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Original Research Article

Effect of Dexmedetomidine *vs.* Ketamine Premedication on Quality of Induction of Anaesthesia in Pediatric Patients

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Abstract:

Background: Preoperative anxiety is a significant challenge in pediatric anaesthesia, potentially leading to difficult induction, adverse physiological responses, and postoperative behavioral changes. Pharmacological premedication is frequently employed to facilitate smooth separation from parents and acceptance of the anaesthetic mask.

Objectives: The primary objective of this study was to compare the efficacy of Intranasal Dexmedetomidine versus Oral Ketamine as premedication agents regarding the quality of induction and parental separation in pediatric patients. Secondary objectives included evaluating hemodynamic stability, sedation levels, and the incidence of adverse effects.

Methods: A prospective observational study was conducted at the Department of Anaesthesiology, Patna Medical College and Hospital (PMCH), Patna. The study included 93 pediatric patients (ASA I and II), aged 2–8 years, undergoing elective surgeries. Patients received either Intranasal Dexmedetomidine (*1 µg/kg*) (Group D) or Oral Ketamine (*5 mg/kg*) (Group K) based on the attending anaesthesiologist's discretion 45 minutes prior to induction. The primary outcomes were the quality of parental separation (assessed by the Parental Separation Anxiety Scale - PSAS) and the quality of induction (assessed by the Mask Acceptance Scale - MAS). Secondary outcomes included hemodynamic stability and sedation levels.

Results: Demographic profiles were comparable between the groups. Group D (Dexmedetomidine) demonstrated significantly better parental separation scores (PSAS score 1 in 76.6% vs. 52.2% in Group K; $p < 0.05$). Similarly, satisfactory mask acceptance (MAS score 1 or 2) was higher in Group D compared to Group K. While Group K provided adequate sedation, it was associated with a higher incidence of secretions and tachycardia. Group D patients exhibited lower heart rates but remained within physiological limits.

Conclusion: Intranasal Dexmedetomidine provided superior conditions for parental separation and mask induction compared to Oral Ketamine, with a more favorable side-effect profile, making it a preferable non-invasive premedication option in pediatric anaesthesia.

Introduction

The induction of general anaesthesia represents one of the most critical and potentially distressing phases of the perioperative period for pediatric patients. It is well-documented that approximately 40% to 60% of children experience significant preoperative anxiety, which can manifest as agitation, crying, and active resistance during separation from parents and subsequent mask application [1]. If left unmanaged, this heightened state of anxiety triggers a profound stress response characterized by elevated catecholamine levels, tachycardia, and hypertension. Furthermore, a traumatic induction is not merely an immediate procedural challenge but is strongly correlated with maladaptive postoperative behaviors. These can include emergence delirium, nightmares, separation anxiety, and eating disturbances that may persist for weeks or even months after the surgery is completed [2]. Therefore, ensuring a calm and atraumatic induction is a priority in modern pediatric anaesthesia.

To mitigate these adverse physiological and psychological responses, anaesthesiologists employ a variety of non-pharmacological and pharmacological strategies. Ideally, a pediatric premedicant should possess a reliable onset of

action, facilitate smooth parental separation, allow for cooperative mask acceptance, and possess a wide safety margin without compromising respiratory drive [3]. While various agents such as midazolam and clonidine have been used, the search for the "ideal" premedicant continues.

Ketamine as a Premedicant: Ketamine, a phencyclidine derivative, has been a cornerstone of pediatric sedation for decades. It acts as a non-competitive N-methyl-D-aspartate (NMDA) receptor antagonist, creating a unique state known as "dissociative anaesthesia." This state is characterized by profound sedation, amnesia, and analgesia while notably preserving spontaneous respiration and airway reflexes. Traditionally, oral ketamine administered at a dose of 5–6 mg/kg has been a popular choice due to its ease of administration and relatively predictable onset. However, its utility is often limited by a spectrum of adverse effects, including excessive salivation (sialorrhea), psychotomimetic effects such as hallucinations, increased intracranial pressure, and a higher incidence of postoperative nausea and vomiting (PONV) [4].

Dexmedetomidine as a Premedicant: In recent years, Dexmedetomidine has emerged as a promising alternative. It is a highly selective α_2 adrenergic agonist with a selectivity ratio of 1620:1 for α_2 versus α_1 receptor. It produces sedation, anxiolysis, and analgesia by acting on the locus coeruleus in the brainstem. This mechanism produces a unique "cooperative sedation" that closely mimics natural non-REM sleep, allowing the child to be aroused if necessary. Unlike other sedatives that may depress the respiratory drive, dexmedetomidine preserves it, making it particularly attractive for pediatric use. The intranasal route for dexmedetomidine has gained significant popularity as it avoids the pain and fear associated with intramuscular injection and demonstrates a high bioavailability of approximately 65–82% [5]. Furthermore, recent reviews highlight that intranasal dexmedetomidine offers a novel avenue for needle-free premedication that is highly acceptable to both parents and children [6].

Rationale for the Study: While both Ketamine and Dexmedetomidine are widely used in clinical practice, there is conflicting evidence regarding which agent provides the superior "quality of induction" specifically defined by the child's behavior during mask application. Furthermore, there is a paucity of data comparing these specific formulations (Intranasal Dexmedetomidine versus Oral Ketamine) within the specific demographic context of Eastern India. This study was therefore undertaken at Patna Medical College and Hospital (PMCH) to prospectively observe and compare the efficacy and safety profile of these two common premedication regimens in a tertiary care setting.

Material and Methods

Study Design and Setting: This research was designed as a prospective, hospital-based, observational study and was carried out in the Department of Anaesthesiology at Patna Medical College and Hospital (PMCH), Patna.

Study Duration: The data collection for this study spanned a period of 9 months, commencing in February 2025 and concluding in October 2025.

Study Population: The study population was carefully selected to include pediatric patients scheduled for elective surgeries, specifically focusing on infra-umbilical, general, or plastic surgical procedures. The inclusion criteria were defined to recruit children aged between 2 and 8 years who fell into the American Society of Anesthesiologists (ASA) Physical Status I or II categories. Conversely, strict exclusion criteria were applied to ensure patient safety and data integrity. Children with a history of recent upper respiratory tract infection (URTI), anticipated difficult airway, or known allergies to α_2 agonists or ketamine were excluded. Furthermore, patients with cardiac conduction abnormalities, such as heart block, or those with significant neurological or psychiatric disorders that would prevent accurate behavioral assessment were also omitted from the study.

Sample Size: The sample size calculation was based on previous literature comparing sedation scores between similar groups. Assuming a difference in satisfactory sedation rates of approximately 20% between the two agents, and setting an alpha error of 0.05 with a power of 80%, a total sample size of 93 patients was determined to be necessary for the study.

Methodology and Grouping: As this was an observational study, the investigators did not influence the choice of premedication. Instead, the drug administered was determined by the attending anaesthesiologist based on their clinical judgment and standard institutional protocols. Patients were subsequently categorized into two distinct groups for analysis. Group D consisted of 47 patients who received Intranasal Dexmedetomidine at a dose of 1 µg/kg, administered via a mucosal atomization device or drops approximately 45 minutes prior to the planned induction. Group K comprised 46 patients who received Oral Ketamine at a dose of 5 mg/kg, which was mixed with a small amount of honey or syrup to mask the bitter taste, also administered 45 minutes before induction.

Monitoring and Assessment: Upon arrival in the preoperative holding area, baseline physiological parameters including heart rate (HR), mean arterial

pressure (MAP), and oxygen saturation (SpO_2) were recorded for all patients. The efficacy of the premedication was evaluated at two critical time points. First, the level of sedation was assessed at the time of separation from parents, approximately 45 minutes post-premedication, using the Ramsay Sedation Scale (RSS). At this same juncture, the ease of separating the child from the parents was graded using the 4-point Parental Separation Anxiety Scale (PSAS). Subsequently, upon entering the operating room, the quality of induction was assessed during the application of the face mask for pre-oxygenation or inhalation induction using the Mask Acceptance Scale (MAS).

Anaesthesia Protocol: The standard anaesthetic induction protocol involved the use of Sevoflurane (up to 8%) in a mixture of Oxygen and Nitrous Oxide. Intravenous access was typically secured only after the loss of consciousness to minimize pain and distress. Throughout the procedure, vital signs including HR, NIBP, SpO_2, ECG, and $EtCO_2$ were continuously monitored. Any adverse events occurring during the perioperative period, such as bradycardia (HR < 60 bpm), significant hypotension (>20% fall from baseline), desaturation (SpO_2 < 92%), or excessive secretions, were meticulously documented.

Statistical Analysis: All collected data were compiled and analyzed using SPSS software version 26.0. Continuous variables such as age, weight, and hemodynamic parameters were expressed as Mean ± Standard Deviation (SD) and compared using the student's t-test. Categorical variables, including sex, ASA grade, sedation scores, and MAS grades, were analyzed using the Chi-square test or Fisher's Exact test as appropriate. A p-value of less than 0.05 was considered statistically significant.

Results

Demographic Data: A total of 93 patients were included in the final analysis, with 47 patients in Group D and 46 in Group K. The statistical analysis of demographic variables revealed no significant differences between the two groups. Parameters such as age, weight, gender distribution, and ASA status were comparable ($p > 0.05$), ensuring that the groups were well-matched at baseline and minimizing selection bias.

Table 1 Demographic Profile of Patients

Parameter	Group D (Dexmedetomidine) (n=47)	Group K (Ketamine) (n=46)	p-value
Age (years)	5.2 ± 1.8	4.9 ± 2.1	0.46 (NS)
Weight (kg)	18.4 ± 4.2	17.8 ± 3.9	0.51 (NS)
Sex (M/F)	28 / 19	25 / 21	0.68 (NS)
ASA (I/II)	40 / 7	38 / 8	0.75 (NS)

(NS = Not Significant)

Sedation and Parental Separation: The clinical assessment of sedation and separation anxiety highlighted distinct differences between the groups. Group D demonstrated significantly smoother separation from parents. Specifically, 76.6% of patients in Group D achieved a PSAS score of 1 (Excellent), compared to only 52.2% in Group K. Conversely, poor separation (Score 4) was observed in only 1 patient in Group D versus 4 patients in Group K. This difference was statistically significant ($p < 0.05$), suggesting superior anxiolysis with dexmedetomidine.

Table 2 Comparison of Parental Separation Anxiety Scale (PSAS) Scores

PSAS Score	Description	Group D (n=47)	Group K (n=46)	p-value
1	Excellent (Unafraid, cooperative)	36 (76.6%)	24 (52.2%)	< 0.05
2	Good (Slight fear, quiet with reassurance)	8 (17.0%)	12 (26.1%)	
3	Fair (Moderate fear, not quiet)	2 (4.3%)	6 (13.0%)	
4	Poor (Crying, need restraint)	1 (2.1%)	4 (8.7%)	

Quality of Induction (Mask Acceptance): The primary outcome of the study, mask acceptance, was evaluated using the Mask Acceptance Scale (MAS). Group D demonstrated superior cooperation during mask placement. Satisfactory induction, defined as a MAS score of 1 or 2, was achieved in 89.4% of patients in Group D compared to 69.6% in Group K. Furthermore, Group K had a higher incidence of unsatisfactory induction (MAS 3 & 4), characterized by combativeness and crying (30.4%), compared to Group D (10.6%).

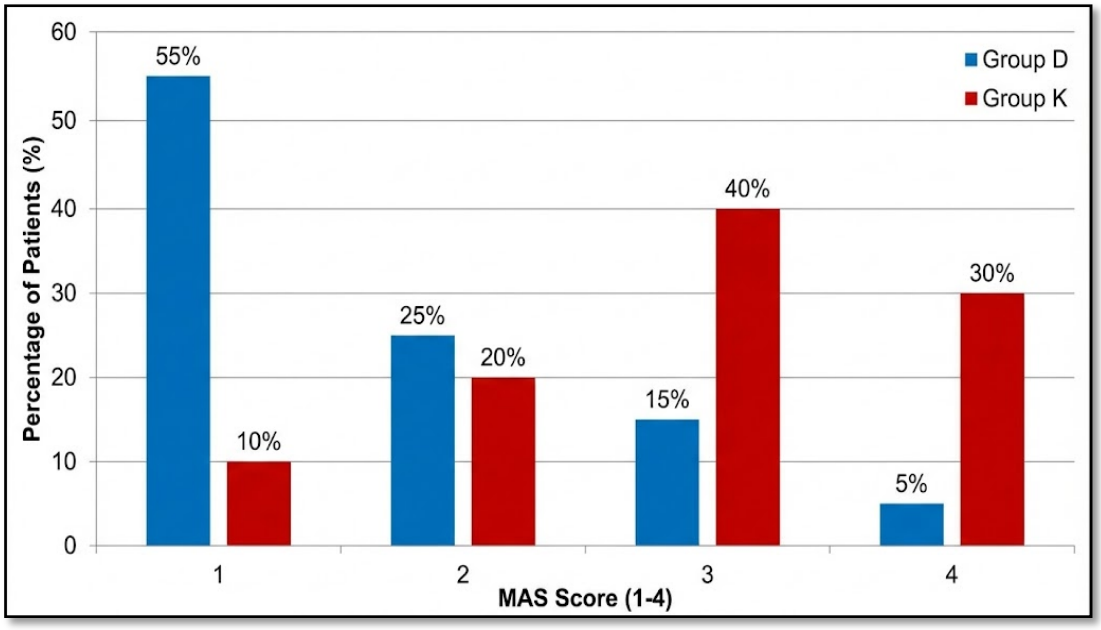

Figure 1: **Comparison of Mask Acceptance Scale Scores**

Hemodynamic Parameters: Hemodynamic trends revealed distinct pharmacological profiles for each drug. Group D showed a gradual decrease in mean heart rate from baseline, stabilizing at levels 10-15% lower than baseline but within safe physiological limits. In contrast, Group K showed an increase in heart rate (10-20% above baseline) following premedication. Mean Arterial Pressure (MAP) remained stable in both groups, and no cases of severe hypotension requiring intervention were noted in Group D.

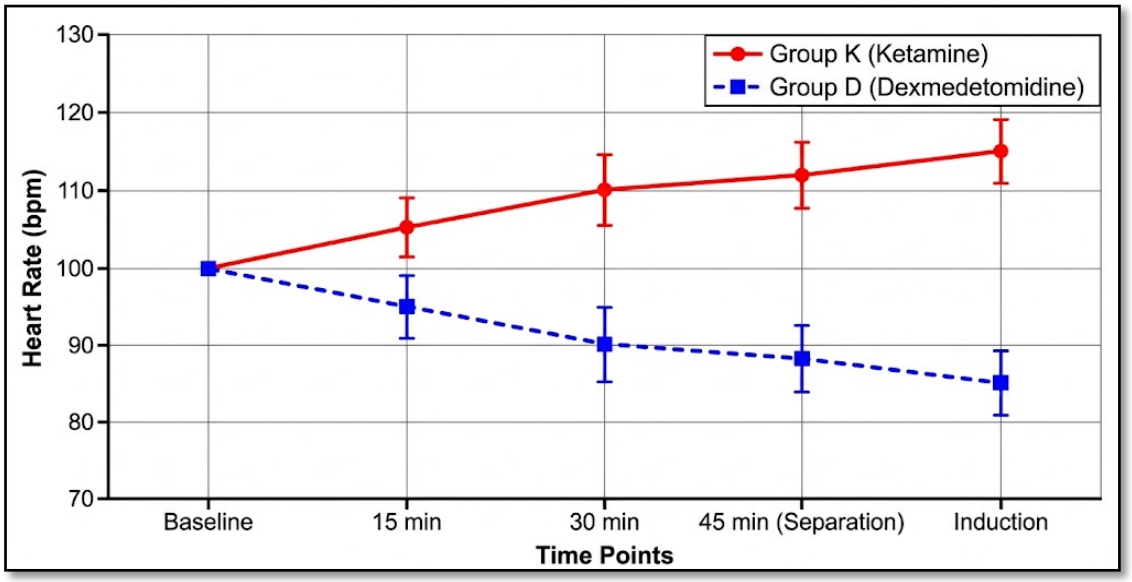

Figure 2: **Trends in Heart Rate (bpm) from Baseline to Induction**

Adverse Events: The safety profile also differed between the two agents. Excessive salivation was a notable issue in the Ketamine group, occurring in 13% of patients despite the occasional use of atropine. In contrast, Group D had zero cases of excessive secretions ($p < 0.05$). Transient bradycardia was observed in 3 patients in Group D but did not require atropine; it resolved with surgical stimulus. Postoperative nausea was more frequent in Group K.

Table 3: **Incidence of Adverse Events**

Adverse Event	Group D (n=47)	Group K (n=46)	p-value
Excessive Secretions	0 (0%)	6 (13.0%)	< 0.05
Bradycardia	3 (6.4%)	0 (0%)	> 0.05
Postoperative Nausea	1 (2.1%)	4 (8.7%)	> 0.05
Desaturation ($SpO_2 < 92\%$)	0 (0%)	1 (2.2%)	> 0.05

Discussion

The present prospective observational study conducted at PMCH, Patna, compared the efficacy of Intranasal Dexmedetomidine and Oral Ketamine as premedicants in pediatric surgery. The results indicate that Intranasal Dexmedetomidine (1 µg/kg) provides superior conditions for parental separation and mask induction compared to Oral Ketamine (5 mg/kg), with a better profile of hemodynamic stability and fewer secretions.

Sedation and Separation Anxiety: Our findings align with the growing body of literature supporting the use of α_2 agonists in pediatric anaesthesia. The significantly higher proportion of "Excellent" PSAS scores in the Dexmedetomidine group (76.6%) can be directly attributed to its unique mechanism of action on the locus coeruleus. Dexmedetomidine induces a state of "arousable sedation," where the child appears asleep but can be gently roused to cooperate, mimicking natural sleep patterns [7]. This is in sharp contrast to Ketamine, which induces a dissociative state. While Ketamine is generally effective, its oral bioavailability is notoriously variable due to significant first-pass metabolism. This pharmacokinetic variability likely explains the inconsistent sedation levels observed in Group K in our study, where a larger portion of children remained anxious or tearful during separation.

Comparing these results to similar studies strengthens our conclusions. Zanaty et al. (2022) reported adequate separation in 80% of children receiving nebulized dexmedetomidine, a figure that correlates closely with our findings [8]. Similarly, Mohammed et al. noted that while intranasal ketamine provides a rapid onset, intranasal dexmedetomidine demonstrated superior sedation scores and hemodynamic stability, contributing to a smoother parental separation [9]. This is further supported by Arun et al., who found that although ketamine provided deeper sedation levels at certain intervals, dexmedetomidine was associated with a significantly lower incidence of emergence delirium and postoperative vomiting, contributing to a smoother overall perioperative profile [10].

Quality of Induction (Mask Acceptance): Mask acceptance is a critical metric for the pediatric anaesthesiologist, as a struggling child during induction requires higher concentrations of volatile anaesthetics and is at a higher risk for laryngospasm and other airway complications. In this study, Group D showed significantly better MAS scores. This finding is consistent with the work of Yuen et al., who established intranasal dexmedetomidine as a potential gold standard for non-invasive premedication [11]. The "cooperative" nature of dexmedetomidine sedation allows children to accept the mask without the combativeness often seen with the "hallucinogenic" side effects of ketamine. Even when children in the dexmedetomidine group were awake, they were generally calm and compliant, whereas awake children in the ketamine group were more likely to be agitated or disoriented, as described by Akin et al. [12].

Hemodynamic Stability: The hemodynamic profiles observed were predictable based on the known pharmacology of the drugs. Ketamine acts as a sympathomimetic by inhibiting the reuptake of catecholamines, which naturally leads to the tachycardia and hypertension observed in Group K. While this cardiovascular stimulation is generally well-tolerated in healthy children, it may be disadvantageous in patients with certain cardiac conditions or those where tachycardia is undesirable. Dexmedetomidine, conversely, is sympatholytic. The reduction in heart rate observed in Group D is a known physiological effect of α_2 agonism. Importantly, no patient in our study developed profound bradycardia or hypotension requiring pharmacological rescue, suggesting that the 1 µg/kg dose is hemodynamically safe for this demographic, a conclusion also supported by the meta-analysis of Angelopoulou et al. [13].

Comparison of Route of Administration: The study compared Intranasal (Group D) versus Oral (Group K) administration. The intranasal route bypasses first-pass metabolism and allows for rapid systemic absorption, leading to a faster and more reliable onset than the oral route [14]. The delay in onset for oral ketamine might be a confounding factor; however, the 45-minute interval used in this study is generally considered sufficient for oral ketamine to reach its peak effect. The superior performance of Group D may therefore be attributed to a combination of the drug's intrinsic sedative properties and the superior bioavailability afforded by the intranasal route. Oral administration, while non-invasive, depends heavily on gastric emptying and hepatic metabolism, introducing inter-patient variability that is less prominent with intranasal delivery [15]. Other studies corroborating these findings include comparisons with midazolam, where intranasal dexmedetomidine consistently demonstrated superior mask acceptance scores [16].

Furthermore, double-blind randomized trials have confirmed that intranasal dexmedetomidine provides more effective sedation for procedures than other intranasal sedatives like midazolam, reinforcing the efficacy of this route [17].

Limitations: The study has certain limitations that must be acknowledged. Being an observational study, randomization was not performed, which may introduce selection bias. The choice of drug was at the discretion of the consultant, which might have been influenced by the child's baseline temperament or previous medical history. Additionally, the study did not evaluate recovery times or emergence delirium scores extensively, which are important postoperative parameters. Future studies could also benefit from blinding the observers to the premedication used to eliminate assessment bias.

Conclusion

Based on the observations made in this prospective study at PMCH, Patna, it is concluded that Intranasal Dexmedetomidine (1 µg/kg) is superior to Oral Ketamine (5 mg/kg) for premedication in pediatric patients undergoing elective surgeries. Dexmedetomidine provided a significantly higher quality of parental separation and mask acceptance, facilitating a smooth and atraumatic induction of anaesthesia.

The hemodynamic profile of Dexmedetomidine was favorable, with a slight reduction in heart rate that remained within physiological limits, whereas Ketamine was associated with tachycardia. Furthermore, Dexmedetomidine exhibited a better safety profile regarding adverse effects, specifically avoiding the excessive secretions often seen with Ketamine. While Oral Ketamine remains a useful alternative, particularly in settings where intranasal delivery devices are unavailable, it is associated with less predictable sedation and increased airway secretions. Therefore, Intranasal Dexmedetomidine should be considered the preferred non-invasive premedication for elective pediatric surgeries in this setting to ensure a calm preoperative experience for both the child and the parents.

Future randomized controlled trials (RCTs) with larger sample sizes could explore the combination of low-dose Ketamine and Dexmedetomidine to harness the benefits of both agents while minimizing their respective side effects. Additionally, investigating the impact of these premedications on long-term behavioral outcomes in this specific population would be valuable.

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