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Distinguishing between Emergence Delirium and Pain in Early Post-Operative Period among Paediatric Patients: A Prospective Observational Study

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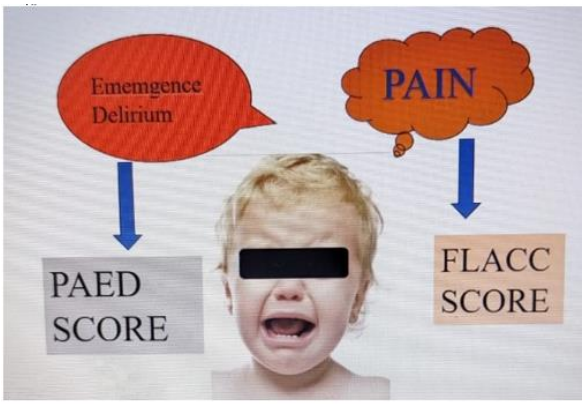
Abstract

Emergence delirium (ED) and postoperative pain are common and significant concerns in paediatric anaesthesia. Both conditions can occur early in the postoperative period and are challenging to distinguish due to overlapping clinical presentations. ED is characterized by confusion, agitation, and disorientation after anaesthesia, often leading to distress in the child and anxiety among caregivers. Postoperative pain can similarly present with agitation and crying, making differentiation critical for effective management. This study aimed to prospectively observe paediatric patients to identify distinguishing characteristics between ED and pain, thereby improving postoperative care and reducing misdiagnosis. This prospective observational study included 100 paediatric patients aged 2 to 6 years. All participants were ASA physical status 1 or 2 and underwent elective surgeries requiring general anaesthesia. Postoperative behaviour was assessed using the PAED score for ED and the FLACC scale for pain. Two trained observers, blinded to the study hypothesis, evaluated the children at multiple time points during and after surgery. The primary outcomes were the incidence of ED and pain, and the relationship between sevoflurane exposure time and these outcomes. The majority of patients (89.375%) exhibited normal postoperative behaviour, while 10.5% experienced ED, and 3.75% experienced pain without ED. A smaller subset (3.5%) experienced both ED and pain. Patients with sevoflurane exposure greater than 100 minutes had a significantly higher risk of ED, with a risk ratio of 4.5 compared to those with less exposure. ED was most prevalent at awakening and rapidly decreased, while pain became more prominent later in the recovery period. While most paediatric patients recover from anaesthesia without issues, a notable group remains at risk for ED, especially with longer sevoflurane exposure.



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Introduction

Emergence delirium (ED) and postoperative pain are significant concerns in pediatric anesthesia, with both conditions frequently occurring in the early postoperative period. The ability to accurately distinguish between these two phenomena is crucial for ensuring appropriate and effective management of pediatric patients [1]. Emergence delirium is characterized by a sudden onset of confusion, agitation, and disorientation following anesthesia, often leading to self-harm and distress in the child as well as anxiety among caregivers. Postoperative pain, on the other hand, can similarly manifest with agitation and crying, making the differentiation between pain and ED challenging for clinicians [2].

Emergence delirium was first described in the pediatric population in the 1960s and has since become a recognized complication following general anesthesia, particularly in younger children. The incidence of ED in pediatric patients varies widely, and it has been reported to range from 2% to 80%, depending on the anesthetic agents used and the method of assessment [3]. ED typically presents within the first 30 minutes following anesthesia, characterized by restlessness, crying, and a lack of response to soothing. Conversely, postoperative pain is a well-documented experience in children following surgery, necessitating prompt and accurate assessment to ensure pain is managed effectively [4].

The overlap in clinical presentation between ED and postoperative pain complicates the task of distinguishing between the two, leading to potential undertreatment or overtreatment. For example, a child with ED might be mistakenly treated for pain, leading to unnecessary administration of analgesics, while a child experiencing severe pain might be misdiagnosed with ED and receive inappropriate treatment [5].

Given the significant overlap in the clinical manifestations of ED and postoperative pain, there is a critical need for reliable tools and methods to differentiate between these two conditions in pediatric patients [6]. The study aims to enhance postoperative care in pediatric patients by distinguishing between emergency department (ED) visits and pain through improved diagnostic protocols. Research indicates that current pain assessment tools, such as the Pain Threshold Index (PTI), show limited predictive accuracy for postoperative pain in children, particularly when used in isolation. However, combining PTI with demographic and physiological factors can enhance predictive accuracy, especially in older children [7]. Additionally, the development of artificial intelligence tools to analyze facial expressions may further refine pain assessment, addressing the challenges of subjective reporting in pediatric populations [8]. Furthermore, the choice of anesthetic type influences postoperative pain levels, with regional anesthesia associated with lower pain scores compared to general anesthesia [9]. These findings underscore the need for comprehensive assessment protocols that integrate clinical indicators and innovative technologies to improve diagnostic accuracy and patient outcomes in pediatric anesthesia practice [10,11].

Materials and Methods

This study was conducted in Saveetha Medical College and Hospital, Chennai after obtaining Institutional Ethical Committee clearance. In this study, 100 paediatric patients aged 2 to 6 years, weighing between 10 to 30 kg, and classified as ASA physical status 1 or 2, were enrolled following parental consent. The study was a prospective observational design utilizing simple random sampling. The inclusion criteria included children within the specified age group undergoing elective surgeries requiring general anaesthesia, of both genders, and with ASA grading 1 and 2. Exclusion criteria involved emergency cases, polytrauma, congenital deficiencies or difficult

airway anatomy, ASA status above 2, moderate or severe obstructive sleep apnoea, concurrent treatment with analgesics or anticonvulsants, and any form of developmental delay.

On the day of surgery after confirming adequate NPO patient was shifted to the Operation theatre, Standard ASA monitors were connected, and peripheral venous access was obtained and secured. Anaesthesia was induced with sevoflurane (2–5%), and prior to tracheal intubation, injection fentanyl (1.5–2 mcg/kg) was administered. The appropriate endotracheal tube was selected, Gentle laryngoscopy followed by intubation was performed and tube position confirmed with 5 point auscultation and End tidal CO2 wave forms . Anaesthesia was maintained with sevoflurane (2–3%) and additional fentanyl boluses as required was administered. Prophylaxis for postoperative nausea and vomiting was provided with dexamethasone (0.15 mg/kg) and ondansetron (0.15 mg/kg), and all children received intravenous paracetamol (15 mg/kg) intraoperatively.

Two trained observers, blinded to the study hypothesis and uninvolved in clinical management, concurrently evaluated each child's behavior using the PAED and FLACC scales at multiple time points: during extubation, at 5 minutes in the operating theater, at 10 minutes during transport to the recovery room, and at 15 minutes upon arrival in the recovery room. Each observer randomly applied either the PAED or FLACC scale to a single patient, recording the worst score for each variable within the specified time frames.

Postoperative negative behavior (e-PONB) was defined as the occurrence of either emergence delirium (ED) or pain during any observation period, with pain being defined as a FLACC score ≥4 and ED as a PAED score ≥10. In the recovery room, assessments were conducted during the first 5 minutes after arrival. The PAED scale was further analyzed by dividing it into components reflecting consciousness and cognition (ED1) versus non-specific behaviors (ED2). Surgical time, sevoflurane exposure time, extubation time, and discharge time from the post-anesthesia care unit were recorded. Additional scales, including the CHIPPS, CHEOPS, and WATCHA scales, were utilized to further assess postoperative negative behaviors in pediatric patients.

The data was analyzed, and the results were expressed in percentages to determine whether PONB was primarily due to ED or pain using SPSS version 22.0.

Results

The study included 100 participants with an average age of 3.94 years, indicating that the study population predominantly consisted of very young children. The gender distribution was relatively balanced, with 54% of the participants being male and 46% female. Additionally, the mean exposure to sevoflurane, a common anaesthetic agent, was 92.61 minutes, with a standard deviation of 20.74 minutes.

Table 1. Baseline Characteristics

Parameter	**Total no of participants**
Age (Average)	3.94
Gender	
Male	54%
Female	46%
Sevoflurane exposure (Mean +/-SD)	92.61+/- 20.74

The bar chart in Figure 1 illustrates the distribution of post-operative behaviors among pediatric patients, revealing that a vast majority (89.375%) exhibited normal behavior following surgery, indicating that most children did not experience significant emergence delirium (ED) or pain. However, 10.5% of patients experienced only emergence delirium, making it a notable concern in this population. A smaller proportion (3.75%) suffered from only pain without any signs of ED, while 3.5% of patients exhibited both ED and pain simultaneously, suggesting a more complex post-operative recovery that necessitates careful management.

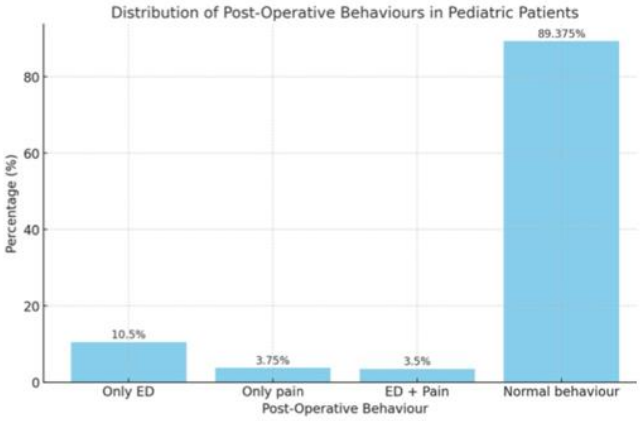

Figure 1. Distribution of Post-operative Behaviours in Pediatric Patients

The figure 2 illustrates the relationship between sevoflurane exposure time and the risk of emergence delirium (ED) in pediatric patients, revealing that longer exposure times are associated with a significantly higher risk of ED. Specifically, among patients with sevoflurane exposure greater than 100 minutes, 60% experienced ED, compared to only 13.3% in those exposed for less than 100 minutes. This results in a calculated risk ratio (RR) of 4.5, indicating that the likelihood of developing ED is 4.5 times higher in patients with prolonged exposure.

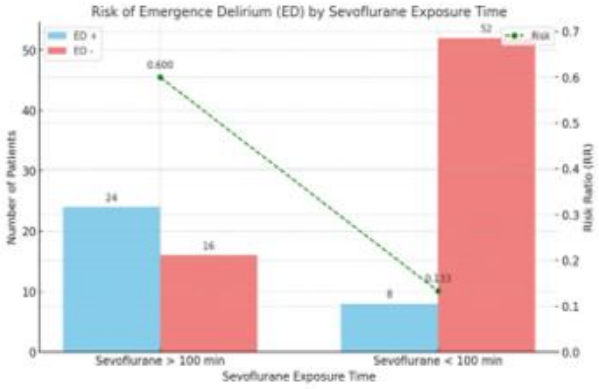

Figure 2. Risk of ED by Sevoflurane Exposure Time

At the moment of awakening, a significant proportion of patients 31% exhibited ED, as indicated by a PAED score of ≥10. However, the incidence of ED sharply decreased, with only 1% of patients showing ED at 5 minutes, and none at 10 or 15 minutes. In contrast, the onset of pain, as indicated by a FLACC score of ≥4, was much lower at awakening (2%) but gradually increased over time, with 4% of patients experiencing pain at 5 minutes, 3% at 10 minutes, and 5% at 15 minutes as shown in figure 3. This pattern suggests that ED is more

likely to occur immediately upon awakening, while pain tends to develop more gradually and may become more prevalent as time progresses post-awakening.

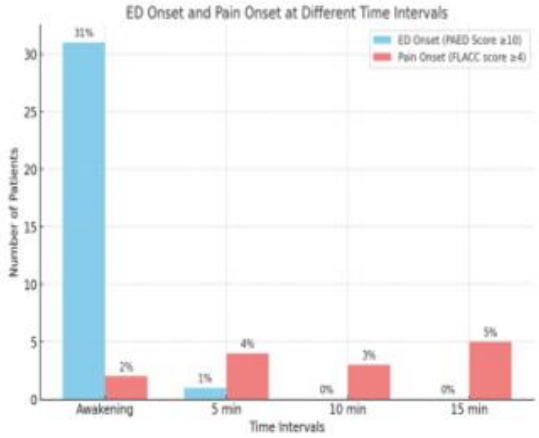

Figure 3. ED Onset and Pain Onset at Different Time Intervals

Figure 4 is a biplot from a factor analysis, showing how different variables relate to two main factors, F1 and F2. The axes represent these factors, with F1 explaining 66.95% of the variation in the data and F2 explaining 22.74%, accounting for 89.69% of the total variance. The red lines indicate how each variable, such as "Crying," "Inconsolability," "Abnormal facial expression," "Restlessness," and "Purposeful actions," correlates with these factors. The position of each variable on the plot shows its relationship to the factors. For instance, "No awareness of surroundings" and "No eye contact" are strongly linked to Factor 2, while behaviors like "Crying" and "Inconsolability" are more closely related to Factor 1.

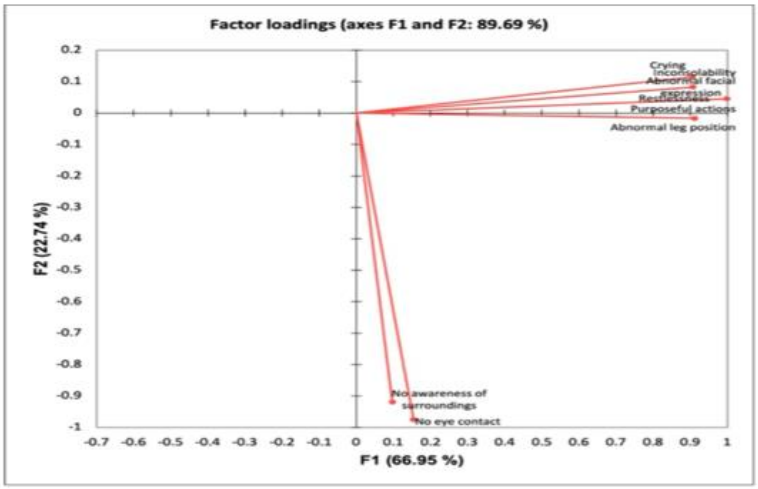

Figure 4. Factor Analyses

Discussion

The findings of this study provide important insights into the incidence and risk factors associated with emergence delirium (ED) and pain in pediatric patients following anesthesia. The results align with, and also contrast from, findings reported in previous studies, providing a nuanced understanding of these postoperative phenomena.

One of the most notable findings is the high prevalence of normal postoperative behavior in the study cohort, with 89.375% of patients not experiencing significant ED or pain. This is consistent with the findings of Aouad et al.

(2007), who reported that the majority of pediatric patients emerge from anesthesia without significant complications when appropriate anesthetic techniques are employed [12]. However, the 10.5% incidence of ED observed in this study highlights that a notable minority of pediatric patients are still at risk, even with current anesthesia practices. This is slightly higher than the 5-10% incidence reported by Sikich and Lerman (2004), suggesting that factors such as the type of surgical procedure or the duration of anesthesia might play a role in increasing this risk [13].

The study's results further underscore the significant impact of sevoflurane exposure time on the development of ED. The finding that a sevoflurane exposure time greater than 100 minutes increases the risk of ED by 4.5 times is in line with previous research by Chandler et al. (2008) [14], who found that prolonged exposure to volatile anesthetics is a key risk factor for ED. This observation supports the recommendation that anesthesiologists should minimize sevoflurane exposure duration whenever possible to reduce the risk of ED. In contrast, studies such as that by Dahmani et al. (2010) have suggested that the choice of anesthetic agent, rather than the duration of exposure, maybe more critical in managing ED risk [15]. However, the present study reinforces the importance of exposure time as a significant factor.

The timing of ED onset also provides valuable insights. As observed in this study, the sharp decline in ED incidence within the first 5 minutes post-awakening is consistent with the pattern described by Moore et al. (2010), who noted that ED is typically an early postoperative event that resolves quickly. This suggests that immediate postoperative management is crucial in mitigating the effects of ED [16]. On the other hand, the gradual increase in pain incidence over the first 15 minutes post-awakening suggests that pain management strategies should be carefully tailored to address this delayed onset, which is often overshadowed by the more immediate concerns of ED. The factor analysis in the current study highlights the distinct behavioural indicators associated with emergency department (ED) outcomes, particularly in paediatric patients experiencing pain and emotional distress (ED). The findings align with Mason's (2011) conceptual model, which advocates for differentiating between ED and pain-related behaviours. Specifically, behaviours such as "No awareness of surroundings" and "No eye contact" were linked to emotional distress, while "Crying" and "Inconsolability" were associated with pain responses. [17] This distinction underscores the necessity for comprehensive assessment tools that capture the multifaceted nature of these complications. Additionally, the study by Semkovych (2023) supports the notion that acute pain significantly influences behavioural outcomes, emphasizing the need for effective pain management strategies [18]. Overall, integrating these insights can enhance clinical practices by fostering a more nuanced understanding of paediatric pain and emotional responses in the ED setting [19]. One limitation of this study is the relatively small sample size of 100 participants, which may not fully capture the variability in postoperative behaviors across a broader pediatric population. Additionally, the study was limited to a single anesthetic agent, sevoflurane, without considering the potential influence of other agents or combinations that might impact the incidence of emergence delirium (ED) and pain. The observational design also limits the ability to establish causal relationships between sevoflurane exposure and the outcomes observed. Future research should focus on larger multi-center studies that include diverse anesthetic protocols to validate these findings.

Exploring the genetic, psychological, and environmental factors contributing to postoperative pain in paediatric patients is crucial for developing personalized management strategies. Research indicates that

children experience postoperative pain differently than adults, necessitating tailored approaches based on age, surgery type, and pain severity [20]. Genetic factors, while less understood in children, may play a role in chronic postsurgical pain, although current evidence suggests their influence is minor.

Conclusion

Postoperative negative behaviour is quite common among paediatric patients, although it usually lasts for a short period. Several factors can contribute to this, including the use of sevoflurane anaesthesia, which was a focus of our study. We assessed the presence of emergency delirium (ED) and pain using the PAED score and FLACC scale. Our findings showed that ED was more frequently observed than pain, contributing significantly to postoperative negative behavior. However, it's important to note that most children displayed normal behavior after surgery, with fewer instances of ED and pain.

In conclusion, while the majority of paediatric patients recover from anaesthesia without issues, a notable group is still at risk for ED, especially with longer exposure to sevoflurane. These results highlight the importance of careful monitoring and personalized care in the immediate postoperative period. Future research should continue to explore the underlying factors contributing to these outcomes and focus on refining anaesthetic practices to reduce the incidence of ED and pain.

Conflict of Interest

The authors declare that there is no conflict of interest.

Acknowledgments

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