (factors VII, X, V, II, and fibrinogen), while activated partial thromboplastin time assesses the intrinsic and common pathways. D-dimer is a byproduct of cross-linked fibrin produced by the action of plasmin and serves as a marker for coagulation within the blood vessels and secondary fibrinolysis [8]. Alongside platelet counts, they constitute an easily accessible test of hemostasis.

The importance of performing routine coagulation tests in pregnancies complicated by hypertension continues to be controversial. Some authors have proposed that platelet count alone would suffice with PT, aPTT, and fibrinogen being performed only in cases of significantly low platelet counts some have shown the presence of abnormalities in PT, aPTT, and fibrinogen despite a normal platelet count especially in cases of severe hypertension and there have been some reservations regarding unnecessary tests [9]. Considering the fact that the extent of haemostatic derangement seems to depend on disease severity and population, information from various clinical settings is essential to determine the significance of these tests.

Pre-eclampsia and eclampsia of different severity make up a significant portion of admissions in the field of obstetrics, and different levels of consumptive coagulopathy play a significant role in the morbidity and even mortality in such cases [10]. Early determination of the severity level is needed to be able to assess high-risk pregnancies and develop proper treatment. Hence, the current study was conducted to compare the level of platelets, PT, aPTT, and D-dimer in normotensive pregnant women versus pre-eclamptic and eclamptic patients in the third trimester and see if the severity of the condition affects these parameters.

Methodology

Study Design: This case-control study conducted on hospital patients was designed to examine and compare platelet count, prothrombin time, activated partial thromboplastin time and D-dimer among normotensive pregnant women and pre-eclampsia/eclampsia during the third trimester of pregnancy.

Study Area: This study was done at the Department of Pathology, Bharati Vidyapeeth Deemed University and Hospital,Sangli,Maharashtra,India. The participants were pregnant women in their third trimester who were admitted to the Department of Obstetrics & Gynaecology at the affiliated hospital, and all laboratory studies were performed in the Department of Pathology.

Study Duration: This research was carried out within a period of one year. Within this time period, all eligible pregnant ladies were enrolled in this study and their clinical and laboratory data was recorded.

Study Participants: The sample used was pregnant women who were at their third trimester and attended the hospital during the duration of the study. The sample was divided into two groups; namely the study group and the control group. The study group included women suffering from pre-eclampsia and eclampsia while the control group included age-matched normotensive pregnant women. The study group was sub-divided into two groups; namely Group PE and Group E.

Inclusion Criteria

- Cases: Women suffering from pre-eclampsia/eclampsia during third trimester of pregnancy admitted in the hospital.

- Controls: Pregnant women with normal blood pressure during third trimester of pregnancy admitted in the hospital.
- Women giving their written informed consent for participation in the study.

Exclusion Criteria

- Bleeding disorders or patients on anticoagulant medication.
- Abruptio placentae or death of the fetus within the uterus.
- Active labouring women.
- Conclusive disseminated intravascular coagulation.
- History of diabetes, kidney diseases, thyroid problems, or liver problems.

Sample Size: Calculation of the minimum number of sample size was done using the following formula, $n = 2(Z\alpha + Z1-\beta)^2 \sigma^2 / d^2$, where we used level of significance (α) of 5% ($Z\alpha = 1.96$), a power of 90% ($Z1-\beta = 1.282$), standard deviation σ of 6.435, and difference of means (d) of 1.09 from previously published literature. This gave us a minimum number of sample size of 45 cases and 45 controls. Finally, 120 women meeting inclusion criteria were included; 60 normotensive pregnant women (Group NP) and 60 patients with hypertensive disorders of which 46 had pre-eclampsia (Group PE) and 14 had eclampsia (Group E). Control group was matched to the study group in terms of age.

Procedure: Each participant was made aware of the protocol used in the study and was given informed consent. The participant's details, including age, parity, and history like headaches, swelling in the legs, vomiting, stomach pains, visual problems, and seizures, were documented on a proforma. Physical examination, including general, systemic, and obstetric, was done, and the blood pressure measured. Other tests included full blood count and urinalysis for the presence of albumin. Proteinuria was assessed using a dipstick test from 1+ to 4+.

Venous blood samples were collected through aseptic techniques at the time of admission to the maternity ward and taken to the laboratory immediately. Platelet count was assessed by automated multi-parameter hematology analyzer (Celltac α MEK-6400 series) and also by manual count using peripheral blood film under oil immersion. Prothrombin time and Activated Partial Thromboplastin Time (APTT) were determined on Stago Start Coagulometer. Quantitative determination of D-dimers was made using latex-enhanced immuno-nephelometric assay (Meriline NepheloQuant D-Dimer kit). Routine tests such as bleeding time by Duke's method and Clotting time by Wright's capillary tube method were also included.

Statistical Analysis: Data entry and analyses were done in Microsoft Excel and SPSS software, respectively, version 22.0. Continuous data were presented as mean ± SD, while categorical variables as frequency and percentage. Frequency distributions of categorical variables in each of the three groups were evaluated using Chi-Square Test. One-Way ANOVA test was used to compare means of the variables between Groups NP, PE and E. P value <0.05 was taken as statistical significance.

Result

There were 120 pregnant subjects during their third trimester of pregnancy; 60 in normotensive control group (NP), 46 in pre-eclamptic group (PE), and 14 in eclamptic group (E).

Table 1 summarizes the demographic and clinical features of the participants of the study. Most women in all three groups were aged 18–25 years (Group NP = 58.33%, Group PE = 60.87%, Group E = 50.00%), while the second age category of 26-35 years included 40.00%, 39.13% and 42.86% of the subjects of the corresponding groups. One woman in Group NP and one in Group E was older than 35 years. The age distributions in the groups were similar (p = 0.472). Primigravidae comprised 33.33% of Group NP and 50.00% of Groups PE and E; second gravidae comprised 38.33%, 30.43% and 28.57%; third or higher gravidae – 28.33%, 19.57% and 21.43%, respectively, and parity was not significantly different (p = 0.478). Mean systolic blood pressure was 111.8 ± 8.1, 153.0 ± 7.3 and 164.0 ± 8.5 mmHg; diastolic blood pressure was 73.1 ± 7.2, 108.0 ± 6.4 and 113.0 ± 7.4 mmHg, respectively.

Table 1: Demographic and clinical characteristics of study participants (n=120)

Variable	Category	Group NP (n=60) n (%)	Group PE (n=46) n (%)	Group E (n=14) n (%)	p-value
Age (years)	18–25	35 (58.33)	28 (60.87)	7 (50.00)	0.472
	26–35	24 (40.00)	18 (39.13)	6 (42.86)	
	>35	1 (1.67)	0 (0.00)	1 (7.14)	
Gravida	Primigravida	20 (33.33)	23 (50.00)	7 (50.00)	0.478
	Second gravida	23 (38.33)	14 (30.43)	4 (28.57)	
	Third or more	17 (28.33)	9 (19.57)	3 (21.43)	
Blood pressure (mmHg), mean ± SD	Systolic	111.8 ± 8.1	153.0 ± 7.3	164.0 ± 8.5	–
	Diastolic	73.1 ± 7.2	108.0 ± 6.4	113.0 ± 7.4	–

NP: normotensive pregnant women; PE: pre-eclampsia; E: eclampsia. p-values by Chi-square test.

The frequency of presenting symptoms and urine albumin of the participants is shown in Table 2. Headache affected 13.33% of participants from Group NP, lower limb swelling affected 16.67%, while vomiting and epigastric pain were each suffered by one patient (1.67%). Lower limb swelling was the most common symptom in Group PE (52.17%), followed by vomiting (30.43%) and headache (28.26%); no patient in this group had epigastric pain or visual disturbance. All the patients from Group E had lower limb swelling and convulsions, while headache, vomiting, epigastric pain and visual disturbance affected 78.57%, 64.29%, 35.71% and 7.14%, respectively. No proteinuria was observed among control participants. In Group PE, 52.17% and 36.96% of patients had 1+ and 2+ proteinuria, respectively, while 6.52% and 4.35% of patients had 3+ and 4+ proteinuria, respectively. Heavier proteinuria occurred in Group E; 3+ and 4+ proteinuria were observed in 35.71% and 21.43% of patients, respectively. Significant proteinuria (2+ or more) was thus present in 47.83% of pre-eclamptic and 78.57% of eclamptic women, indicating increasing proteinuria with disease severity.

Table 2: Distribution of participants according to presenting symptoms and urine albumin (n=120)

Variable	Category	Group NP (n=60) n (%)	Group PE (n=46) n (%)	Group E (n=14) n (%)
Symptoms*	Headache	8 (13.33)	13 (28.26)	11 (78.57)
	Swelling of lower limbs	10 (16.67)	24 (52.17)	14 (100.00)
	Vomiting	1 (1.67)	14 (30.43)	9 (64.29)
	Epigastric pain	1 (1.67)	0 (0.00)	5 (35.71)
	Visual disturbances	0 (0.00)	0 (0.00)	1 (7.14)
	Convulsions	0 (0.00)	0 (0.00)	14 (100.00)
Urine albumin	Absent	60 (100.00)	0 (0.00)	0 (0.00)
	1+	0 (0.00)	24 (52.17)	3 (21.43)
	2+	0 (0.00)	17 (36.96)	3 (21.43)
	3+	0 (0.00)	3 (6.52)	5 (35.71)
	4+	0 (0.00)	2 (4.35)	3 (21.43)

**Multiple responses were possible; percentages may therefore exceed 100.*

Table 3 shows the distribution of subjects by platelet count. Of Group NP subjects, 50.00% had platelet counts ranging between 1.51-2.50 lakh/mm³, and just 10.00% had platelet counts ≤1.50 lakh/mm³. Of Group PE subjects, 41.30% had platelet counts ranging between 1.51-2.50 lakh/mm³, 32.61% had platelet counts of 2.51-3.50 lakh/mm³, whereas the percentage of subjects with platelet counts ≤1.50 lakh/mm³ was increased to 19.57%. On the other hand, the majority of the subjects in Group E (57.14%) had platelet counts ≤1.50 lakh/mm³, 28.57% had platelet counts of 1.51-2.50 lakh/mm³, while only one subject in each case (7.14%) had platelet counts 2.51-3.50 and >3.50 lakh/mm³. However, subjects with platelet counts >3.50 lakh/mm³ were 18.33% in controls but only 6.52% in pre-eclamptic group. Platelet count distribution in three groups showed significant variation (χ^2=20.95, p=0.002).

Table 3: Distribution of participants according to platelet count (n=120)

Platelet count (lakh/mm³)	Group NP (n=60) n (%)	Group PE (n=46) n (%)	Group E (n=14) n (%)	Total n (%)
≤1.50	6 (10.00)	9 (19.57)	8 (57.14)	23 (19.17)
1.51–2.50	30 (50.00)	19 (41.30)	4 (28.57)	53 (44.17)
2.51–3.50	13 (21.67)	15 (32.61)	1 (7.14)	29 (24.17)
>3.50	11 (18.33)	3 (6.52)	1 (7.14)	15 (12.50)
Total	60 (100)	46 (100)	14 (100)	120 (100)

χ^2 = 20.95; p = 0.002 (Chi-square test).

The distribution of the participants according to their prothrombin time and activated partial thromboplastin time is provided in Table 4. In Group NP, the PT values ranged from 12.0 to 16.0 seconds in 98.33% of women, while 1.67% of women in this group (one participant) had the PT value higher than 16.0 seconds. Higher PT value (>16.0 s) was found in 17.39% and 28.57% of women in Groups PE and E, correspondingly, and the PT distributions in different groups varied significantly (χ^2=13.93,

p=0.008). The change was even more significant for aPTT. In Group NP, the aPTT values were rather equally distributed between 26.0 and 35.0 seconds, and only 1.67% of women (one participant) had the aPTT value higher than 35.0 seconds. However, in Groups PE and E, the values exceeded 35.0 seconds in 39.13% and 64.29% of women, respectively; only 4.35% and 7.14% of them had aPTT values below 26.0 seconds. Thus, the distribution of aPTT among three groups varied significantly (χ^2=42.10, p<0.001).

Table 4: Distribution of participants according to prothrombin time and activated partial thromboplastin time (n=120)

Parameter	Category (seconds)	Group NP (n=60) n (%)	Group PE (n=46) n (%)	Group E (n=14) n (%)	χ^2 (p-value)
Prothrombin time	12.0–14.0	29 (48.33)	14 (30.43)	3 (21.43)	13.93 (0.008)
	14.1–16.0	30 (50.00)	24 (52.17)	7 (50.00)	
	>16.0	1 (1.67)	8 (17.39)	4 (28.57)	
aPTT	26.0–29.0	19 (31.67)	2 (4.35)	1 (7.14)	42.10 (<0.001)
	29.1–32.0	20 (33.33)	13 (28.26)	1 (7.14)	
	32.1–35.0	20 (33.33)	13 (28.26)	3 (21.43)	
	>35.0	1 (1.67)	18 (39.13)	9 (64.29)	

aPTT: activated partial thromboplastin time.

The distribution of participants based on their D-dimer values is presented in Table 5. Among controls, most individuals had lower D-dimer values as 41.67% and 51.67% respectively had values from 0.2 to 0.9 mg/L and from 1.0 to 1.7 mg/L. It means that 93.33% of normotensive women had D-dimer values less than 1.8 mg/L. As for group PE, here D-dimer values varied within wider limits as 41.30% had less than 1.8 mg/L, 17.39% - 1.8–2.5 mg/L and 2.6–3.1 mg/L, 13.04% - 3.2–3.9 mg/L, and 10.87% - 4.0 mg/L and above. In Group E, D-dimer values shifted toward higher limits as 21.43% of participants had D-dimer values 3.2–3.9 mg/L and 50.00% had values 4.0 mg/L or above. The difference in distribution was highly significant (χ^2=65.25, p<0.001).

Table 5: Distribution of participants according to D-dimer level (n=120)

D-dimer (mg/L)	Group NP (n=60) n (%)	Group PE (n=46) n (%)	Group E (n=14) n (%)	Total n (%)
0.2–0.9	25 (41.67)	6 (13.04)	1 (7.14)	32 (26.67)
1.0–1.7	31 (51.67)	13 (28.26)	1 (7.14)	45 (37.50)
1.8–2.5	1 (1.67)	8 (17.39)	1 (7.14)	10 (8.33)
2.6–3.1	1 (1.67)	8 (17.39)	1 (7.14)	10 (8.33)
3.2–3.9	1 (1.67)	6 (13.04)	3 (21.43)	10 (8.33)
≥4.0	1 (1.67)	5 (10.87)	7 (50.00)	13 (10.83)
Total	60 (100)	46 (100)	14 (100)	120 (100)

χ^2 = 65.25; p < 0.001 (Chi-square test).

The mean coagulation parameters of the three groups have been presented in Table 6. There was a decrease in the mean platelet count from 2.55 ± 0.88 lakh/mm³ in Group NP to 2.21 ± 0.82 lakh/mm³ in Group PE and 1.49 ± 0.80 lakh/mm³ in Group E (F=9.43, p<0.001). Mean PT increased from 14.1 ± 0.69 seconds in Group NP to 14.9 ± 1.24 seconds in Group PE and 15.1 ± 1.26 seconds in Group E (F=10.25, p<0.001) despite the group means being within the reference range. The mean aPTT increased from 30.8 ± 2.6 seconds in Group NP to 34.5 ± 3.7 seconds in Group PE and 37.6 ± 5.3 seconds in Group E (F=28.46, p<0.001). However, the most significant change was recorded in the mean value of D-dimer, which increased from 1.09 ± 0.41 mg/L in Group NP to 2.50 ± 1.66 mg/L in Group PE and 5.65 ± 4.77 mg/L in Group E (F=33.18, p<0.001), showing a more than fivefold increase in D-dimer in eclampsia compared to control subjects. Bleeding time (163.5 ± 24.8, 183.8 ± 29.8 and 208.8 ± 46.3 seconds) and clotting time (310.0 ± 51.7, 321.6 ± 50.4 and 383.9 ± 66.3 seconds) also increased significantly from Group NP to Group E (p<0.001 for both) though the mean values were within the normal limit.

Table 6: Comparison of mean coagulation parameters among the study groups (n=120)					
Parameter	**Group NP (n=60) Mean ± SD**	**Group PE (n=46) Mean ± SD**	**Group E (n=14) Mean ± SD**	**F-value**	**p-value**
Platelet count (lakh/mm³)	2.55 ± 0.88	2.21 ± 0.82	1.49 ± 0.80	9.43	<0.001
Prothrombin time (s)	14.10 ± 0.69	14.90 ± 1.24	15.10 ± 1.26	10.25	<0.001
aPTT (s)	30.80 ± 2.60	34.50 ± 3.70	37.60 ± 5.30	28.46	<0.001
D-dimer (mg/L)	1.09 ± 0.41	2.50 ± 1.66	5.65 ± 4.77	33.18	<0.001
Bleeding time (s)	163.50 ± 24.75	183.80 ± 29.81	208.80 ± 46.33	15.34	<0.001
Clotting time (s)	310.03 ± 51.69	321.60 ± 50.39	383.92 ± 66.25	11.05	<0.001

p-values by one-way analysis of variance (ANOVA); df = 2, 117.

Table 7 shows the distribution of subjects based on management. In Group NP, 73.33% of the women had deliveries vaginally while 26.67% had LSCS. In Group PE, the commonest method involved administration of antihypertensive treatment and subsequent vaginal delivery (56.52%), followed by administration of antihypertensive treatment with LSCS (17.39%). Termination of pregnancy by vaginal delivery occurred in 13.04%, while 13.04% had administration of injection magnesium sulphate ($MgSO_4$) along with antihypertensive treatment prior to vaginal delivery. All women in Group E received $MgSO_4$; 57.14% also received antihypertensive treatment and had deliveries vaginally, 21.43% received $MgSO_4$ along with antihypertensive treatment and LSCS, and 14.29% received $MgSO_4$ and then deliveries vaginally. There was one case of eclamptic woman (7.14%) who suffered from coagulation failure due to HELLP syndrome, which necessitated transfusion of fresh frozen plasma and platelet concentrate in addition to $MgSO_4$ and antihypertensive treatment prior to termination of pregnancy.

Table 7: Distribution of participants according to management (n=120)			
Group	**Management**	**Frequency (n)**	**Percentage (%)**
Group NP (n=60)	Vaginal delivery	44	73.33
	LSCS	16	26.67
Group PE (n=46)	Termination of pregnancy by vaginal route alone	6	13.04
	Antihypertensives + vaginal delivery	26	56.52
	Antihypertensives + LSCS	8	17.39
	$MgSO_4$ + antihypertensives + vaginal delivery	6	13.04
Group E (n=14)	$MgSO_4$ + antihypertensives + vaginal delivery	8	57.14
	$MgSO_4$ + antihypertensives + LSCS	3	21.43
	$MgSO_4$ + vaginal delivery	2	14.29
	$MgSO_4$ + antihypertensives + FFP and platelet concentrates (coagulation failure/HELLP)	1	7.14

LSCS: lower segment caesarean section; $MgSO_4$: magnesium sulphate; FFP: fresh frozen plasma.

Discussion

The current study evaluated the platelet count, PT, aPTT, and D-dimer in pregnant women who were normotensive, as well as in women who suffered from pre-eclampsia and eclampsia in their third trimester in Bharati Vidyapeeth Deemed University and Hospital,Sangli,Maharashtra,India. The main result was a progressive alteration in hemostasis in order of normotensive pregnancy to pre-eclampsia and eclampsia; the platelet count decreased in a progressive manner, but the PT, aPTT, and particularly D-dimer increased accordingly [11] (FitzGerald et al., 1996).

The majority of women in all categories belonged to the age group 18-25 years, and since the control group was matched for age, no significant difference was observed. About half the patients suffering from pre-eclampsia and eclampsia were primigravidae, as opposed to one-third in the controls [12] (Barron et al., 1999). This preponderance of primigravidae is in agreement with the widely acknowledged association between nulliparity and the condition, and who have stated that eclampsia occurred in 46.7% primiparae as against 26.7% in both second and multiparous women. Though the parity difference was not statistically significant in the present study, which could be because of small sample size of eclampsia group, still the direction is correct as anticipated [13] (Dube et al., 1975). The increase in the percentage of women having symptoms of headache, vomiting, epigastric pain, and heavy proteinuria in going from pre-eclampsia to eclampsia again demonstrates increased

multisystem involvement; significant proteinuria (2+ or above) was observed in 47.83% pre-eclampsia and 78.57% eclampsia patients.

The mean platelet count in the current study was lower in pre-eclampsia (2.21 lakh/mm³) and eclampsia (1.49 lakh/mm³) as compared to control (2.55 lakh/mm³) and the percentage of patients with platelets less than or equal to 1.5 lakh/mm³ increased from 10.00% to 19.57% and 57.14% respectively. Such an inverse relationship between platelet count and the severity of the condition is well explained by the results obtained, who reported mean platelet counts of 2.38, 2.23, 1.82 and 1.21 lakh/mm³ in controls, mild pregnancy-induced hypertension, pre-eclampsia and eclampsia respectively [14] (Mohapatra et al., 2007). Similarly, a fall from 215,000/mm³ in normal pregnancy to 168,000/mm³ in mild and 142,000/mm³ in severe pre-eclampsia has been reported and the reduction has been attributed to platelet consumption during intravascular coagulation. Significantly lower platelet counts have also been reported in severe pre-eclampsia (1.70 ± 0.57 lakh/mm³) and eclampsia (1.51 ± 0.56 lakh/mm³), the latter being almost the same as in our study. Low platelet counts have been seen in 47% of hypertensive pregnant women and in 60% of cases of eclampsia, similar to the 57.14% recorded in our case of eclampsia. The increase in bleeding time in control up to the case of eclampsia although within the normal range is in concordance with the platelet function defect in pre-eclampsia described [15] (Howie et al., 1971).

The mean PT of 14.1 seconds recorded in the control group increased to 14.9 seconds and 15.1 seconds in the groups with pre-eclampsia and eclampsia, respectively [16] (Jambhulkar et al., 2001). Though significantly different, the change was minimal, and the mean values were within the reference range; the PT exceeding 16 seconds was observed in 17.39% of cases with pre-eclampsia and in 28.57% with eclampsia. also observed a minimal difference in the PT levels between normotensive and hypertensive pregnancies, while did not report any significant difference in PT levels between normal pregnancy and mild or severe pre-eclampsia. However, reported prolongation of the PT in 28.57% of patients with mild and 82.86% of patients with severe pregnancy-induced hypertension with thrombocytopenia, and also reported prolongation of PT in a few women with pre-eclampsia. observed prolongation of the PT in 36.6% of cases with pre-eclampsia. It can be said that PT is affected rather late in the disease process due to the depletion of the factors involved in the extrinsic pathway.

On the other hand, aPTT exhibited a more marked response. Mean aPTT values rose from 30.8 seconds in the control group to 34.5 seconds in pre-eclampsia and 37.6 seconds in eclampsia, and aPTT exceeding 35 seconds occurred in 39.13% and 64.29% of these groups as opposed to 1.67% in the control group. observed that there was a significant rise in aPTT in cases of severe pre-eclampsia and eclampsia whereas PT showed only a slight increase and concluded that platelet count and aPTT may be useful in predicting the presence of consumptive coagulopathy. noted a significant increase in aPTT among women with severe pre-eclampsia and eclampsia compared with those of control women, and aPTT was significantly higher in severe pre-eclampsia than in normal pregnancy. documented prolonged aPTT in half of their pre-eclamptic cases. mentioned prolonged aPTT in 42% of their cases with pregnancy induced hypertension and stressed that prolonged aPTT is an important indicator of a need for vigorous treatment. The results of the current study lend support to the hypothesis that aPTT is a good marker of consumption of the intrinsic pathway in hypertensive pregnancies [17] (Rahim et al., 2010).

The D-dimer test was the parameter which showed the most pronounced changes, namely increasing from 1.09 mg/L in control to 2.50 mg/L in pre-eclampsia and 5.65 mg/L in eclampsia; one-half of eclamptic patients had the levels above 4.0 mg/L. This gradually increasing trend corresponds well with, who observed mean plasma D-dimer levels of 1.45 mg/L in healthy third trimester of pregnancy, 3.09 mg/L in pre-eclampsia and 5.62 mg/L in eclampsia, concluding that D-dimer is highly valuable for the prediction of the prognosis of the disease in hypertensive pregnant women. they found statistically significant increases in D-dimer levels in pre-eclamptic women compared with normotensive ones, which corresponded to coagulation activation with subsequent fibrinolysis [18] (Kelton et al., 1985). A gradual increase in D-dimer levels from normotensive controls to eclampsia and elevated D-dimer levels in all patients with subclinical and clinical coagulation dysfunction and found a statistically significant increase in D-dimer in severe pre-eclampsia compared with mild one.

When taken together, it is possible to conclude that preeclampsia and eclampsia are associated with the process of progressive consumption of platelets, involvement of intrinsic and to some extent of the extrinsic pathways, as well as increasing fibrin formation and degradation [19] (Chauhan et al., 2014). Since this phenomenon occurs in a gradable manner, it makes sense to use the panel of tests including the platelet count, PT, aPTT and D-dimer test, which is not only relatively inexpensive but also easy to perform. It is particularly important since one woman in the current research suffered from the development of coagulation disorders, due to the presence of HELLP syndrome in eclampsia and was treated with blood components. In that case, earlier

suggestions to use only the platelet count might be misleading [20] (Shetty et al., 2016).

Conclusion

The current study conducted at ASMC, Kaushambi has revealed that the presence of pre-eclampsia and eclampsia during the third trimester is correlated with significant disturbance of the haemostatic system in comparison with normotensive pregnancy. The platelet count reduced gradually, whereas prothrombin time, activated partial thromboplastin time and D-dimer were found to increase from normotensive pregnancy to pre-eclampsia and eclampsia. The changes in aPTT and D-dimer were found to be the most considerable ones. The changes described above correspond to the clinical picture and are the signs of the trend towards the development of consumption coagulopathy in hypertensive pregnancies. Platelet count, PT, aPTT and D-dimer are cheap, fast and accessible methods for evaluating the severity of the condition and imminent coagulation disorders. It is highly recommended to perform these tests routinely in all cases of pre-eclampsia and eclampsia during the third trimester.

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