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PREDICTION OF EXTUBATION SUCCESS USING OPTIC NERVE SHEATH DIAMETER IN ECLAMPSIA PATIENTS: A PROSPECTIVE OBSERVATIONAL STUDY

Anaesthesiology

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ABSTRACT

Background and Aims: Eclampsia, a severe pregnancy complication, can lead to increased intracranial pressure (ICP) due to cerebral edema, necessitating mechanical ventilation post-lower segment cesarean section (LSCS). Accurate extubation timing is critical in managing such patients, as both early and delayed extubation can pose significant risks. Optic nerve sheath diameter (ONSD) is a non-invasive tool that may help predict extubation success by detecting changes in ICP. This study aims to assess the predictive value of ONSD in determining successful extubation in eclampsia patients requiring mechanical ventilation post-LSCS. **Methods:** A prospective observational study was conducted from May 2023 to April 2024 in the ICU of our institution, enrolling 105 female eclampsia patients aged 18-50 years who underwent LSCS and required mechanical ventilation. Daily ONSD measurements were taken using ultrasound. Extubation criteria included stable cardiovascular and respiratory parameters. Statistical analysis was performed using SPSS, with P-values, mean ± SD, and 95% confidence intervals used to assess the predictive accuracy of ONSD. **Results:** The ONSD threshold for predicting extubation success was identified as 5.6 mm, with a sensitivity of 84.4% and a specificity of 94.37%. The majority of patients (85.7%) were successfully extubated, with 49.5% discharged by Day 2. All deaths (14.3%) occurred in patients who were not extubated. **Conclusion:** ONSD is a reliable non-invasive predictor of extubation success in eclampsia patients. Timely extubation and ONSD monitoring can significantly improve ICU outcomes.

KEYWORDS

Eclampsia; Optic Nerve Sheath Diameter; Extubation; Intracranial Pressure; ICU

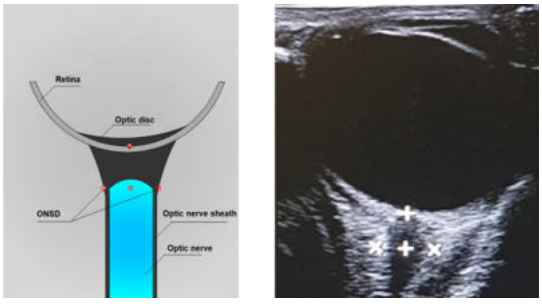
INTRODUCTION

Eclampsia, a severe complication of pregnancy characterized by seizures, can result in significant neurological issues, including increased intracranial pressure (ICP) due to cerebral edema.[1] These critically ill patients often require mechanical ventilation post-lower segment cesarean section (LSCS), and determining the right time for extubation is crucial.[2] Both early and delayed extubation carry risks, such as reintubation, ventilator-associated pneumonia, and prolonged ICU stays. As a result, timely and accurate extubation is key to reducing complications and improving outcomes.[3]

Invasive ICP monitoring, although considered the gold standard, is often impractical due to the associated risks like bleeding and coagulation problems.[4] Other alternatives, such as CT or MRI scans, are not feasible for frequent assessments due to high costs, radiation exposure, and the difficulty of transporting critically ill patients.[5] Non-invasive techniques like fundoscopy for detecting papilledema are limited by delayed diagnosis and inconsistent results. Therefore, the need for a reliable, non-invasive method to predict extubation success in patients with increased ICP is pressing.[6]

One promising tool is ultrasound-guided measurement of the optic nerve sheath diameter (ONSD).[7] The optic nerve sheath, which communicates with the intracranial space, can expand in response to increased ICP, making its diameter a useful indicator of pressure changes.[7,8] Studies suggest that an ONSD above 5.5 mm is strongly linked to elevated ICP, providing a reliable, repeatable, and bedside method of assessing ICP non-invasively.[6,7]

This prospective study aims to evaluate whether ONSD measurement can be used to predict extubation success in eclampsia patients requiring mechanical ventilation post-LSCS. We hypothesise that a reduction in ONSD will correlate with a decrease in ICP, allowing clinicians to identify the optimal time for safe extubation, thus improving patient outcomes and reducing ICU-related complications.



Above figure Shows Optic Nerve Sheath Diameter Ultrasound

MATERIALS AND METHODS

This prospective observational study was conducted in the ICU of our institution from May 2023 to April 2024, following ethics committee approval. A total of 105 female patients, aged 18-50 years, with eclampsia who underwent lower segment cesarean section (LSCS) and required postoperative mechanical ventilation were enrolled. Written informed consent was obtained from the guardian or next of kin.

Study Protocol

Patients received standard ICU care, including mechanical ventilation, fluid therapy, blood transfusions, and medications like magnesium sulphate and antihypertensives. Routine monitoring included ECG,

heart rate, SpO2, systolic, diastolic, and mean arterial pressures. ONSD measurements were taken using ocular ultrasound at ICU admission (day 0) and repeated daily until ICU discharge or death.

Weaning and Extubation Process

Patients were switched to CPAP mode once their condition stabilised. Weaning criteria included a tidal volume >5 mL/kg, respiratory rate <35/min, PaO2 >60 mmHg, and stable cardiovascular function. A 1-hour spontaneous breathing trial (SBT) was conducted using a T-piece. Successful extubation was determined by the patient's ability to maintain adequate breathing and oxygenation without significant respiratory distress. Patients were observed for 48 hours post-extubation to assess success or the need for reintubation.

ONSD Measurement

Bilateral ONSD measurements were performed using a high-frequency linear ultrasound probe (13-6 MHz). The ONSD was measured 3 mm behind the globe, and the average of three readings was recorded for each eye.

Statistical Analysis

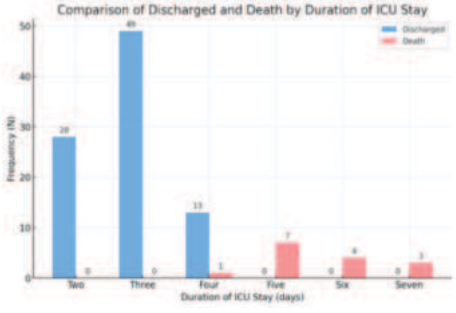
Data were analyzed using SPSS version 28.0. Continuous variables were expressed as mean ± SD, and categorical data as percentages. Chi-squared tests were used for categorical variables, while t-tests were applied to continuous data. ROC analysis was performed to determine the optimal ONSD cut-off for predicting extubation success, with sensitivity, specificity, and predictive values calculated.

RESULTS

Table 1 Socio-Demographic and Parity Characteristics of Study Population

This bar diagram presents the socio-demographic characteristics of the study population, including age groups and parity distribution. The majority of the patients (50.5%) were aged 21-25 years, with a higher frequency of primiparous patients (57.14%).

Table 2 Distribution of Study Subjects According to ICU Stay Duration and Outcomes



This bar diagram highlights the distribution of ICU stay duration and outcomes among the study population. The majority of patients (46.7%) were discharged after a three-day ICU stay, while mortality was highest on the fifth day, with 7 deaths. The data underscores the critical importance of the first three days of ICU stay in predicting patient recovery.

Table 4 Descriptive Statistics of Cardiovascular and Respiratory Parameters by Extubation Day Status

Parameter	Extubated on Day	Mean	SD
Heart Rate	Day 1	119.11	13.059
	Day 2	110.04	9.088
	Day 3	106.40	6.096
	No	104.67	15.055
SpO2	Day 1	98.25	1.898
	Day 2	98.54	1.35
	Day 3	98.60	0.966
	No	95.53	5.668
SBP	Day 1	138.43	15.845
	Day 2	129.77	18.864
	Day 3	138.00	19.322
	No	89.33	10.328
DBP	Day 1	98.54	9.739
	Day 2	112.54	8.079
	Day 3	119.00	8.756
	No	76.40	8.356
MAP	Day 1	105.71	10.732
	Day 2	109.60	11.547
	Day 3	129.40	13.032
	No	63.40	4.778
ONSD (Right Eye)	Day 1	5.33	0.646
	Day 2	5.61	0.227
	Day 3	5.74	0.241
	No	7.45	1.144
ONSD (Left Eye)	Day 1	5.02	0.596
	Day 2	5.39	0.565
	Day 3	5.40	0.230
	No	7.35	0.788

This table provides descriptive statistics of cardiovascular and respiratory parameters based on extubation day status in ICU patients. It includes means, standard deviations, and confidence intervals for heart rate, SpO2, SBP, DBP, MAP, and ONSD measurements.

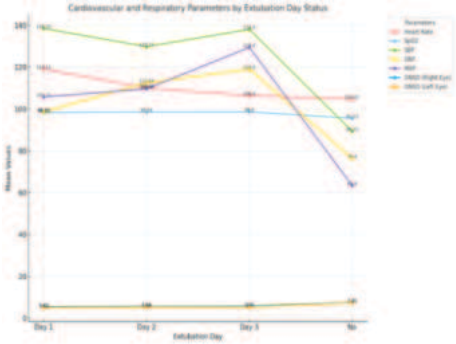


Table 5 Distribution of Outcomes by Extubation Day: Frequencies and Percentage

Outcome	EXTUBATED ON DAY	Counts	% of Total
Discharged	1	28	26.7%
	2	52	49.5%
	3	10	9.5%
	No	0	0.0%
Death	1	0	0.0%
	2	0	0.0%
	3	0	0.0%
	No	15	14.3%

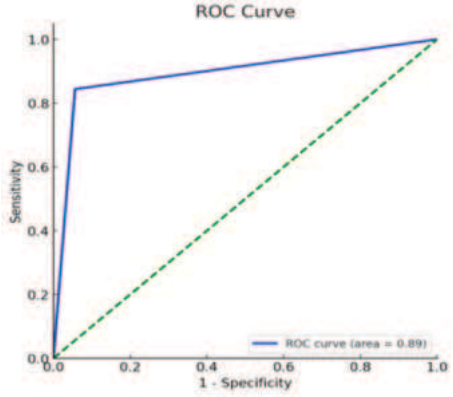
This table presents the distribution of outcomes (discharged and death) by extubation day. The majority of discharges occurred on Day 2, while all deaths were recorded in patients who were not extubated.

Table 6 Predictability of ONSD as a Prognostic Tool

Parameter	Value	95% C.I
Sensitivity	84.40%	83.69%-85.39%
Specificity	94.37%	93.70%-95.31%

Positive Predictive Value	92.42%	91.63%-93.41%
Negative Predictive Value	73.27%	72.73%-74.13%
Likelihood Ratio of Positive Test	13.06	14-16
Likelihood Ratio of Negative Test	0.143	0.012-0.214
ONSD Mortality Predictor Threshold	5.6	

This table indicates the predictive performance of the optic nerve sheath diameter (ONSD) as a prognostic tool. It includes sensitivity, specificity, predictive values, and likelihood ratios, highlighting the ONSD threshold value (5.6) as a mortality predictor.



DISCUSSION

This study evaluated the role of optic nerve sheath diameter (ONSD) as a predictor of extubation success in 105 eclampsia patients post-LSCS in the ICU. Daily ONSD measurements were found to correlate with extubation outcomes, ICU stay duration, and hemodynamic parameters, positioning ONSD as a critical prognostic tool for ICU management.

The study revealed that 50.5% of patients were aged between 21-25 years, with 25.7% in the 26-30 age group, showing eclampsia was more common in younger women. Younger patients, particularly those aged 21-25, had better extubation rates—28.6% by Day 2—while older patients, particularly those aged over 46, struggled with extubation. This finding echoes research by Sabhia Jan et al.[9] (2022), Bala et al.[10] (2019), and Simenc et al.[11] (2018), which similarly found younger eclampsia patients to have quicker recovery and extubation success. Age clearly plays a crucial role in predicting recovery and extubation outcomes in critically ill patients.

Primiparous women made up 57.14% of the study population, while multiparous women constituted 42.85%. This suggests primiparous women were more likely to develop complications requiring ICU admission. Sahu et al.[12] (2020) and Bhide et al.[13] (2022) also found that primiparous women were at higher risk of complications, such as raised intracranial pressure, which aligns with the results of this study.

Most patients (76.2%) were successfully extubated within two days, with a smaller percentage (9.5%) extubated on Day 3. Patients who remained intubated beyond three days had a much higher risk of mortality. Bala et al.[10] (2019) and Simenc et al.[11] (2018) reported similar trends, with early extubation linked to better outcomes and prolonged intubation associated with increased mortality. Mortality rates climbed significantly after the fourth day, emphasizing the importance of effective early ICU management.

Patients successfully extubated in the first three days had more stable hemodynamic parameters. On Day 0, heart rates were highest in those extubated early (119.11 bpm), while non-extubated patients had significantly lower rates. Similarly, systolic and diastolic blood pressures were higher in early extubation cases. Non-extubated patients exhibited higher ONSD values (>5.6 mm) and lower mean arterial pressure (MAP), indicating raised intracranial pressure (ICP). These results are in line with studies by Das et al.[14] (2012) and Dubost et al.[15] (2012), which found elevated ONSD and lower MAP linked to extubation failure.

The study found that 85.7% of patients were discharged, while 14.3% died, reflecting a favorable prognosis but highlighting the severity of the condition in some patients. Maissan et al.[16] (2020) reported a similar discharge rate of around 82%, underscoring the role of early ONSD monitoring in improving outcomes. Chopra et al.[17] (2021) found a 16% mortality rate in neuro-critical patients, closely aligning with this study's findings. Ortega et al.[18] (2020) also noted that elevated ONSD was linked to poorer outcomes, confirming the present study's conclusion that ONSD is a crucial prognostic tool.

The study confirms ONSD's value as a reliable predictor of extubation success and mortality in eclampsia patients. With a sensitivity of 84.40% and specificity of 94.37%, ONSD proves to be a robust tool for identifying patients at risk of adverse outcomes. The findings align with studies by Maissan et al.[16] (2020), Ortega et al.[18] (2020), and Chopra et al.[17] (2021), who similarly highlighted ONSD's importance in critical care settings. The integration of ONSD monitoring alongside BMI, age, and hemodynamic parameters can significantly enhance patient management and improve ICU outcomes.

Strengths

This study utilizes a non-invasive, bedside method (ONSD measurement) to predict extubation success in critically ill eclampsia patients, reducing the risks associated with invasive ICP monitoring. The large sample size and daily monitoring provide a robust dataset, improving the reliability of the findings.

Limitations

The study is conducted in a single institution, limiting the generalizability of the results to other settings. Additionally, factors such as operator-dependent variability in ultrasound measurements and other confounding variables influencing extubation outcomes were not fully explored.

CONCLUSION

This study uncovered key findings on ICU outcomes for eclampsia patients post-LSCS. The majority of patients were young (50.5% aged 21-25) and primiparous (57.14%). Early extubation was closely linked to more stable heart rates, blood pressure, and MAP observed in those successfully extubated. ONSD proved to be a strong predictor of mortality, with a threshold of 5.6 mm demonstrating 84.4% sensitivity and 94.37% specificity. By Day 2, 49.5% of patients had been discharged, while all deaths occurred in those not extubated. These findings underscored the importance of timely extubation, stable vitals, and ONSD monitoring in improving patient outcomes, affirming ONSD's value as a crucial tool in ICU care.

Conflict of Interest: The authors declare no conflicts of interest.
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Consent: Written consent from participants has been obtained and preserved.
Ethical Approval: Ethical approval was obtained and documented as per institutional guidelines.

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