Section: Obstetrics and Gynaecology

Original Research Article

COMPARISON OF INTRAMUSCULAR AND INTRAVENOUS MAGNESIUM SULFATE REGIMENS IN SEVERE PRE-ECLAMPSIA AND ECLAMPSIA: A PROSPECTIVE COMPARATIVE STUDY

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ABSTRACT

Background: Magnesium sulfate is the standard anticonvulsant therapy for severe pre-eclampsia and eclampsia. Intramuscular (IM) and intravenous (IV) regimens are commonly used, but their comparative maternal and fetal outcomes require evaluation.

Materials and Methods: A prospective comparative study was conducted among 100 women with severe pre-eclampsia or eclampsia. Participants were equally allocated to IM (Pritchard regimen) and IV (Zuspan regimen) magnesium sulfate groups. Maternal haemodynamic parameters, fetal heart rate, serum magnesium levels, recurrence of seizures, mode of delivery, Apgar score, and neonatal outcomes were assessed.

Results: The study included 50 women in each group; 91% had severe pre-eclampsia and 9% had antepartum eclampsia. Significant reductions in systolic and diastolic blood pressure and mean arterial pressure occurred in both groups. Eclampsia after treatment occurred in 2 (4%) women in each group. NICU admission occurred in 60% of IM and 64% of IV cases (p=0.680). Apgar score <7 occurred in 28% and 20%, respectively (p=0.348). No magnesium toxicity was observed.

Conclusion: Both intramuscular Pritchard and intravenous Zuspan magnesium sulphate regimens demonstrated comparable haemodynamic, maternal and fetal outcomes. The intravenous regimen offers practical advantages in dose titration and maintenance of a relatively steady serum magnesium concentration, whereas the intramuscular regimen remains useful where infusion pumps and continuous monitoring facilities are limited.

Keywords: Severe pre-eclampsia, Eclampsia, Magnesium sulfate, Intramuscular regimen, Intravenous regimen.

INTRODUCTION

Hypertensive disorders of pregnancy are important causes of maternal and perinatal morbidity and mortality.[1] Severe preeclampsia is characterized by severe hypertension associated with significant proteinuria and/or features of maternal organ dysfunction. Eclampsia represents the most severe manifestation and is defined by the occurrence of seizures in a woman with preeclampsia in the absence of another identifiable cause.[2] Eclamptic seizures may occur during the antepartum, intrapartum or postpartum period and require prompt treatment to prevent serious maternal and fetal complications.[3] Magnesium sulphate ($MgSO_4$) is the established anticonvulsant for the prevention and treatment of eclampsia. It reduces neuromuscular transmission and central nervous system excitability, thereby preventing and controlling seizures.[4] Two widely used methods of magnesium sulphate administration are the intramuscular Pritchard regimen and the intravenous Zuspan regimen. The Pritchard regimen consists of an intravenous loading dose followed by intramuscular loading and maintenance doses,

whereas the Zuspan regimen consists of an intravenous loading dose followed by continuous intravenous infusion.[5] The route of administration may influence serum magnesium concentration and the ease of maintaining therapeutic drug levels.[7] Intravenous administration permits controlled and continuous delivery, allowing the maintenance dose to be adjusted according to clinical response. It also avoids repeated painful intramuscular injections. However, intravenous therapy requires an infusion pump, trained personnel and appropriate monitoring facilities.[8] The intramuscular regimen is comparatively simple and remains particularly useful in settings where such resources are limited. Repeated intramuscular administration, however, may cause considerable pain and may result in greater fluctuations in serum magnesium concentration.[9] Monitoring is essential during magnesium sulphate therapy because excessive magnesium accumulation can lead to toxicity, clinically manifested by loss of patellar reflexes, respiratory depression, and reduced urine output.[10] Measurement of serum magnesium concentration can provide additional information regarding drug exposure, particularly in patients with recurrent seizures or suspected magnesium toxicity.[11] In the present study, serum magnesium concentrations were measured at 2 and 6 hours after initiation of treatment, while maternal blood pressure, pulse rate, and fetal heart rate were monitored to assess and compare the haemodynamic effects of the two treatment regimens. The choice of magnesium sulphate regimen is influenced by both clinical efficacy and the availability of healthcare resources. The intravenous route offers advantages in dose titration and maintenance of relatively stable serum magnesium concentrations, whereas the intramuscular route provides a practical alternative, particularly in resource-limited settings. Therefore, the present study was undertaken to compare the intramuscular Pritchard and intravenous Zuspan magnesium sulphate regimens with respect to serum magnesium concentrations, maternal haemodynamic responses, occurrence of seizures, mode of delivery, and fetal and neonatal outcomes.

MATERIALS AND METHODS

Study Design and Study Population: A prospective comparative study was conducted among pregnant women diagnosed with severe preeclampsia and eclampsia. A total of 105 eligible women were assessed for participation, of whom five were excluded because they did not provide consent. The final study population consisted of 100 women. Participants were allocated into two equal groups of 50 each according to the magnesium sulphate administration regimen. The intramuscular (IM) group received the Pritchard regimen, while the intravenous (IV) group received the Zuspan regimen.

Eligibility Criteria: Women with severe preeclampsia and women presenting with antepartum, intrapartum or postpartum eclampsia were considered for inclusion. Severe preeclampsia was identified based on severe hypertension and/or features of severe disease, including significant proteinuria, neurological symptoms, epigastric pain, oliguria and relevant laboratory abnormalities. Women with renal failure, pulmonary oedema with respiratory failure, hydatidiform mole, cerebrovascular accident, disseminated intravascular coagulation, prior administration of magnesium sulphate before admission, or those unwilling to participate were excluded.

Magnesium Sulphate Regimens: Participants in the IM group received the Pritchard regimen. A loading dose of 4 g of 20% magnesium sulphate was administered intravenously over approximately 20 minutes, followed by 5 g of 50% magnesium sulphate administered intramuscularly into each buttock. Maintenance therapy consisted of 5 g of 50% magnesium sulphate administered by deep intramuscular injection into alternate buttocks every 4 hours. Participants in the IV group received the Zuspan regimen. A loading dose of 4 g of magnesium sulphate diluted in 100 mL of Ringer's lactate was administered intravenously over approximately 20 minutes, followed by a maintenance infusion of magnesium sulphate at 1–2 g/hour using an infusion pump. In both groups, magnesium sulphate therapy was continued for 24 hours after delivery or the last seizure, whichever occurred later. In the event of recurrent seizures, an additional 2 g of 20% magnesium sulphate was administered.

Clinical Assessment and Monitoring: A detailed history was obtained regarding headache, vomiting, blurring of vision, epigastric pain and previous seizures. General examination included assessment of pallor, pedal oedema, facial puffiness and icterus, together with measurement of blood pressure and pulse rate. A systemic examination and detailed obstetric examination were performed, followed by appropriate fetal surveillance. Patients receiving magnesium sulphate were monitored for clinical evidence of magnesium toxicity. Patellar reflexes, respiratory rate and urine output were assessed before administration of maintenance doses. A respiratory rate of at least 16 breaths/minute and urine output of at least 100 mL during the preceding 4 hours were considered before administering subsequent maintenance doses.

Haemodynamic Assessment: Blood pressure was recorded before each maintenance dose and at 2 and 6 hours after initiation of magnesium sulphate therapy. Systolic blood pressure, diastolic blood pressure and mean arterial pressure were assessed and compared between the IM and IV groups. Maternal pulse rate was also recorded at the specified time points. Fetal heart rate was monitored to assess fetal response following administration of magnesium sulphate. The changes observed at 2 and 6 hours were compared between the two treatment groups.

Serum Magnesium Estimation: Venous blood samples were collected at the second and sixth hours

after initiation of magnesium sulphate therapy in both treatment groups. Serum magnesium concentrations were measured and compared between the IM and IV regimens to assess differences in magnesium exposure and the pattern of change over time.

Maternal Outcomes: The participants were followed until delivery, and maternal outcomes were recorded. The occurrence or recurrence of eclamptic seizures following initiation of magnesium sulphate therapy was documented. The mode of delivery was recorded and categorized according to the type of delivery, including vaginal delivery and caesarean section. Maternal haemodynamic parameters and clinical evidence of magnesium toxicity were also assessed.

Fetal and Neonatal Outcomes: Fetal and neonatal outcomes were evaluated following delivery. The parameters recorded included birth weight, Apgar score, NICU admission, meconium staining, neonatal hypotonia and respiratory distress. These outcomes were compared between neonates born to mothers receiving the IM and IV magnesium sulphate regimens.

Study Outcomes: The primary outcomes assessed were the comparative effects of the two magnesium sulphate regimens on maternal haemodynamic parameters, serum magnesium concentration and seizure control. Secondary outcomes included mode of delivery, birth weight, Apgar score, NICU admission and neonatal complications such as respiratory distress, meconium staining and hypotonia.

Statistical Analysis: The collected data were analyzed to compare the IM and IV groups. Continuous variables were summarized using appropriate descriptive statistics, while categorical variables were expressed as frequencies and percentages. Statistical comparisons were performed between the two groups, and a p-value <0.05 was considered statistically significant.

Ethical Considerations: Participation was based on informed consent. Women who did not provide consent were excluded from the study. The study was conducted according to the institutional requirements applicable to research involving pregnant women.

RESULTS

Baseline Characteristics of the Study Population: A total of 100 women with severe preeclampsia or eclampsia were included in the study. The age of the participants ranged from 19 to 40 years, with a mean age of 24.65 ± 4.52 years. The majority of participants (67.0%) belonged to the 21–30-year age group, followed by 21.0% who were aged 19–20 years and 12.0% who were aged 31–40 years [Figure 1, Table 1] Regarding parity, 53.0% were primigravida and 47.0% were multigravida. Severe preeclampsia was the indication for magnesium sulphate administration in 91.0% of participants, while antepartum eclampsia accounted for 9.0%. The mean age of the study population was 24.65 ± 4.52 years, with an age range of 19–40 years.

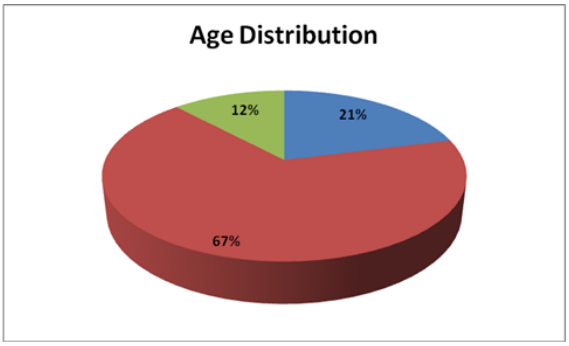

Figure: 1 Age wise distribution

Table 1: Baseline Characteristics of Study Participants

Characteristic	Frequency (n=100)	Percentage (%)
Age group		
19–20 years	21	21
21–30 years	67	67
31–40 years	12	12
Parity		
Primigravida	53	53
Multigravida	47	47
Indication for $MgSO_4$		
Severe preeclampsia	91	91
Antepartum eclampsia	9	9

Maternal Haemodynamic Parameters

Systolic Blood Pressure: Following magnesium sulphate administration, systolic blood pressure decreased in both treatment groups. In the intramuscular group, the mean systolic blood pressure decreased from 150.16 ± 8.90 mmHg at baseline to 124.04 ± 4.34 mmHg at 2 hours, representing a mean reduction of 26.12 mmHg (p<0.001). In the intravenous group, the corresponding decrease was from 150.04 ± 11.39 mmHg to 123.80 ± 6.82 mmHg, representing a mean reduction of 26.24 mmHg (p<0.001). At 6 hours, systolic blood pressure was 122.32 ± 3.46 mmHg in the IM group and 122.64 ± 6.57 mmHg in the IV group. The reported analysis indicated no significant difference between the two regimens in the magnitude of systolic blood pressure reduction. Within-group change from baseline to 2 hours was statistically significant in both groups (p<0.001). The source manuscript reports no significant difference between the IM and IV groups [Table 2]

Table 2: Systolic Blood Pressure Before and After Magnesium Sulphate Administration

Time point	IM group Mean ± SD (mmHg)	IV group Mean ± SD (mmHg)
Baseline (0 hour)	150.16 ± 8.90	150.04 ± 11.39
2 hours	124.04 ± 4.34	123.80 ± 6.82
Mean reduction at 2 h	26.12	26.24
6 hours	122.32 ± 3.46	122.64 ± 6.57
Mean reduction at 6 h	27.84	27.4

Diastolic Blood Pressure: The mean diastolic blood pressure also decreased following administration of magnesium sulphate. In the IM group, mean diastolic blood pressure decreased from 102.36 ± 5.47 mmHg at baseline to 82.96 ± 4.76 mmHg at 2 hours, corresponding to a reduction of 19.40 mmHg ($p<0.001$). In the IV group, the corresponding values decreased from 99.44 ± 5.91 mmHg to 83.84 ± 5.41 mmHg, representing a reduction of 15.60 mmHg ($p<0.001$). At 6 hours, the mean diastolic blood pressure was 83.84 ± 5.41 mmHg in the IM group and 82.36 ± 5.17 mmHg in the IV group. The source analysis reported no significant difference between the two treatment groups [Table 3]

Table 3: Diastolic Blood Pressure Before and After Magnesium Sulphate Administration

Time point	IM group Mean ± SD (mmHg)	IV group Mean ± SD (mmHg)
Baseline (0 hour)	102.36 ± 5.47	99.44 ± 5.91
2 hours	82.96 ± 4.76	83.84 ± 5.41
Mean reduction at 2 h	19.4	15.6
6 hours	83.84 ± 5.41	82.36 ± 5.17
Mean reduction at 6 h	18.52	17.08

Mean Arterial Pressure: Mean arterial pressure decreased following magnesium sulphate administration in both groups. At 2 hours, the IM group showed a decrease from 117.90 ± 5.37 mmHg to 94.48 ± 14.20 mmHg, representing a mean reduction of 23.42 mmHg ($p<0.001$). In the IV group, mean arterial pressure decreased from 116.16 ± 6.60 mmHg to 96.94 ± 5.15 mmHg, representing a mean reduction of 19.22 mmHg ($p<0.001$). At 6 hours, mean arterial pressure was 96.54 ± 3.91 mmHg in the IM group and 95.76 ± 4.87 mmHg in the IV group [Table 4] The reported analysis indicated no significant difference between the two groups.

Table 4: Mean Arterial Pressure Before and After Magnesium Sulphate Administration

Time point	IM group Mean ± SD (mmHg)	IV group Mean ± SD (mmHg)
Baseline (0 hour)	117.90 ± 5.37	116.16 ± 6.60
2 hours	94.48 ± 14.20	96.94 ± 5.15
Mean reduction at 2 h	23.42	19.22
6 hours	96.54 ± 3.91	95.76 ± 4.87
Mean reduction at 6 h	21.36	20.4

Maternal Pulse Rate: The maternal pulse rate showed minimal change following magnesium sulphate administration. At baseline, the mean pulse rate was 80 beats/minute in both groups. At 2 hours, it was 81 beats/minute in the IM group and 82 beats/minute in the IV group. At 6 hours, the corresponding values were 80 beats/minute and 81 beats/minute, respectively [Table 5] The source manuscript concluded that there was no significant difference in maternal pulse-rate changes between the two routes of administration.

Table 5: Maternal Pulse Rate During Magnesium Sulphate Therapy

Time point	IM group Mean ± SD (beats/min)	IV group Mean ± SD (beats/min)
Baseline	80 ± 3.91	80 ± 3.23
2 hours	81 ± 3.43	82 ± 3.62
6 hours	80 ± 3.59	81 ± 3.20

Fetal Heart Rate: Fetal heart rate was monitored following initiation of magnesium sulphate therapy. At baseline, the mean fetal heart rate was 136 ± 7.28 beats/minute in the IM group and 140 ± 6.79 beats/minute in the IV group. At 2 hours, fetal heart rate decreased to 132 ± 4.62 beats/minute in the IM group and 133 ± 7.53 beats/minute in the IV group [Table 6] The reported mean reductions were 4 beats/minute in the IM group and 7 beats/minute in the IV group. At the reported assessment point, the source manuscript concluded that there was no significant difference between the groups.

Table 6: Fetal Heart Rate During Magnesium Sulphate Therapy

Time point	IM group Mean ± SD (beats/min)	IV group Mean ± SD (beats/min)
Baseline	136 ± 7.28	140 ± 6.79
2 hours	132 ± 4.62	133 ± 7.53
Mean change	4	7

Six-Hour Haemodynamic Assessment: At 6 hours, the mean systolic blood pressure was 122.32 ± 3.46 mmHg in the IM group and 122.64 ± 6.57 mmHg in the IV group. The corresponding diastolic blood pressures were 83.84 ± 5.41 and 82.36 ± 5.17 mmHg, respectively. Mean arterial pressure was 96.54 ± 3.91 mmHg in the IM group and 95.76 ± 4.87 mmHg in the IV group [Table 7]. The study reported that there was no statistically significant difference between the IM and IV regimens with respect to changes in systolic blood pressure, diastolic blood pressure or mean arterial pressure.

Table 7: Comparison of Haemodynamic Parameters at 6 Hours

Parameter	IM group	IV group	Interpretation
Systolic BP (mmHg)	122.32 ± 3.46	122.64 ± 6.57	No significant difference
Diastolic BP (mmHg)	83.84 ± 5.41	82.36 ± 5.17	No significant difference
Mean arterial pressure (mmHg)	96.54 ± 3.91	95.76 ± 4.87	No significant difference
Maternal pulse rate (beats/min)	80 ± 3.59	81 ± 3.20	No significant difference

Serum Magnesium Concentration: Serum magnesium concentration was measured at 2 and 6 hours after initiation of magnesium sulphate therapy. In the IM group, the mean serum magnesium concentration was 4.442 mg/dL at 2 hours and 4.946 mg/dL at 6 hours, giving an absolute difference of approximately 0.504 mg/dL between the two measurements. In the IV group, the corresponding mean serum magnesium concentrations were 3.328 mg/dL at 2 hours and 3.374 mg/dL at 6 hours, with an absolute difference of approximately 0.046 mg/dL [Table 8]. Thus, the IM regimen demonstrated a greater change between the two sampling points, whereas the IV regimen showed a comparatively smaller variation in serum magnesium concentration.

Table 8: Serum Magnesium Concentration at 2 and 6 Hours

Route	2 hours Mean (mg/dL)	6 hours Mean (mg/dL)	Absolute change (mg/dL)
IM – Pritchard	4.442	4.946	0.504
IV – Zuspan	3.328	3.374	0.046

Mode of Delivery: Among the 100 women included in the study, 43% had vaginal deliveries and 57% underwent caesarean delivery. In the IM group, 31 women (62.0%) underwent lower-segment caesarean section (LSCS), while 18 (36.0%) had vaginal delivery and 1 (2.0%) had assisted breech delivery. In the IV group, 26 women (52.0%) underwent LSCS, 22 (44.0%) had vaginal delivery, 1 (2.0%) had assisted breech delivery and 1 (2.0%) had vacuum-assisted delivery. The difference between the groups was not statistically significant (p=0.428) [Figure 2]

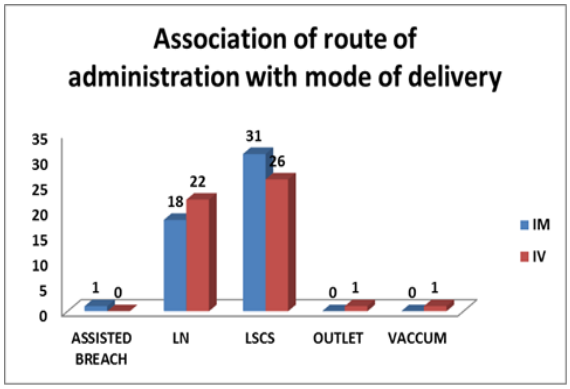

Figure 2: Association Between Route of Magnesium Sulphate Administration and Mode of Delivery

Birth Weight: Overall, 75% of neonates had a birth weight below 2.5 kg, while 25% had a birth weight above 2.5 kg. When birth weight was compared according to the route of magnesium sulphate administration, no statistically significant association was observed (p=0.815) [Figure 3 & 4]

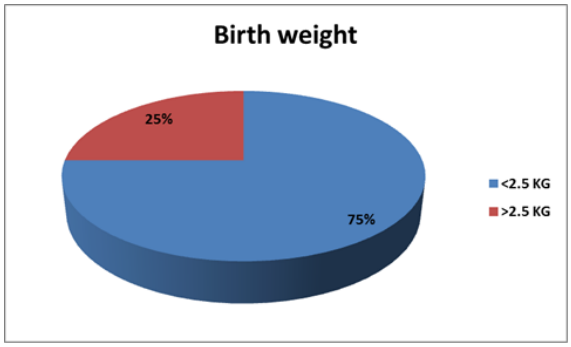

Figure 3: Birth Weight of Neonates

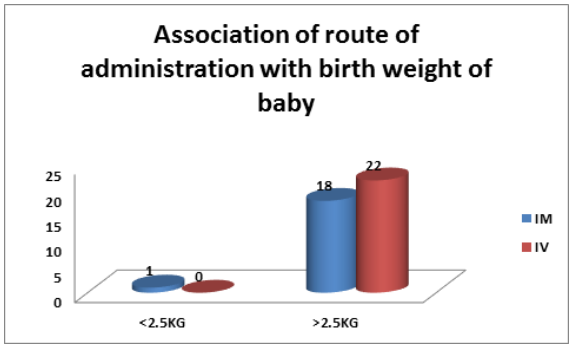

Figure 4: Association Between Route of Administration and Birth Weight

Apgar Score: Apgar scores were assessed at birth as an indicator of neonatal condition. Overall, 24 neonates (24.0%) had an Apgar score below 7, while 76 (76.0%) had an Apgar score of 7 or above. In the IM group, 14 neonates (28.0%) had an Apgar score <7 and 36 (72.0%) had a score ≥7. In the IV group,

10 neonates (20.0%) had a score <7 and 40 (80.0%) had a score ≥7. The difference was not statistically significant (p=0.348) [Table 9] There was no statistically significant difference in Apgar outcome between the two magnesium sulphate regimens.

Table 9: Association Between Route of Magnesium Sulphate

Apgar score	IM n (%)	IV n (%)	Total n (%)
<7	14 (28.0)	10 (20.0)	24 (24.0)
≥7	36 (72.0)	40 (80.0)	76 (76.0)
Total	50 (100)	50 (100)	100 (100)

NICU Admission: Overall, 62 neonates (62.0%) were admitted to the neonatal intensive care unit. NICU admission occurred in 30 neonates (60.0%) in the IM group and 32 (64.0%) in the IV group. Forty percent of neonates in the IM group and 36% in the IV group did not require NICU admission. There was no statistically significant difference between the groups with respect to NICU admission (p=0.680) [Table 10]

Table 10: Association Between Route of Administration and NICU Admission

NICU admission	IM n (%)	IV n (%)	Total n (%)
Yes	30 (60.0)	32 (64.0)	62 (62.0)
No	20 (40.0)	18 (36.0)	38 (38.0)
Total	50 (100)	50 (100)	100 (100)

Neonatal Complications Among NICU-Admitted Neonates: Among neonates admitted to the NICU, neonatal complications were comparable between the intramuscular and intravenous magnesium sulphate groups. Neonatal distress was observed in 4 (13.3%) neonates in the IM group and 5 (15.6%) in the IV group, with no statistically significant difference between the groups (p=0.438). Meconium-related distress was not observed in the IM group but occurred in 2 (6.3%) neonates in the IV group; this difference was not statistically significant (p=0.164). Neonatal hypotonia was observed in 2 (6.7%) neonates in the IM group and 4 (12.5%) in the IV group, with no significant difference between the groups (p=0.438) [Table 11] Overall, none of the assessed neonatal complications differed significantly according to the route of magnesium sulphate administration.

Table 11: Neonatal Complications Among NICU-Admitted Neonates According to Magnesium Sulphate Regimen

Neonatal outcome	IM Group, n (%)	IV Group, n (%)	p-value
Neonatal distress			
Yes	4 (13.3)	5 (15.6)	0.438
No	26 (86.7)	27 (84.4)	
Meconium-related distress			
Yes	0 (0.0)	2 (6.3)	0.164
No	30 (100.0)	30 (93.8)	
Neonatal hypotonia			
Yes	2 (6.7)	4 (12.5)	0.438
No	28 (93.3)	28 (87.5)	

Occurrence of Eclampsia After Magnesium Sulphate Administration: Two women in each treatment group developed eclampsia after initiation of magnesium sulphate therapy. Thus, eclampsia occurred in 2 women (4.0%) in the IM group and 2 women (4.0%) in the IV group. The difference was not statistically significant (p=1.000) [Table 12] There was no significant difference in the occurrence of eclampsia following initiation of magnesium sulphate therapy between the Pritchard and Zuspan regimens.

Table 12: Occurrence of Eclampsia After Initiation of Magnesium Sulphate

Occurrence of eclampsia	IM n (%)	IV n (%)	p-value
Yes	2 (4.0)	2 (4.0)	1.000
No	48 (96.0)	48 (96.0)	
Total	50 (100)	50 (100)	

DISCUSSION

Magnesium sulphate is the established anticonvulsant for the prevention and treatment of eclampsia and is recommended by the World Health Organization (WHO) for women with severe pre-eclampsia and eclampsia.[12] In the present prospective comparative study, the intramuscular Pritchard and intravenous Zuspan regimens demonstrated broadly comparable maternal and neonatal outcomes. The principal findings were significant reductions in systolic and diastolic blood pressure and mean arterial pressure in both groups, with no significant difference between the two

regimens in haemodynamic response. In addition, recurrence of eclampsia occurred in only 4% of women in each group, while Apgar score, NICU admission, birth weight and neonatal complications were also comparable between the groups. The reduction in systolic blood pressure observed in the present study was similar in both treatment groups. Systolic blood pressure decreased by approximately 26 mmHg at 2 hours in both the IM and IV groups, and there was no significant difference in the magnitude of reduction between the two regimens. Similarly, diastolic blood pressure and mean arterial pressure decreased significantly following treatment. These findings suggest that the route of magnesium sulphate administration did not substantially influence the short-term haemodynamic response. However, it is important to note that magnesium sulphate is primarily used for seizure prevention and treatment rather than as an antihypertensive drug; therefore, the observed blood-pressure reduction may also reflect concurrent management of severe hypertension and stabilization of the clinical condition. The findings are consistent with previous comparative studies evaluating intramuscular and intravenous magnesium sulphate regimens. A large prospective study comparing the Pritchard regimen with a low-dose intravenous regimen reported no significant difference in recurrence of convulsions, maternal mortality, serious maternal morbidity or perinatal outcomes.[3] Similarly, another randomized comparative study involving 144 women found that low-dose intravenous magnesium sulphate was as effective as the standard Pritchard intramuscular regimen, with no significant difference in seizure recurrence.[5] These observations support the present finding that the two routes provide comparable anticonvulsant efficacy.

In the present study, recurrent eclampsia occurred in 2 women (4%) in both the IM and IV groups, with no statistically significant difference (p=1.000). This finding is clinically important because prevention of recurrent seizures is one of the principal objectives of magnesium sulphate therapy. The recurrence rate observed in our study is comparable to rates reported in previous comparative studies. In a study comparing intramuscular Pritchard therapy with low-dose intravenous magnesium sulphate, recurrence of convulsions occurred in 3.3% of women receiving the IM regimen and 2% receiving the IV regimen, with no significant difference.[3] Likewise, a randomized trial comparing low-dose IV therapy with the standard IM regimen reported seizure recurrence rates of 7.46% and 8.57%, respectively, again without a significant difference.[5] The consistency of these findings suggests that both routes can provide effective seizure control when administered according to established protocols. An important difference between the two regimens in the present study was observed in serum magnesium concentrations. The IM group demonstrated an increase from 4.442 mg/dL at 2 hours to 4.946 mg/dL at 6 hours, whereas the IV group showed relatively stable concentrations, increasing only from 3.328 to 3.374 mg/dL. Thus, the absolute change between 2 and 6 hours was considerably greater with the IM regimen (0.504 mg/dL) than with the IV regimen (0.046 mg/dL). This finding supports the pharmacokinetic advantage of continuous intravenous administration, which can provide more controlled drug delivery. Our findings are consistent with pharmacokinetic observations reported by Salinger et al., who compared intramuscular and intravenous magnesium sulphate regimens among women at risk of eclampsia in India.[13] Their study demonstrated differences in magnesium exposure between the two routes and highlighted the importance of route of administration in achieving and maintaining serum magnesium concentrations. Similarly, a comparative study of low-dose IM and IV magnesium sulphate reported significantly higher serum magnesium concentrations among women receiving the IV regimen, although seizure recurrence and overall maternal outcomes were comparable.[14] These studies support the observation in the present study that the IV regimen provides a relatively stable serum magnesium concentration, whereas the IM regimen may produce greater fluctuations. Despite these pharmacokinetic differences, no magnesium toxicity was observed in either group in the present study. Clinical monitoring included assessment of patellar reflexes, respiratory rate and urine output before maintenance doses. This is consistent with the established safety profile of magnesium sulphate when appropriate clinical monitoring is performed. The WHO recommends continued clinical monitoring during magnesium sulphate treatment and recognizes both full intravenous and intramuscular regimens as acceptable approaches.[12] The mode of delivery also did not differ significantly between the two groups. Caesarean delivery occurred in 62% of women in the IM group and 52% in the IV group, while vaginal delivery occurred in 36% and 44%, respectively. The difference was not statistically significant (p=0.428). This finding is consistent with the understanding that the route of magnesium sulphate administration itself is unlikely to determine the mode of delivery. Rather, the decision for caesarean or vaginal delivery is influenced by gestational age, fetal status, cervical status, severity of maternal disease, obstetric indications and response to stabilization. Neonatal outcomes in the present study were also comparable between the two regimens. Seventy-five percent of neonates had a birth weight below 2.5 kg, but no significant association was observed between birth weight and magnesium sulphate route (p=0.815). An Apgar score below 7 occurred in 28% of neonates in the IM group and 20% in the IV group, although this difference was not statistically significant (p=0.348). NICU admission occurred in 60% and 64% of neonates in the IM and IV groups, respectively, with no significant difference (p=0.680).

These findings are broadly consistent with previous studies. The study by Kanti et al. found no significant

difference in perinatal morbidity or mortality between women treated with intramuscular and intravenous magnesium sulphate regimens.[15] Similarly, the randomized study by Bhattacharya et al. reported comparable maternal and perinatal outcomes between low-dose intravenous and standard intramuscular magnesium sulphate regimens.[5] A study comparing low-dose IM and IV regimens also found that overall maternal and fetal outcomes were comparable, despite differences in serum magnesium concentrations and some clinical indicators of magnesium exposure.[14] The neonatal complications observed in our study were relatively infrequent and did not differ significantly between the treatment groups. Neonatal distress occurred in 13.3% of IM-treated and 15.6% of IV-treated women among NICU-admitted neonates. Neonatal hypotonia was observed in 6.7% and 12.5%, respectively. These differences were not statistically significant. The absence of a significant increase in neonatal complications with either route is reassuring and is in agreement with previous comparative studies reporting broadly similar neonatal outcomes between IM and IV magnesium sulphate regimens.[13,14]

The present findings should also be interpreted in the context of evidence from systematic reviews. A Cochrane review of alternative magnesium sulphate regimens concluded that the evidence comparing different administration regimens remains limited and that the optimal dose and route cannot be established with high certainty.[16] The review included trials comparing intravenous and intramuscular maintenance regimens but emphasized the small sample sizes and methodological limitations of many studies. Therefore, although our findings support comparable clinical efficacy between the Pritchard and Zuspan regimens, they should be considered alongside the broader evidence base rather than interpreted as definitive evidence that one regimen is superior. The WHO currently recommends both full intravenous and intramuscular magnesium sulphate regimens for the prevention and treatment of eclampsia.[12] This recommendation is particularly relevant to resource-limited settings. The intravenous Zuspan regimen provides the practical advantages of controlled administration and relatively stable serum magnesium concentrations, and it avoids repeated painful intramuscular injections. However, it requires infusion pumps, trained personnel and close monitoring. In contrast, the Pritchard regimen can be implemented in settings where continuous infusion facilities are unavailable and therefore remains particularly useful in resource-constrained hospitals. The clinical significance of these practical differences is important.[17] In the present study, both regimens achieved comparable seizure control and maternal and neonatal outcomes, while the IV regimen demonstrated less variation in serum magnesium concentration. Therefore, the choice of regimen may reasonably depend on institutional resources, staff expertise, monitoring capacity and patient-specific considerations. In facilities with reliable infusion pumps and adequate monitoring, the Zuspan regimen may offer advantages in dose titration and maintenance of relatively stable drug exposure. Where such resources are limited, the Pritchard regimen remains an effective and WHO-supported alternative.[12] The strengths of the present study include its prospective comparative design, equal allocation of participants to the two treatment groups, measurement of serum magnesium concentrations at defined time points, and assessment of both maternal and neonatal outcomes. However, several limitations should be considered. The sample size was relatively small, with only 100 participants, limiting the ability to detect small differences in uncommon outcomes such as recurrent seizures, severe magnesium toxicity and maternal mortality. In addition, the study was conducted at a single centre, which may limit generalizability. The study also measured serum magnesium at only two time points, and more frequent pharmacokinetic sampling could have provided a clearer description of peak and trough concentrations. Furthermore, neonatal outcomes may be influenced by gestational age, birth weight, prematurity and severity of maternal disease, which should be considered when interpreting differences between treatment groups.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the study was conducted at a single tertiary-care hospital with a relatively small sample size of 100 participants, which may limit the generalizability of the findings to other populations and healthcare settings. Second, although the study prospectively compared the intramuscular Pritchard and intravenous Zuspan regimens, the relatively short follow-up period primarily assessed immediate maternal and neonatal outcomes and did not evaluate long-term maternal or neonatal effects. Third, the study included women with severe pre-eclampsia and eclampsia, but the relatively small number of women with eclampsia (9%) limits the ability to draw definitive conclusions regarding the effectiveness of the two regimens specifically for prevention of recurrent seizures. Fourth, serum magnesium levels were assessed at selected time points and may not fully represent the pharmacokinetic profile of magnesium sulfate throughout treatment. Fifth, the study was not powered to detect differences in uncommon outcomes such as magnesium toxicity, recurrent eclampsia, maternal mortality, or severe neonatal complications. Finally, potential confounding factors, including differences in disease severity, obstetric management, timing and mode of delivery, and concomitant antihypertensive treatment, may have influenced maternal and neonatal outcomes. Larger, multicentre randomized controlled studies with longer follow-up are therefore warranted to confirm these findings.

CONCLUSION

In this prospective comparative study, both the intramuscular Pritchard regimen and intravenous Zuspan regimen of magnesium sulfate demonstrated comparable effectiveness in women with severe pre-eclampsia and eclampsia. Both groups showed significant reductions in systolic blood pressure, diastolic blood pressure, and mean arterial pressure, with no significant differences between the two treatment groups. Maternal pulse and fetal heart rate remained stable with both regimens, indicating good maternal and fetal tolerance. Serum magnesium levels showed greater variation with the intramuscular regimen, whereas the intravenous regimen maintained relatively stable concentrations during follow-up. Despite this difference, there were no significant differences in recurrent eclampsia, mode of delivery, birth weight, Apgar scores, NICU admission, or neonatal complications. No clinical features of magnesium toxicity were observed in either group. Overall, both Pritchard and Zuspan regimens appear to be effective and safe for seizure prophylaxis and management in severe pre-eclampsia and eclampsia. The choice of regimen may be guided by clinical circumstances, availability of intravenous access, monitoring facilities, and institutional resources.

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