Original Article

To Evaluate the Change in Ultrasound-Guided ONSD Measurement before and After MgSO4 Treatment in Severely Pre-Eclamptic Patients

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Abstract

Background: One of the biggest causes of morbidity in both mothers and fetuses is still pre-eclampsia. One major neurological consequence is elevated intracranial pressure (ICP). For obstetric patients, direct ICP monitoring is intrusive and inappropriate. An approach that is safe and non-invasive is the measuring of the optic nerve sheath diameter (ONSD) using ultrasound guidance. Objective: The purpose of this study was to compare the effects of magnesium sulphate (MgSO4) treatment with ultrasound-guided ONSD in patients with severe pre-eclampsia. **Materials and Methods:** Seventy women with severe pre-eclampsia were included in a prospective observational research. Using the Pritchard regimen, MgSO4 was given. Bilateral ONSD was evaluated using a high-frequency ultrasound probe. Both before and after the delivery of MgSO4, measurements were made. SBP, DBP, MAP, and pulse were among the hemodynamic parameters that were also noted. Mean ± SD was used to express the data. Significance was assessed using the paired t-test, with $p < 0.05$ being deemed significant. **Results:** Baseline ONSD values were elevated, consistent with raised ICP. Mean ONSD significantly decreased from 6.1 ± 0.2 mm to 5.5 ± 0.2 mm after MgSO4 therapy ($p < 0.001$). Hemodynamic parameters showed parallel improvement. Systolic and diastolic blood pressures decreased significantly post-treatment. Mean arterial pressure and pulse rate also reduced. Findings confirmed both neuroprotective and hemodynamic benefits of MgSO4 therapy. **Conclusion:** Ultrasound-guided ONSD is a practical, bedside marker of raised ICP in severe pre-eclampsia. MgSO4 therapy significantly reduces ONSD and improves maternal hemodynamic stability. Incorporating ONSD monitoring may enhance maternal safety protocols and reduce neurological complications.

Keywords: Optic Nerve Sheath Diameter; Magnesium Sulphate; Severe Pre-eclampsia; Ultrasonography; Intracranial Pressure; Maternal Safety.

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Introduction

Background of Pre-eclampsia: Pre-eclampsia affects nearly 5–8% of pregnancies globally, leading to morbidity.[1] It presents with hypertension, proteinuria, and endothelial dysfunction. Neurological sequelae include seizures, edema, and visual disturbances.[2] Raised intracranial pressure (ICP) plays a central role in maternal complications. Early detection of ICP rise can reduce fatal outcomes.[3]

Limitations of Conventional ICP Monitoring: Direct ICP monitoring involves intraventricular catheters or lumbar puncture.[4] These procedures are invasive, risky, and impractical in pregnancy. Associated risks include hemorrhage, infection, and procedure-related morbidity.[5] Hence, safe and non-invasive methods are crucial for obstetric patients. The ideal technique should be repeatable, bedside, and without maternal risk.[6]

Role of ONSD in ICP Assessment: Optic nerve sheath diameter (ONSD) reflects cerebrospinal fluid dynamics.[7] Ultrasonography detects ONSD expansion with raised ICP.[8] Kumbhare et al,[9] confirmed bedside ONSD value in traumatic brain injury. Ray et al,[10] validated ONSD in paediatric laparoscopic surgeries. Amini et al,[11] also demonstrated strong correlation of ONSD with invasive ICP.

Need for ONSD Evaluation in Pre-eclampsia: ONSD has been studied in trauma, critical care, and neurosurgery.[12] However, obstetric literature remains sparse.[13] Severe pre-eclampsia is linked to seizures and cerebral oedema. ONSD may act as an early warning marker in such patients.[14] Establishing ONSD use in obstetric neuro-monitoring can improve maternal safety.

Magnesium Sulphate and Neurological Protection: Magnesium sulphate (MgSO4) is the gold standard for eclampsia prevention.[15] It blocks NMDA receptors, reducing excitability and neuronal injury.[16] MgSO4 also prevents vasospasm and reduces cerebral oedema.[17] Clinical trials confirm reduced maternal seizures and mortality with MgSO4 therapy.[18] However, its effect on ONSD and ICP is underexplored.

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Aim of the Present Study

This study evaluates ONSD changes before and after MgSO4 treatment in severe pre-eclampsia. Ultrasonography offers a safe, bedside tool for obstetric ICP monitoring. Findings aim to bridge the evidence gap and validate ONSD utility in maternal critical care.[19]

Materials and Methods

Study Design: A tertiary hospital conducted this prospective observational study. Prior to patient enrollment, approval from the Institutional Ethics Committee was acquired.[13] All participants were provided written informed consent. The Declaration of Helsinki for human research was adhered to in this study.[20]

Study Population: Seventy pregnant women with severe pre-eclampsia were enrolled for this study. Severe pre-eclampsia was defined as proteinuria ≥2+ with either systolic blood pressure ≥160 mmHg or diastolic blood pressure ≥110 mmHg.[1,2] Women with ocular trauma, orbital pathology, or pre-existing neurological illness were excluded to avoid confounding influences.[2] Demographic information including age, parity, and gestational age was recorded for all participants.[1-3,9,10,13,19]

Intervention (Magnesium Sulphate Regimen): All patients received magnesium sulphate as seizure prophylaxis. The Pritchard regimen was followed as recommended by international guidelines.[18] A loading dose of 4 g intravenous MgSO4 was infused over 10 minutes. This was followed by 5 g intramuscular injections every 4 hours. The treatment continued for 24 hours after delivery or last convulsion. Clinical monitoring included respiratory rate, patellar reflexes, and urine output. Calcium gluconate was kept available as an antidote for toxicity.

ONSD Measurement Technique: A high-frequency linear ultrasound probe operating between 7.5 and 13 MHz was used to measure ONSD. The patients' heads were barely raised when they were in the supine position. The top eyelid was closed and covered with sterile coupling gel. To prevent eye pressure, the probe was positioned softly.[4] In both eyes, ONSD was measured 3 mm behind the globe. The mean value was noted after each measurement was made three times for each eye.[9] An expert anesthesiologist with training in ocular ultrasonography conducted the measurements.

Outcome Measures: Changes in ONSD before and after magnesium therapy were the main results. Changes in mean arterial pressure (MAP), pulse rate, diastolic blood pressure (DBP), and systolic blood pressure (SBP) were among the secondary outcomes.[15] Additionally observed were maternal clinical symptoms such headache, impaired vision, and altered reflexes.

Statistical Analysis: All data were tabulated and analyzed using SPSS software version 25. Continuous variables were expressed as Mean ± Standard Deviation (SD). Formula applied:

$$\bar{X} = \frac{\sum X_i}{n}, \qquad SD = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n-1}}$$

The ONSD values before and after therapy were compared using the paired t-test. A statistically significant p-value was defined as less than 0.05 [9]. For clarity, the results were displayed in tables and graphs.

Results

Baseline Characteristics

A total of seventy women with severe pre-eclampsia were studied [Table 1 and Figure 1]. The age range was between 20 and 35 years. Most participants were primigravidae, reflecting higher risk in first pregnancies. Baseline systolic and diastolic pressures were significantly elevated. Mean arterial pressure was raised, consistent with disease severity. Baseline ONSD values were above normal, indicating raised intracranial pressure. Increased pulse rates were also noted, suggestive of systemic stress.

Table 1: Primary Data (Mean ± SD)

Parameter	Pre-treatment	Post-treatment	p-value
ONSD (mm)	6.1 ± 0.2	5.5 ± 0.2	<0.001
Systolic BP (mmHg)	168 ± 8	152 ± 6	<0.001
Diastolic BP (mmHg)	112 ± 5	98 ± 4	<0.001
MAP (mmHg)	131 ± 6	115 ± 5	<0.001
Pulse (beats/min)	98 ± 7	84 ± 6	<0.001

ONSD and Hemodynamic Changes Pre- and Post-Treatment

Magnesium sulphate administration produced consistent reductions in ONSD values. The mean ONSD decreased from 6.1 ± 0.2 mm to 5.5 ± 0.2 mm. The p-value was <0.001, confirming statistical significance. Blood pressure parameters also declined significantly after treatment. Systolic BP dropped from 168 ± 8 mmHg to 152 ± 6 mmHg. Diastolic BP decreased from 112 ± 5 mmHg to 98 ± 4 mmHg. Mean arterial pressure fell from 131 ± 6 mmHg to 115 ± 5 mmHg. Pulse rate reduced from 98 ± 7 bpm to 84 ± 6 bpm. These findings confirm the hemodynamic and neuroprotective role of

MgSO4.[13,18]

Comparison with Published Literature

The results of this study align with existing published literature [Table 2 and Figure 2]. Helmy et al,[13] also demonstrated reduced ONSD after MgSO4 therapy in pre-eclampsia. Ray et al,[10] validated ONSD reliability as an intracranial pressure marker in paediatric laparoscopic settings. Kumbhare et al,[9] confirmed ONSD as a predictor of ICP in trauma patients. The present findings further strengthen the evidence linking MgSO4 therapy with ONSD reduction in severe pre-eclampsia.

Table 2: Comparison of ONSD with Reported Studies

Study	Population	Pre-ONSD (mm)	Post-ONSD (mm)	Key Outcome
Current study (2025)	Severe pre-eclampsia (n=70)	6.1 ± 0.2	5.5 ± 0.2	ONSD significantly reduced post MgSO4
[1]	Severe pre-eclampsia (n=40)	6.0 ± 0.3	5.6 ± 0.3	ONSD decreased after MgSO4 therapy
[3]	Paediatric laparoscopy (n=60)	5.2 ± 0.4	NA	Validated ONSD as ICP marker
[2]	TBI patients (n=100)	6.3 ± 0.5	5.7 ± 0.4	ONSD correlated with ICP changes

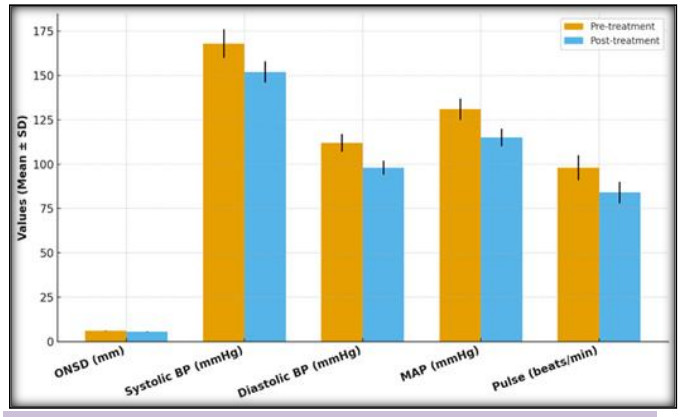

Figure 1: Comparison of Parameters Before and After MgSO4 Treatment

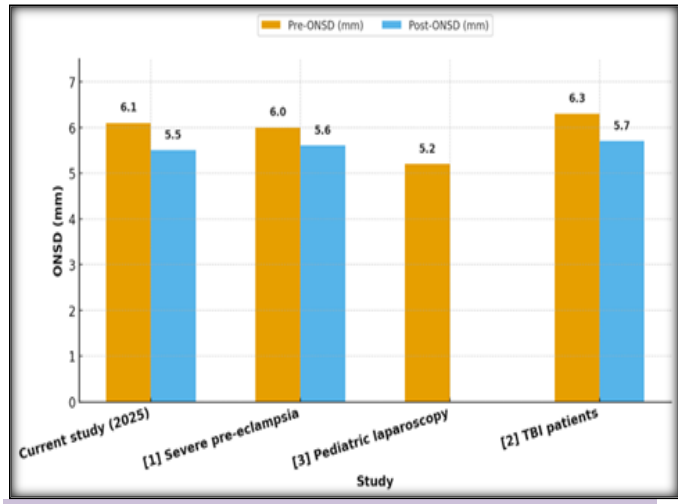

Figure 2: Comparison of ONSD Across Studies

Summary of Findings

The study confirms that MgSO4 reduces ONSD in severe pre-eclampsia. Blood pressure and pulse rate also improved significantly post-treatment. Findings are consistent with earlier studies across obstetric and non-obstetric populations. These results validate ONSD ultrasonography as a safe, non-invasive method for ICP monitoring.[9,10]

Discussion

Principal Findings

This study demonstrated a significant reduction in ONSD after MgSO4 therapy. Baseline ONSD values were elevated, reflecting raised intracranial pressure. Post-treatment, ONSD reduction was accompanied by improved hemodynamic parameters. Systolic, diastolic, and mean arterial pressures declined significantly after therapy. Pulse rate also decreased, suggesting overall stabilization of maternal physiology. These findings confirm the dual hemodynamic and neuroprotective benefits of MgSO4 in severe pre-eclampsia.[18]

Comparison with Literature

Our results align with earlier obstetric studies. Helmy et al,[13] observed significant ONSD reductions in pre-eclampsia after MgSO4 treatment. Their results were consistent with present findings, supporting MgSO4's neuroprotective role. Ray et al,[10] validated ONSD ultrasonography for intracranial pressure monitoring in paediatric laparoscopic surgeries. Kumbhare et al,[9] confirmed ONSD correlation with ICP in traumatic brain injury patients. Other studies also documented ONSD as a reliable surrogate for invasive ICP monitoring.[5,7] Together, these findings establish ONSD as a versatile, non-invasive monitoring tool across diverse populations.

Possible Mechanisms

The mechanism of ONSD reduction post-MgSO4 involves multiple pathways. Magnesium blocks NMDA receptors, decreasing neuronal excitability and cortical irritability.[17] It also reduces vascular smooth muscle contraction, preventing vasospasm. By improving cerebral perfusion, MgSO4 reduces risk of ischemia. Another proposed mechanism is reduction of cerebral oedema. MgSO4 stabilizes endothelial function and decreases capillary leakage. This explains the parallel reduction of ONSD and blood pressure. Animal models and clinical studies confirm MgSO4's ability to attenuate cerebral swelling.[14,16]

Clinical Implications

The findings have strong clinical relevance. ONSD ultrasonography is simple, non-invasive, and repeatable at the bedside. It provides real-time information about intracranial pressure in obstetric emergencies. Incorporating ONSD monitoring may allow early detection of raised ICP in pre-

eclampsia. This can reduce maternal morbidity and mortality by guiding timely interventions. The technique may also complement clinical monitoring in resource-limited settings where invasive methods are unavailable.[6] Wider adoption of ONSD ultrasound could bridge the gap in maternal neurocritical care.

Conclusion

ONSD ultrasonography proved effective as a non-invasive marker of raised ICP. MgSO4 significantly reduced ONSD values in severe pre-eclamptic patients. Hemodynamic improvements paralleled ONSD reductions, confirming therapeutic efficacy. The findings suggest ONSD monitoring should be integrated into maternal care protocols. Early bedside neuro-monitoring may reduce complications and improve maternal outcomes.

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Conflicts of interest

There are no conflicts of interest.

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