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Intranasal ketamine for sedation and analgesia in wound repair without local anesthesia in the Pediatric Emergency Department

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Abstract

Introduction: Wounds requiring suturing with sedation and analgesia (SA) are a common reason for visiting the Pediatric Emergency Department (PED).

Objective: To evaluate the adequacy of SA achieved with intranasal (IN) ketamine during simple wound suturing in the PED.

Material and Methods: A descriptive observational study was conducted. Children weighing up to 30 kg who presented with a simple wound requiring repair between November 2022 and February 2023 were included. A dose of 7 mg/kg of IN ketamine was administered in aliquots of 0.5 ml per nostril using a MAD Nasal™ atomizer, alternating between sides. The study variables included: demographic data, clinical characteristics, degree of SA, sedation duration, operator roles (sedation and suturing), vital signs, sedation, and pain levels (Ramsay and Campbell scales), physician satisfaction, and parent satisfaction. Data were analyzed using SPSS v21, and the protocol was approved by the institutional ethics committee.

Results: Thirty-five patients were included, with a median age of 5 years (p25-75: 3–8), and 24/35 (68.6%) were male. Median weight was 21 kg (p25-p75: 16–27). SA with IN ketamine was successful in 29/35 (82.8%) patients (Ramsay score ≥ 2 and Campbell score ≤ 3). Adverse effects included vomiting in 5/35 (14.3%) and hypertension in 1/35 (2.9%). The mean sedation duration was 29.8 ± 8.95 minutes, and the total suturing time was 10.3 ± 3.57 minutes. At the end of the procedure, 7/29 (24.1%) patients reported no pain, while 22/29 (75.9%) reported mild pain. Physicians were satisfied with the level of SA in 32/35 (91.5%) procedures. All parents indicated they would consent to a similar procedure again.

Conclusion: Adequate SA was achieved with IN ketamine administration without the need for local wound infiltration of the wounds during suturing in the PED.

SEDOANALGESIA CON KETAMINA INTRANASAL EN LA REPARACIÓN DE HERIDAS SIN ANESTESIA LOCAL EN EL DEPARTAMENTO DE EMERGENCIAS PEDIÁTRICAS

Resumen

Introducción: *Las heridas que requieren sutura con sedoanalgesia (SA) son un motivo de consulta frecuente en el Departamento de Emergencias Pediátricas (DEP).*

Objetivo: *Determinar si los pacientes alcanzan una SA adecuada con ketamina intranasal (IN) en suturas de heridas simples en el DEP.*

Material y Métodos: *Estudio observacional descriptivo. Fueron incluidos niños hasta 30 kg atendidos en el DEP con una herida simple que requirió reparación en el periodo*

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de noviembre de 2022 a febrero de 2023. Se administró 7 mg/kg de ketamina IN en alícuotas de 0,5 ml por fosa nasal con un atomizador MAD Nasal®. Variables: Datos demográficos y características clínicas, grado de sedoanalgesia, duración y operador de la sutura, signos vitales, sedación y dolor (Ramsay ≥ 2 y Campbell ≤ 3), satisfacción de médicos, y satisfacción de los padres. Los datos se analizaron con SPSSv21. El protocolo fue aprobado por el comité de ética institucional.

Resultados: *Incluimos 35 pacientes, con mediana de edad 5 años (p25-75: 3-8), varones 24/35 (68,6%). Peso 21 kg (p25-p75: 16-27). En 29/35 (82,8%) pacientes la SA con ketamina IN fue exitosa. Los efectos colaterales fueron vómitos 5/35 (14,3%) e hipertensión arterial 1/35 (2,9%). El tiempo medio de sedación (minutos): 29,8 ± 8,95 y el tiempo total de sutura 10,3 ± 3,57. Al finalizar el procedimiento: no sintieron dolor 7/29 (24,1%) de los pacientes y refirieron dolor leve 22/29 el (75,9%). Los médicos estuvieron satisfechos con el grado de SA alcanzado en 32/35 (91,5%) procedimientos. La totalidad de los padres volvería a aceptar un procedimiento similar.*

Conclusión: *Se logró un buen nivel de SA con la administración IN de ketamina sin infiltración local de las heridas durante las suturas en el DEP.*

INTRODUCTION

Wounds requiring sutures are a common occurrence among children presenting to the Pediatric Emergency Department (PED). It is essential for emergency physicians to possess the necessary skills to manage these cases effectively. Pain and anxiety management should be regarded as fundamental components of wound care in PEDs[1]. Sedation and analgesia (SA), when administered by emergency physicians trained in these procedures, have been well demonstrated to be safe and effective outside the operating room[2-4].

Topical anesthetics and tissue adhesives have been shown to facilitate wound treatment. However, their use may not always be feasible in certain clinical situations, and these options are not universally available across all countries and healthcare settings. In our country, alternative non-infiltrative local anesthetic agents for open wounds, such as LAT gel, are unavailable[5].

Lidocaine infiltration remains a commonly used local treatment alongside systemic SA during wound repair in children outside the operating room[6].

Ketamine, a sedative agent frequently used in procedures in the PED, offers a combination of sedation, amnesia, and analgesia while maintaining spontaneous breathing and preserving normal airway reflexes, making it a preferred choice over other sedative agents[7-9].

Evidence supports the use of intravenous (IV) ketamine without local infiltration or the application of local anesthetics for the successful repair of minor wounds. Studies have shown no significant differences in pain scale scores between patients who received local infiltration or anesthetics and those who did not[10,11].

Intranasal (IN) administration is a well-studied method in PEDs. It is fast, non-invasive, well-tolerated, and capable of achieving adequate plasma concentrations of sedative agents and specific analgesics for relieving acute pain[12-16]. This method is particularly advantageous in overcrowded emergency departments, as it optimizes the time of medical and nursing staff while avoiding the pain and anxiety associated with IV line placement[17]. The effective dose of IN ketamine for minor wound repair has been investigated and established in previous research[18-20].

Although rare, local lidocaine infiltration can cause local and systemic adverse effects[21-23], making its avoidance a potential added benefit. In this context, the present study was designed to describe the characteristics of procedural SA achieved with IN administration of ketamine without local lidocaine infiltration during simple wound sutures in the PED. Secondary objectives included determining the time required to achieve adequate SA, the duration of sedation, identifying adverse effects, and evaluating the perceptions of parents or caregivers as well as the attending physicians.

MATERIAL AND METHODS

Study design and population

A prospective, descriptive, observational study was conducted in the PED of a tertiary academic pediatric hospital. Following informed consent from parents or guardians, pediatric patients weighing 10 to 30 kg, who presented with a simple wound less than 5 cm requiring suturing outside the operating room between November 1, 2022, and February 28, 2023, and with an ASA score less than 3, were included by non-probabilistic sampling at the convenience of the investigators. Children with behavioral difficulties, a history of adverse reactions to ketamine, wounds requiring intervention by a pediatric surgeon due to complexity, facial trauma, or nasal and facial malformations, moderate or severe airway infections, or congenital heart disease were excluded.

Measurement of the variables

Patient demographic data (sex and age), clinical variables (weight and personal medical history), and wound location were recorded. The following aspects of personal medical history were assessed: allergies, adverse reactions to SA or previous anesthesia, and the presence of comorbidities. Sedation level was evaluated using the Ramsay scale[24], with adequate sedation defined as a value ≥ 2. Pain was assessed

TABLE 1. Satisfaction survey of physicians and parents regarding procedural sedation and analgesia using intranasal ketamine.

		Very satisfied	Satisfied	Neutral	Not very satisfied	Dissatisfied
Pysician satisfaction	Degree of sedation and analgesia achieved					
	Duration of the procedure from start to finish					
	No need for local anesthesia					
Parent/caregiver satisfaction	Degree of satisfaction with the procedural sedation and analgesia					

using the Campbell scale[25], with adequate analgesia defined as a score ≤ 3. For both scales, scores were recorded before the procedure and at 1, 5, 10, and 30 minutes after the procedure began.

Patients were monitored throughout the procedural SA until recovery. Vital signs, including respiratory rate (RR), heart rate (HR), blood pressure (BP), and oxygen saturation (SpO_2), were measured before the start of the procedure and at 1, 5, 10, 30, and 45 minutes after IN ketamine administration.

The time (in minutes) required to achieve adequate sedation, the duration of sedation, and the duration of the suturing procedure were recorded as quantitative variables.

Data were collected on the professional categories of those who performed the sedation and suturing procedures, including pediatric residents, emergency medicine fellows, pediatricians, and emergency physicians.

Possible adverse effects were monitored, including hypertension, hypotension, bradycardia, laryngospasm, vomiting, nystagmus, tremor, headache, and irritability.

At the end of the procedural SA, patients assessed their perceived pain using age-appropriate pain scales: the Wong-Baker scale for patients under seven years of age[28] and the numeric rating score for patients aged seven years or older[28].

Successful IN SA was defined as achieving the desired scores on the Ramsay scale (≥ 2) and the Campbell scale (≤ 3) from baseline to the completion of the procedure. Procedural failure was defined as the inability to achieve adequate SA within 30 minutes following IN ketamine administration. In such cases, data were collected regarding the need for infiltration with a local anesthetic or the placement of a peripheral venous line (PVL) for ketamine administration at a dose of 1–2 mg/kg.

The perceptions of parents and physicians regarding the SA procedure were assessed using a survey. The survey included two closed-ended questions for parents and four for physicians, with responses measured on a Likert scale (Table 1). Parents were asked whether they would agree to the administration of IN SA if given the opportunity, with a dichotomous response option (Yes or No).

Procedure

Three operators participated in each procedure: 1) the individual responsible for enrolling patients, explaining the study, obtaining informed consent from the parents, and collecting data; 2) the supervisor overseeing drug administration and patient monitoring; and 3) the person in charge of wound suturing.

After obtaining informed consent, IN ketamine was administered at a dose of 7 mg/kg using a MAD Nasal™ atomizer in volumes of 0.5 to 1 ml per nostril, alternating sides. The maximum dose was set at 200 mg (equivalent to 4 ml), determined by volume. If the required volume exceeded 1 ml, the medication was administered in repeated increments until the full dose was achieved. This method was used to facilitate absorption through the mucosa, enhance tolerability, and prevent runoff of the drug into the pharynx.

Data analysis

Data were analyzed using the SPSS 21 program. Qualitative variables were expressed as percentages, while quantitative variables were presented as means with standard deviations or medians with ranges, according to their distribution.

Ethical considerations

The study was approved by the hospital ethics committee, and informed consent was obtained from the parents or caregivers.

RESULTS

A total of 41 patients were eligible for the study. Thirty-five of these patients received IN ketamine for procedural SA and were included in the analysis. Six patients were excluded due to their refusal to receive medication via the IN route. None of the patients had a history of previous adverse reactions to SA or any comorbidities.

The median age of the patients was five years, with a male predominance. The majority of wounds were located on the head. The characteristics of the patients included in the study are detailed in Table 2.

SA with IN ketamine was successful in 29 out of 35 patients (82.8%), as assessed by achieving a Ramsay score of ≥ 2 and Campbell score of ≤ 3. In these patients, neither local infiltration nor the use of a PVL was required. SA via the IN route without additional local anesthetic was unsuccessful in six patients (17.2%). Among these, three patients (8.5%) required local anesthetic infiltration in addition to IN ketamine, while two patients (5.7%) required PVL placement and IV ketamine administration. One patient received both local anesthesia and IV ketamine. Adverse effects occurred in 17.2% (6/35) of the children, with vomiting being the most

TABLE 2. Demographic data and clinical characteristics of patients who received procedural sedation and analgesia with intranasal ketamine. N: 35.

Variables	n (%)
Sex	
Male	24 (68.6)
Age (years)	
Median (p25 – p75)	5 (3-8)
Wound location	
Face/Forehead	11 (31.4)
Scalp	9 (25.7)
Upper limb	6 (17.1)
Lower limb	9 (25.7)
Weight (kg)	
Median (p25-p75)	21 (16-27)
PMH	
Yes	2 (5.7)
No	33 (94.3)
Allergy	2 (5.7)

PMH: personal medical history.

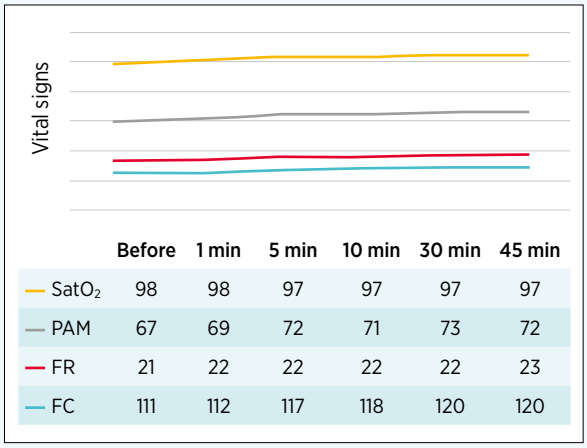

FIGURE 1. Mean variation of vital signs during procedural SA.

common, observed in 14.3% (5/35). One patient (2.9%) experienced arterial hypertension. These data are summarized in Table 3.

The SA operator was a second-year pediatric emergency medicine fellow in 31 out of 35 procedures and a senior emergency physician in the remaining four procedures. The suture operator was a pediatric resident in all cases. The mean total sedation time was 29.8 minutes (±8.95), while the mean total suture time was 10.3 minutes (±3.57).

The mean values of vital signs (SpO_2, BP, RR, and HR), recorded before the procedure and at 1, 5, 10, 30, and 45 minutes, are presented in Figure 1. The mean time to achieve SA before initiating wound repair was 10 minutes. Specifically, the mean time to achieve a Campbell scale score of ≤ 3 was 10 minutes (±0.7 SD), and the mean time to reach a Ramsay scale score of ≥ 2 was 10 minutes (±0.5 SD). Among the patients with successful SA using IN ketamine, seven out of 29 (24.1%) reported no pain at the end of the procedure, while 22 out of 29 (75.9%) reported mild pain.

TABLE 3. Patients with successful and unsuccessful outcomes of intranasal ketamine as a sole medication and associated adverse effects.

Variables	n (%)
***Adequate SA n (35)**	
Yes	29 (82.8)
Local anesthesia + IN Ketamine	
Yes	3 (8.5)
***PVL + IV Ketamina**	
Yes	2 (5.7)
Local anesthesia + IV Ketamine	
Yes	1 (2.8)
***Pain n (29)**	
No pain	7 (24.1)
Mild	22 (75.9)
Adverse effects	
Vomiting	5 (14.3)
AHT	1 (2.9)

***Adequate SA:** SA achieved with a level of sedation measured with a Ramsay scale ≥ 2 points and analgesia measured with a Campbell scale ≤ 3 points; **PVL:** peripheral venous line; **IV:** intravenous; **Pain:** assessed using the Wong-Baker scales in children ≤ 7 years and numeric score in children older than 7 years.*

TABLE 4. Degree of physician satisfaction with the administration of intranasal sedation and analgesia.

Variables	n (%)
With the level SA	
Dissatisfied	0
Not very satisfied	2 (5.7)
Neutral	1 (2.9)
Satisfied	10 (28.6)
Very satisfied	22 (62.9)
With the procedure duration	
Dissatisfied	0
Not very satisfied	2 (5.7)
Neutral	9 (25.7)
Satisfied	9 (25.7)
Very satisfied	15 (42.9)
With the lack of need for IV SA	
IDissatisfied	1 (2.9)
Not very satisfied	1 (2.9)
Neutral	0
Satisfied	8 (22.9)
Very satisfied	25 (71.4)
With the lack of need for local anesthesia	
Dissatisfied	0
Not very satisfied	7 (20)
Neutral	3 (8.6)
Satisfied	5 (14.3)
Very satisfied	20 (57.1)

SA: Sedation and analgesia; IV: intravenous.

Physician satisfaction with IN SA (the level of sedation achieved, duration, no need for PVL placement, and no need for local anesthetic infiltration in the wound) was evaluated using a Likert scale, as shown in Table 4.

None of the patients had prior experience with SA, and all caregivers (35/35) indicated they would consent to similar

procedural SA in the future. In the satisfaction survey, 94% (33/35) of caregivers reported being satisfied or very satisfied with the procedure; one caregiver was indifferent, and one reported being not very satisfied. No caregiver expressed dissatisfaction.

DISCUSSION

The administration of IN SA with ketamine in the PED resulted in a significant reduction in pain scores, achieving adequate sedation levels in the majority of patients without requiring local lidocaine infiltration into the wounds.

Previous studies on SA with IV ketamine[10,11] have demonstrated that using ketamine without local anesthetic infiltration offers advantages, including reduced costs (supplies and drugs) and avoidance of potential adverse effects associated with lidocaine administration. The undesirable effects of lidocaine include local reactions, such as pain, edema, hematomas, hyperalgesia, and muscular trismus, as well as systemic effects such as seizures, arterial hyper- or hypotension, and respiratory depression[21,22]. In this context, IN ketamine appears to provide a safer and more cost-effective alternative.

In our patients, IN procedural SA avoided the need for PVL placement in eight out of ten cases, providing clear benefits by reducing the anxiety and pain associated with line placement. Although not specifically evaluated in our study, the IN technique may also result in resource savings, despite potentially increasing administration time for nursing staff. Nevertheless, this approach simplifies the process by eliminating the need for IV line placement, which represents a significant advantage in high-demand settings.

Several studies support IN administration of ketamine as a safe and effective method for procedural SA for procedures performed outside the operating room[28]. The benefits of atomized administration include reduced drug loss in the oropharynx, higher ketamine concentrations in the cerebrospinal fluid, and greater patient acceptability[29]. As such, the IN technique offers advantages over other routes of administration, such as IV or intramuscular routes.

With regard to the dose of IN ketamine, several studies have demonstrated the effectiveness of doses of 3 mg/kg, 6 mg/kg, and 9 mg/kg[18,20]. However, a study by Tsze et al. suggested that a dose of 3 to 6 mg/kg may not be sufficient to achieve adequate sedation, as assessed by the Ramsay score, during simple wound suturing procedures in the PED[19]. In our study, a dose of 7 mg/kg was used, which proved effective for most patients, although the findings by Tsze et al. indicate that higher doses might be required in certain cases.

An operational challenge was the pharmacological presentation of ketamine in our setting, which is 50 mg/ml. This required administering the drug in aliquots to avoid exceeding the maximum recommended volume. To ensure tolerability and minimize discomfort from repeated IN doses, a maximum dose of 200 mg (equivalent to 4 ml) was established.

The time required to achieve adequate sedation in our patients was approximately 10 minutes, which is longer than the onset time reported in studies using IV ketamine, where sedation is typically achieved within one to two minutes. This difference may be attributed to the need to administer the drug in sequential doses due to its pharmacological presentation. However, some studies have reported comparable sedation times for both methods of administration[30,31].

The mean time required to complete wound repair was 10 minutes, which was shorter than the duration of SA. This finding suggests that a shorter sedation period may be sufficient for suturing minor wounds, potentially reducing the risk of adverse effects.

The Ramsay scale has been used in numerous studies on SA with ketamine[19,32] and was valuable in assessing sedation in our study. The effects of ketamine are classified into different ranges: analgesic dose, recreational dose, partially dissociative dose, and dissociative dose. In minor procedures, patients may experience partial or complete dissociation. Partial dissociation occurs when the dose is insufficient for complete dissociation but still affects the patient's consciousness, partially disconnecting them from external stimuli. Complete dissociation, which is typically the goal in painful procedures or during endotracheal intubation, fully isolates the patient from external stimuli[33].

The pain perceived by patients at the end of the procedure was reported as either absent or mild. This result may have been influenced by ketamine-induced amnesia, which limits the reliability of pain assessment at this time. However, measurements taken during the wound repair procedure, using the Ramsay and Campbell scales, indicated that SA was adequate for wound repair in our patients.

Regarding adverse effects, vomiting was the most frequent, occurring more often than in other studies using IV or intramuscular doses of ketamine[34,35]. This finding suggests the need for further research with comparatively lower doses of IN ketamine to determine whether the incidence of vomiting can be reduced. One patient developed arterial hypertension during the procedure, which improved within 30 minutes without the need for additional medical intervention.

The satisfaction survey indicated that physicians were highly satisfied with the implementation of this technique, as were parents and caregivers, who stated that, if necessary, they would choose this method again for their children. This is a positive indication of the technique's acceptance in both clinical and family settings.

Although the use of topical anesthetics applied to wounds remains the standard in many developed countries, the IN alternative is valuable in settings where these anesthetics are unavailable. In the case of suturing in the PED, SA with IN ketamine has recently been explored by Rached-d'Astous et al. in Canada[36]. The advantage of performing SA in a single step with a single, fast-acting drug is particularly beneficial in high-demand settings.

This study has limitations inherent to its observational design. Since only one dose of ketamine was used, it was not possible to determine the optimal dose for this type of procedure. In addition, the use of convenience sampling and the small sample size may have introduced biases that affect the generalizability of the results. Nevertheless, we consider the results obtained to be of interest, as they demonstrate the feasibility of IN SA in wound repair with fewer supporting steps. These findings could serve as a foundation for future,

larger studies exploring efficacy, ideal dosing, and the most appropriate age range for its application.

CONCLUSION

A dose of 7 mg/kg of IN ketamine, administered via a MAD Nasal™ atomizer, achieved a satisfactory level of SA in 80% of the included pediatric patients during wound repair, without the need for local infiltration or IV access. These findings should be validated in controlled studies.

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REFERENCES

1. Knapp JF. Updates in wound management for the pediatrician. Pediatr Clin North Am. 1999; 46(6): 1201-13. doi: 10.1016/s0031-3955(05)70183-8.
2. Ronco RM, Castillo AM, Carrasco J, Carrasco C, Parraguez RT, Zamora MZ, et al. Sedación y analgesia para procedimientos pediátricos fuera del pabellón. Rev Chil Pediatr. [Internet]. 2003 Mar [citado 2024 Jun 14]; 74(2): 171-8. doi: 10.4067/S0370-41062003000200005.
3. Krauss B, Green SM. Procedural sedation and analgesia in children. Lancet. 2006; 367(9512): 766-80. doi: 10.1016/S0140-6736(06)68230-5.
4. Godoy ML, Pino AP, Córdova LG, Carrasco OJA, Castillo MA. Sedación y analgesia para procedimientos invasivos en los niños. Arch Argent Pediatr. 2013; 111(1): 22-8. doi: 10.5546/aap.2013.eng.22.
5. Valls Durán T, Díaz Sanisidro E, Nadal González L. Uso del gel LAT para suturar heridas en niños. Pediatr Aten Primaria [Internet]. 2009 [citado el 4 de julio de 2024]; 11(44): 575-95. Disponible en: https://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1139-76322009000500003
6. Tayeb BO, Eidelman A, Eidelman CL, McNicol ED, Carr DB. Topical anaesthetics for pain control during repair of dermal laceration. Cochrane Database Syst Rev. 2017; 2(2): CD005364. doi: 10.1002/14651858.CD005364.pub3.
7. Bali A, Dang AK, Gonzalez DA, Kumar R, Asif S. Clinical uses of ketamine in children: A narrative review. Cureus. 2022; 14(7): e27065. doi: 10.7759/cureus.27065.
8. Dolansky G, Shah A, Mosdossy G, Rieder M. What is the evidence for the safety and efficacy of using ketamine in children? Paediatr Child Health. 2008; 13(4): 307-8. doi: 10.1093/pch/13.4.307.
9. Mistry RB, Nahata MC. Ketamine for conscious sedation in pediatric emergency care. Pharmacotherapy. 2005; 25(8): 1104-11. doi: 10.1592/phco.2005.25.8.1104.
10. Ko MJ, Choi JH, Cho YS, Lee JW, Lim H, Moon HJ. Is local anesthesia necessary in ketamine sedation for pediatric facial laceration repair?: A double-blind, randomized, controlled study. J Trauma Inj. 2014; 27(4): 178-85.
11. Kwon H, Lee JH, Choi YJ, Jung JY. Is ketamine sedation without local anesthesia sufficient for pediatric laceration repair? A double-blind randomized clinical trial. Am J Emerg Med. 2021; 44: 208-12. doi: 10.1016/j.ajem.2020.03.030.
12. Del Pizzo J, Callahan JM. Intranasal medications in pediatric emergency medicine. Pediatr Emerg Care. 2014; 30(7): 496-501; quiz 502-4. doi: 10.1097/PEC.0000000000000171.
13. Cristoforo T, Gonzalez D, Bender M, Uy G, Papa L, Ben Khallouq BA, et al. A pilot study testing intranasal ketamine for the treatment of procedural anxiety in children undergoing laceration repair. J Child Adolesc Trauma. 2021; 15(2): 479-86. doi: 10.1007/s40653-021-00402-9.
14. Ferguson CL, Beckett RD. Intranasal ketamine for treatment of acute pain in pediatrics: A systematic review. Pediatr Emerg Care. 2020; 36(8): e476-81. doi: 10.1097/PEC.0000000000002181.
15. Andolfatto G, Willman E, Joo D, Miller P, Wong WB, Koehn M, et al. Intranasal ketamine for analgesia in the emergency department: A prospective observational series. Acad Emerg Med. 2013; 20(10): 1050-4. doi: 10.1111/acem.12229.
16. Poonai N, Canton K, Ali S, Hendrikx S, Shah A, Miller M, et al. Intranasal ketamine for anesthetic premedication in children: A systematic review. Pain Manag. 2018; 8(6): 495-503. doi: 10.2217/pmt-2018-0039.
17. Guthrie AM, Baum RA, Carter C, Dugan A, Jones L, Tackett T, et al. Use of intranasal ketamine in pediatric patients in the emergency department. Pediatr Emerg Care. 2021; 37(12): e1001-7. doi: 10.1097/PEC.0000000000001863.
18. Rached-d'Astous S, Bailey B, Marquis C, Lebel D, Desjardins MP, Trottier ED. Laceration repair using intranasal ketamine: A phase 2 dose escalation clinical trial. CJEM. 2022; 24(3): 347-8. doi: 10.1007/s43678-021-00235-3.
19. Tsze DS, Steele DW, Machan JT, Akhlaghi F, Linakis JG. Intranasal ketamine for procedural sedation in pediatric laceration repair: A preliminary report. Pediatr Emerg Care. 2012; 28(8): 767-70. doi: 10.1097/PEC.0b013e3182624935.
20. Rached-d'Astous S, Finkelstein Y, Bailey B, Marquis C, Lebel D, Desjardins MP, et al. Intra-nasal ketamine for laceration repair in the emergency department: The DosINK studies. Paediatr Child Health. 2020; 25(Suppl 2): e35-6. doi: 10.1093/pch/pxaa068.085.
21. Batinac T, Sotošek Tokmadžić V, Peharda V, Brajac I. Adverse reactions and alleged allergy to local anesthetics: Analysis of 331 patients. J Dermatol. 2013; 40(7): 522-7. doi: 10.1111/1346-8138.12168.
22. Berkun Y, Ben-Zvi A, Levy Y, Galili D, Shalit M. Evaluation of adverse reactions to local anesthetics: Experience with 236 patients. Ann Allergy Asthma Immunol. 2003; 91(4): 342-5. doi: 10.1016/S1081-1206(10)61680-8.
23. Cherobin ACFP, Tavares GT. Safety of local anesthetics. An Bras Dermatol. 2020; 95(1): 82-90. doi: 10.1016/j.abd.2019.09.025.
24. Ramsay MA, Savege TM, Simpson BR, Goodwin R. Controlled sedation with alfaxalone-alfadolone. BMJ. 1974; 2(5920): 656-9. doi: 10.1136/bmj.2.5920.656.
25. Pardo C, Muñoz T, Chamorro C. Monitorización del dolor: Recomendaciones del grupo de trabajo de analgesia y sedación de la SEMICYUC. Med Intensiva. 2006; 30(8): 379-85. Disponible en: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S0210-56912006000800004&lng=es.

26. Lawson SL, Hogg MM, Moore CG, Anderson WE, Osipoff PS, Runyon MS, et al. Pediatric pain assessment in the emergency department: Patient and caregiver agreement using the Wong-Baker FACES and the Faces Pain Scale-Revised. Pediatr Emerg Care. 2021; 37(12): e950-4. doi: 10.1097/PEC.0000000000001837.
27. Voepel-Lewis T, Burke CN, Jeffreys N, Malviya S, Tait AR. Do 0-10 numeric rating scores translate into clinically meaningful pain measures for children? Anesth Analg. 2011; 112(2): 415-21. doi: 10.1213/ane.0b013e318203f495.
28. Rocchio RJ, Ward KE. Intranasal ketamine for acute pain. Clin J Pain. 2021; 37(4): 295-300. doi: 10.1097/AJP.0000000000000918.
29. Pansini V, Curatola A, Gatto A, Lazzareschi I, Ruggiero A, Chiaretti A. Intranasal drugs for analgesia and sedation in children admitted to pediatric emergency department: A narrative review. Ann Transl Med. 2021; 9(2): 189. doi: 10.21037/atm-20-5177.
30. Míguez Navarro MC, Santervás YF, La Calle M de CV, Millán AB, Arrieta NC. Protocolo de sedoanalgesia en urgencias pediátricas [Internet]. Seup.org. [citado el 4 de julio de 2024]. Disponible en: https://seup.org/pdf_public/pub/protocolos/27_Psedoanalgesia.pdf
31. Simonini A, Brogi E, Cascella M, Vittori A. Advantages of ketamine in pediatric anesthesia. Open Med (Wars). 2022; 17(1): 1134-47. doi: 10.1515/med-2022-0509.
32. Zaki HA, Ibrahim T, Osman A, Elnabawy WA, Gebril A, Hamdi AH, Mohamed EH. Comparing the safety and effectiveness of ketamine versus benzodiazepine/opioid combination for procedural sedation in emergency medicine: A comprehensive review and meta-analysis. Cureus. 2023; 15(3): e36742. doi: 10.7759/cureus.36742.
33. Strayer JR. Current concepts in ketamine therapy in the emergency department. Emerg Med Pract. 2024; 26(5): 1-24.
34. Grunwell JR, Travers C, McCracken CE, Scherrer PD, Stormorken AG, Chumpitazi CE, et al. Procedural sedation outside of the operating room using ketamine in 22,645 children: A report from the Pediatric Sedation Research Consortium. Pediatr Crit Care Med. 2016; 17(12): 1109-16. doi: 10.1097/PCC.0000000000000920.
35. Bhatt M, Johnson DW, Chan J, Taljaard M, Barrowman N, Farion KJ, et al; Sedation Safety Study Group of Pediatric Emergency Research Canada (PERC). Risk factors for adverse events in emergency department procedural sedation for children. JAMA Pediatr. 2017; 171(10): 957-64. doi: 10.1001/jamapediatrics.2017.2135.
36. Rached-d'Astous S, Finkelstein Y, Bailey B, Marquis C, Lebel D, Desjardins MP, et al. Intranasal ketamine for procedural sedation in children: An open-label multicenter clinical trial. Am J Emerg Med. 2023; 67: 10-6. doi: 10.1016/j.ajem.2023.01.046.