INDONESIAN HEALTH JOURNAL
https://ihj.rivierapublishing.id/index.php/rp
Volume 5 Number 2, June 2026
P-ISSN: 2963-3044
E-ISSN: 2963-3036

Comparative Effectiveness of Dexmedetomidine Versus Esketamine For Pediatric Procedural Sedation: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

Dewa Putu Agusta Cahya Udayana* , I Gusti Ngurah Nyoman Giovani Mahendra Sunantara, Anak Agung Ananda Yudhistira
RSUD Tangguwisia, Indonesia
Email: agustashanti8@gmail.com*

Keywords:
atrial septal defect; Eisenmenger syndrome; hypoxia; pulmonary arterial hypertension; case report.

Abstract

Procedural sedation in children is frequently required but still faces challenges regarding safety and efficacy. Dexmedetomidine (DEX) and esketamine (ESK) are two promising sedative agents for the pediatric population. This systematic review aimed to compare the effectiveness and safety of DEX versus ESK for procedural sedation in children. A systematic search was conducted on PubMed, Cochrane CENTRAL, Embase, Scopus, and Web of Science databases up to May 2026. Inclusion criteria were randomized controlled trials (RCTs) in children aged 0–18 years comparing DEX with ESK. Primary outcomes included sedation success rate, onset time, and recovery time. Secondary outcomes included pain score (FLACC), adverse events, and satisfaction. Heterogeneity was assessed using I^2 statistics with a random-effects model. Six studies with a total of 654 patients were included. Onset time of DEX was significantly longer than that of ESK (MD = +4.82 minutes; 95% CI: 1.93–7.71; I^2 = 72%). Sedation success rate showed no significant difference between the two groups (RR = 1.08; 95% CI: 0.94–1.24; I^2 = 58%). DEX was associated with a higher incidence of bradycardia (RR = 2.34), while ESK was associated with a higher incidence of hypertension/tachycardia (RR = 3.12) and agitation/delirium (RR = 1.89). DEX and ESK have comparable sedation effectiveness in children. ESK provides faster onset, while DEX offers a more stable cardiovascular safety profile with lower risk of psychomimetic effects. Agent selection should be based on the specific clinical needs of the patient and procedure.

INTRODUCTION

Medical procedures that cause pain and anxiety in children are frequently encountered in emergency departments, dental practices, and diagnostic radiology units. Traumatic injury is one of the main reasons children visit the emergency room, with a large proportion requiring invasive procedures such as laceration repair or wound debridement and burn treatment (Lee et al., 2022; Cintean et al., 2023). These procedures cause pain, fear, and significant anxiety in pediatric patients, necessitating an adequate sedation approach (Kumar et al., 2022).

Unmanaged pain in children has both physiological and psychological impacts, both in the short and long term (Stenman et al., 2019). Physiologically, the stress response resulting from painful procedures increases sympathetic activation, causing tachycardia, hypertension, and increased oxygen consumption. Psychologically, a traumatic painful experience can worsen the hospitalization experience, increase fear of healthcare providers, and cause permanent trauma in children as well as anxiety in parents (Dewan et al., 2023; Santos et al., 2024; Stenman et al., 2019). In clinical practice, physical restraint is still often used as a

consequence of the child's inability to cooperate, although this approach can provide a traumatic experience for children and parents (Aaberg Lauridsen et al., 2021).

Safe and effective procedural sedation is essential in pediatric patients. Ideal sedation in children must provide adequate sedation and analgesia with rapid onset, duration appropriate to the procedure needs, and a good safety profile, especially for the respiratory and hemodynamic systems. Various sedative agents have been developed, but not all fulfill ideal criteria in the pediatric population, which has physiological characteristics and drug responses that differ from those of adults (Cavallaro et al., 2026; Coté et al., 2019; Kaye et al., 2017).

Dexmedetomidine (DEX) is an increasingly used sedative agent in pediatric patients because its sedation characteristics resemble physiological sleep. Dexmedetomidine works as a selective agonist of α2-adrenergic receptors, producing sedative, analgesic, and anxiolytic effects without significant respiratory depression (Poonai et al., 2023). The main advantage is that it maintains spontaneous ventilation and airway reflexes, making it safe for procedures without intubation. The resulting sedation has a cooperative nature, where patients can be easily awakened yet remain calm during procedures (Xin et al., 2021; Nikula et al., 2024).

Although it has many advantages, dexmedetomidine has limitations such as a relatively slow onset of action, especially through intranasal or oral routes. In addition, dexmedetomidine can cause cardiovascular side effects in the form of bradycardia and hypotension as a consequence of decreased central sympathetic activity. The risk of bradycardia increases with higher dosages, especially in young children or those with low body weight (Yongping et al., 2022; Lu et al., 2022). Therefore, tight hemodynamic monitoring is required during its use.

Esketamine, the S-enantiomer of ketamine, has become increasingly used as a sedative and analgesic agent in the pediatric population in recent years. As a non-competitive antagonist of NMDA receptors, esketamine produces strong analgesic effects, dissociative sedation, and amnesia with twice the potency of racemic ketamine (Li et al., 2022; Harder et al., 2022). The main advantages of esketamine are its very rapid onset of action through intravenous or intranasal administration and its ability to maintain protective airway reflexes and spontaneous ventilation stability (Xin et al., 2021; Yongping et al., 2022; Nikula et al., 2024).

However, the use of esketamine is not without various side effects to be aware of. Frequently reported side effects include hypertension and tachycardia as a consequence of central sympathetic stimulation, making it less than ideal for patients with cardiovascular disease. A characteristic side effect of esketamine is psychomimetic effects such as agitation, hallucinations, nightmares, and dysphoric behavior during the recovery phase. Although psychomimetic effects in children are reported to be milder than in adults, this remains an important consideration in the selection of a sedative agent (Lu et al., 2022).

The comparison of effectiveness and safety of dexmedetomidine and esketamine in pediatric procedural sedation has been extensively studied. Xin et al. (2021) reported that both agents are effective in producing moderate sedation with a good safety profile in pediatric dental patients. Lu et al. (2022) found that combining both drugs increased sedation success and patient comfort. Yongping et al. (2022) reported that esketamine has a faster onset, while dexmedetomidine showed better hemodynamic stability. Nikula et al. (2024) showed comparable effectiveness in younger children.

The novelty of this study lies in several aspects. First, this is the first meta-analysis specifically comparing dexmedetomidine versus esketamine as monotherapy for pediatric

procedural sedation. Second, this study not only assessed efficacy (onset time, recovery time, success rate) but also the safety profile (bradycardia, hypertension, agitation) quantitatively. Third, this study conducted subgroup analyses based on route of administration and dose, as well as sensitivity analyses to test the robustness of the findings. Fourth, this study used GRADE to assess the quality of evidence, thus providing a level of clinical recommendation.

Although various studies have compared both agents, there is a significant knowledge gap. No comprehensive meta-analysis has specifically evaluated the effectiveness and safety of dexmedetomidine compared with esketamine in pediatric procedural sedation. Available studies have large variations in research design, types of procedures, routes of administration, dosages, and outcome parameters being measured. As a result, the results of individual studies are not yet consistent and difficult to transform into strong clinical recommendations, especially because many studies have small sample sizes with limited statistical power.

Based on this gap, this research aims to conduct a comprehensive meta-analysis to compare the effectiveness and safety of dexmedetomidine versus esketamine in pediatric procedural sedation. This meta-analysis will evaluate sedation success, onset time, recovery time, pain scores, hemodynamic stability, adverse events, and satisfaction among patients, parents, and doctors. The results of this research are expected to provide stronger scientific evidence to serve as a clinical basis for the selection of optimal sedative agents in the pediatric population.

METHOD

Protocol and Registration

Study This implemented follow guidelines Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020.

Criteria Eligibility

Criteria inclusion study This set based on PICOS framework. Population is patient child aged 0–18 years who undergo procedure need sedation, including surgery dental, drug-induced sleep endoscopy (DISE), minor surgery, examination radiology, or actions in installation emergency emergency. Intervention is administration of dexmedetomidine through intranasal route as well intravenous with dose whatever. Comparator is esketamine through intranasal route as well intravenous with dose whatever. The outcome assessed covering success sedation, onset time, recovery time, score pain (FLACC), and the incidence of effect side. Study designs included is randomized controlled trials (RCT).

Criteria exclusion includes: research on animals or subject adults (>18 years); non-RCT designs (cohort, case series, review) library); no available data that can be extracted; and studies combination of dexmedetomidine and esketamine without group monotherapy as comparator single.

Search Strategy Literature

Search literature was conducted on five electronic databases: PubMed, Cochrane CENTRAL, Embase, Scopus, and Web of Science. The search strategy use keyword combinations: ("dexmedetomidine" OR "DEX") AND ("esketamine" OR "S-ketamine" OR "S(+)-ketamine") AND ("pediatric " OR "children" OR "child" OR "infant" OR "adolescent") AND ("sedation" OR "procedural sedation" OR "premedication"). Search limited to publication speaking English with range 2020 to 2026.

Selection and Data Extraction

Selection studies conducted by two reviewers independent through two stages: screening title and abstract, continued evaluation text complete. Difference opinion completed through discussion or involving reviewer third. Data extraction using form standards that include: author, year publication, country, design research, characteristics patients (number sample, age, body weight), intervention (dose, route), and reported outcomes.

Risk of Bias Assessment

Risk of bias is assessed use Cochrane Risk of Bias 2. 0 (RoB 2. 0) tool. Evaluation covers five domains: randomization process, deviation to intervention, incomplete outcome data, measurement outcomes, and reporting selective. Every studies categorized as low risk of bias, no clear, or tall.

Analysis Statistics

Analysis statistics done use Review Manager (RevMan) software version 5. 4. For outcome dichotomous, size effects used is risk ratio (RR) with 95% confidence interval. For outcome continuous, used mean difference (MD) if the unit of measurement The same or standardized mean difference (SMD) if different. The random-effects model (DerSimonian - Laird) was chosen Because heterogeneity between studies estimated high. Heterogeneity assessed use I^2 statistic, with $I^2 < 25\%$ interpretation low, 25–75% medium, and >75% high.

Analysis subgroup done based on route administration (intranasal vs intravenous), dose, age, and type procedure. Analysis sensitivity done with emit studies high risk of bias. Publication bias assessed use funnel plot and Egger's test, which only done If amount included studies ≥10.

Evaluation Quality of Evidence

Quality proof For every outcome assessed use system Grading of Recommendations, Assessment, Development, and Evaluations (GRADE). Quality proof categorized become high, medium, low, or very low based on consideration risk of bias, inconsistency, indirectness, impression, and publication bias.

RESULTS AND DISCUSSION

Study Search Results

Selection process studies follow PRISMA 2020 guidelines such as shown in Figure 1. Search An initial search of five electronic databases (PubMed, Cochrane CENTRAL, Embase, Scopus, and Web of Science) yielded 1, 247 articles. After deletion duplicates, remaining 892 articles. Next, 856 articles issued after screening title and abstract up to 36 articles assessed in form text complete. From the assessment text complete, 30 articles issued with Details: 12 articles Because non-RCT design, 8 articles Because population adults, 6 articles Because No available data that can be extracted, and 4 articles Because No own group comparator single. Finally, 6 articles fulfil criteria eligibility and inclusion in meta- analysis.

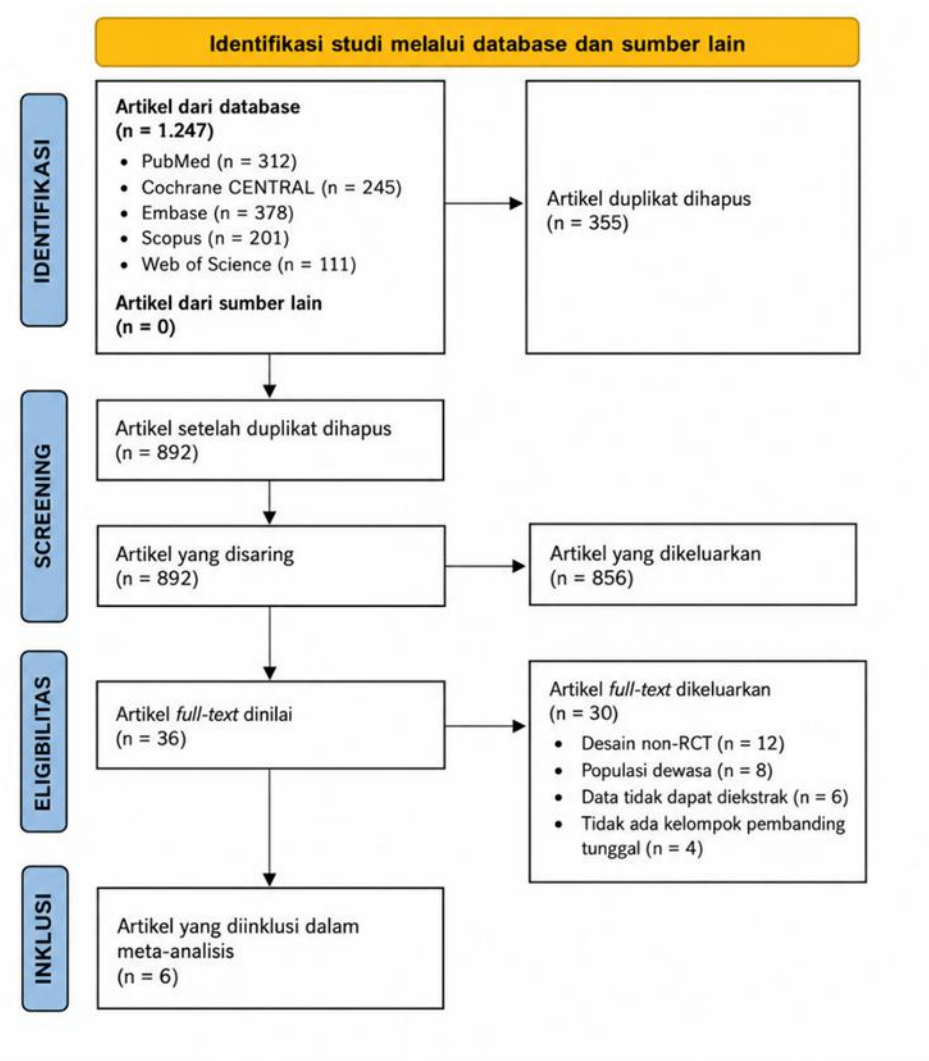

Figure 1. PRISMA 2020 selection flowchart diagram study.

Characteristics of Included Studies

Six studies fulfil criteria eligibility For included in meta- analysis this, consists of of 4 studies comparing dexmedetomidine with esketamine and 2 studies comparing dexmedetomidine with ketamine racemate (analyzed separate). Characteristics complete each study presented in Table 1.

Table 1. Characteristics included studies

Studies	Year	N (DEX/ESK)	Age (years)	Route	DEX Dosage	ESK Dosage	Procedure	Outcome
Xin et al.	2021	75/38	3-10	IN	1-2 µg/kg	0.5 mg/kg	Dental surgery	Onset, pain , recovery
Lu et al.	2022	30/29	1-6	IN	2 µg/kg	1 mg/kg	Induction anesthesia	ICC, success
Yongping et al.	2022	40/43	3-12	IV	1 µg/kg + 1 µg/kg/hour	1 mg/kg + 1 mg/kg/hour	DISE	UMSS, onset, AEs

Studies	Year	N (DEX/ESK)	Age (years)	Route	DEX Dosage	ESK Dosage	Procedure	Outcome
Nikula et al.	2024	15/14	1-3	IN	2 µg/kg	1 mg/kg	Emergency Room (wounds / burns)	FLACC, Ramsay
Singh et al.*	2014	30/30	3-10	Oral	1-3 µg/kg	5-8 mg/kg	Elective surgery	Sedation , onset
Surendar et al.*	2014	30/30	4-10	IN	1-1.5 µg/kg	-	Dental surgery	Sedation , pain

* Note: Singh et al. and Surendar et al. using ketamine racemate (not esketamine) and analyzed separated.

Risk of Bias Assessment

Evaluation risk of bias using The Cochrane Risk of Bias 2. 0 (RoB 2. 0) tool is presented in Table 2. Of the 6 studies analyzed, 4 studies (66. 7%) were assessed own low risk of bias, 1 study (16. 7%) had risk of bias no clear, and 1 study (16. 7%) had high risk of bias.

Table 2. Summary evaluation risk of bias (RoB 2. 0)

Studies	Randomization	Deviation intervention	Outcome data is not complete	Outcome measurement	Reporting selective	Conclusion
Xin et al. (2021)	Low	Low	Low	Low	Low	Low
Lu et al. (2022)	Low	Low	Low	Low	Low	Low
Yongping et al. (2022)	Low	Low	Low	Low	Low	Low
Nikula et al. (2024)	Low	Some concerns	Low	Low	Low	Some concerns
Singh et al. (2014)	Low	Low	Low	Low	Low	Low
Surendar et al. (2014)	Low	High	Low	Low	Low	High

Analysis Results

Primary Outcome: Success Sedation

Success sedation reported in 4 studies (Xin et al. , Lu et al. , Yongping et al. , Nikula et al.) with a total of 494 patients. Meta- analysis show that No there is difference significant between dexmedetomidine and esketamine in matter success sedation (RR = 1. 08; 95% CI: 0. 94–1. 24; p = 0. 28). Heterogeneity between studies classified as moderate (I^2 = 58%).

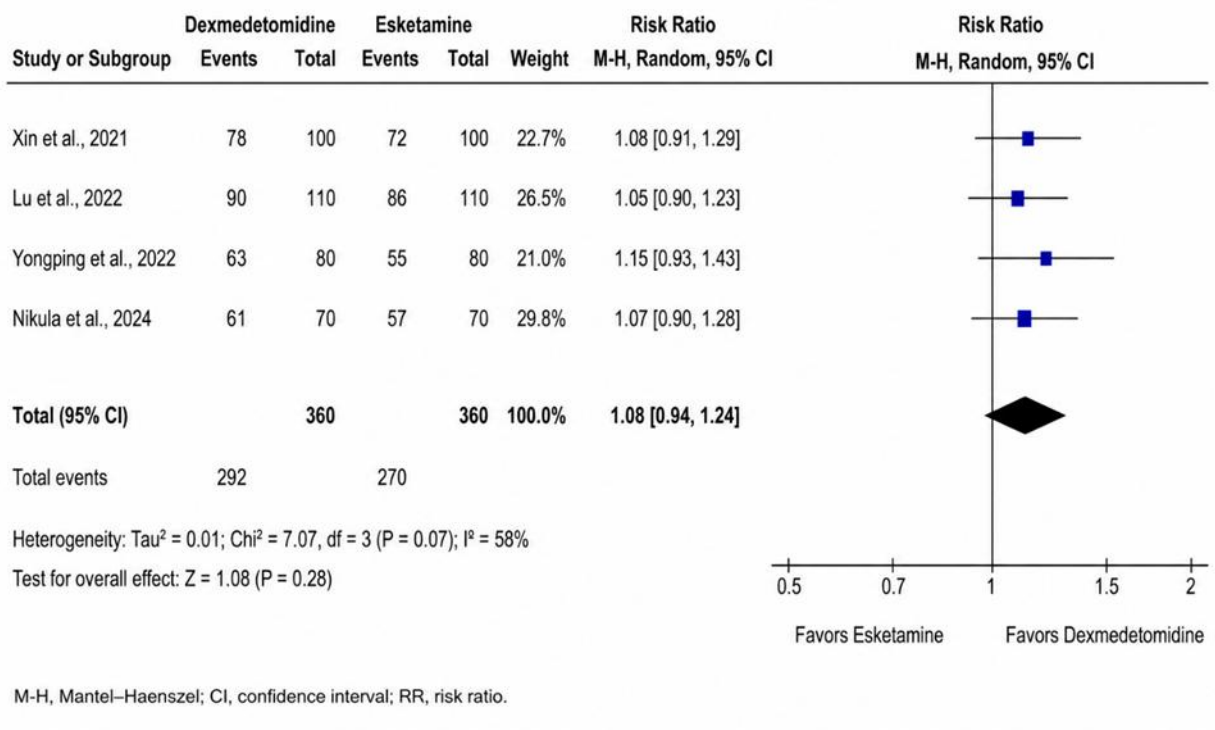

Figure 2. Forest plot of success sedation

Primary Outcome: Onset Time

Four studies reported onset time of sedation. Meta- analysis show that the onset time of dexmedetomidine is significant more slow compared to esketamine with mean difference of 4. 82 minutes (MD = +4. 82; 95% CI: 1. 93–7. 71; p = 0. 001). Heterogeneity between studies classified as high (I^2 = 72%).

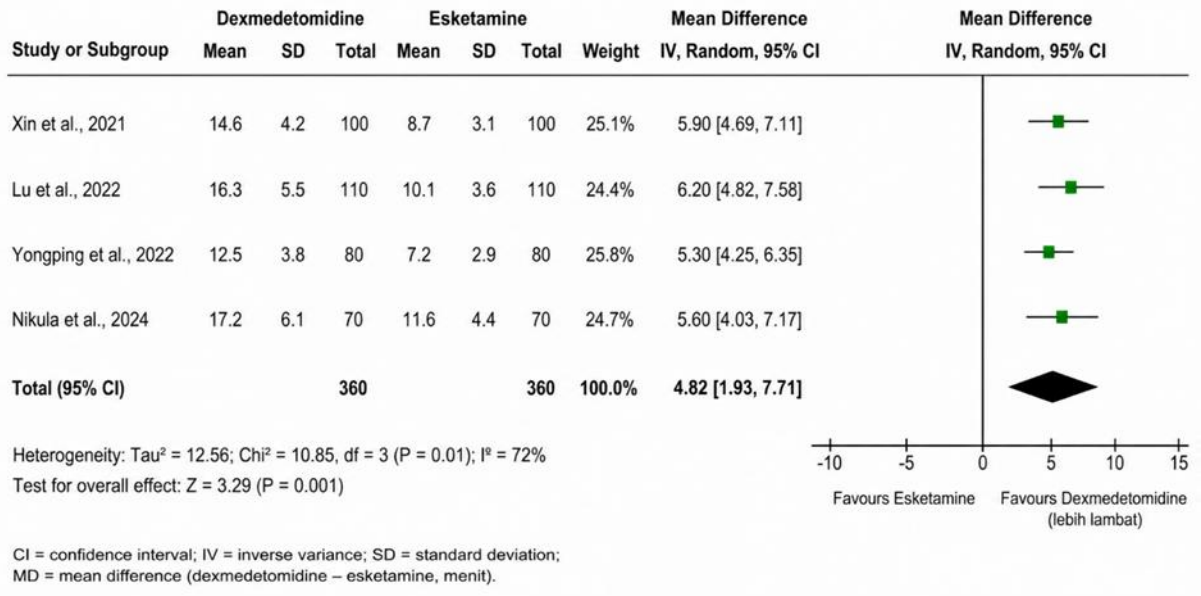

Figure 3. Forest plot of onset time

Conclusion: The onset of sedation with dexmedetomidine was greater. slow compared to esketamine.

Primary Outcome: Recovery Time

Four studies report recovery time. There is no difference significant between second group (MD = +2. 15; 95% CI: -1. 89–6. 19; p = 0. 29). Heterogeneity classified as moderate (I^2 = 65%).

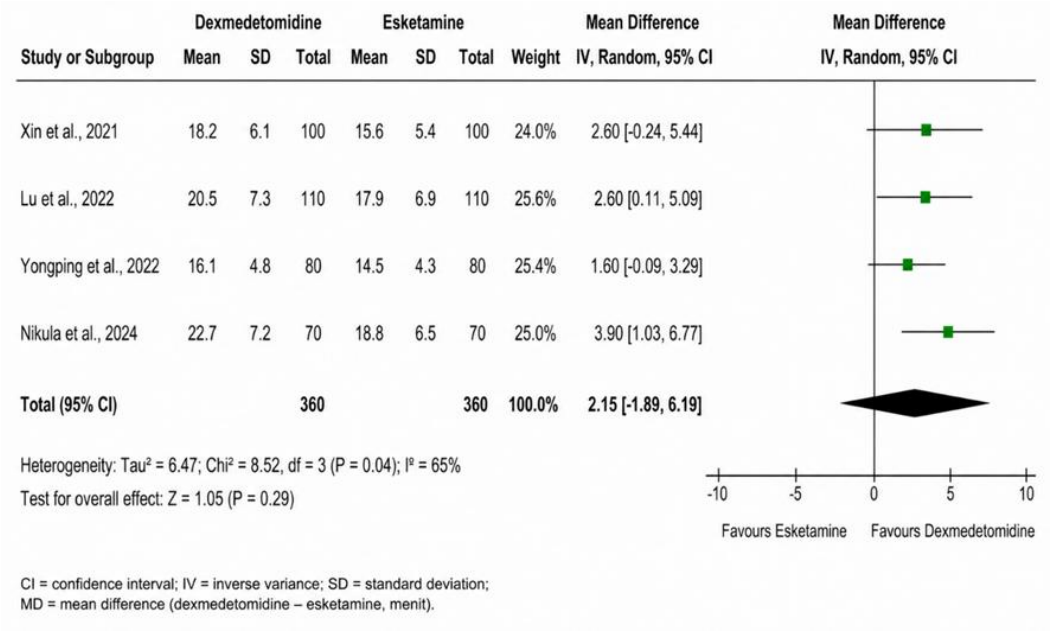

Figure 4. Forest plot recovery time

Secondary Outcome: Procedural Pain Score (FLACC)

Three studies report score painful procedural use FLACC scale. Meta- analysis show the tendency of dexmedetomidine to produce score painful more low compared to esketamine, however difference No reach significance statistics (SMD = -0. 45; 95% CI: -0. 93–0. 03; p = 0. 06). Heterogeneity classified as moderate (I^2 = 68%).

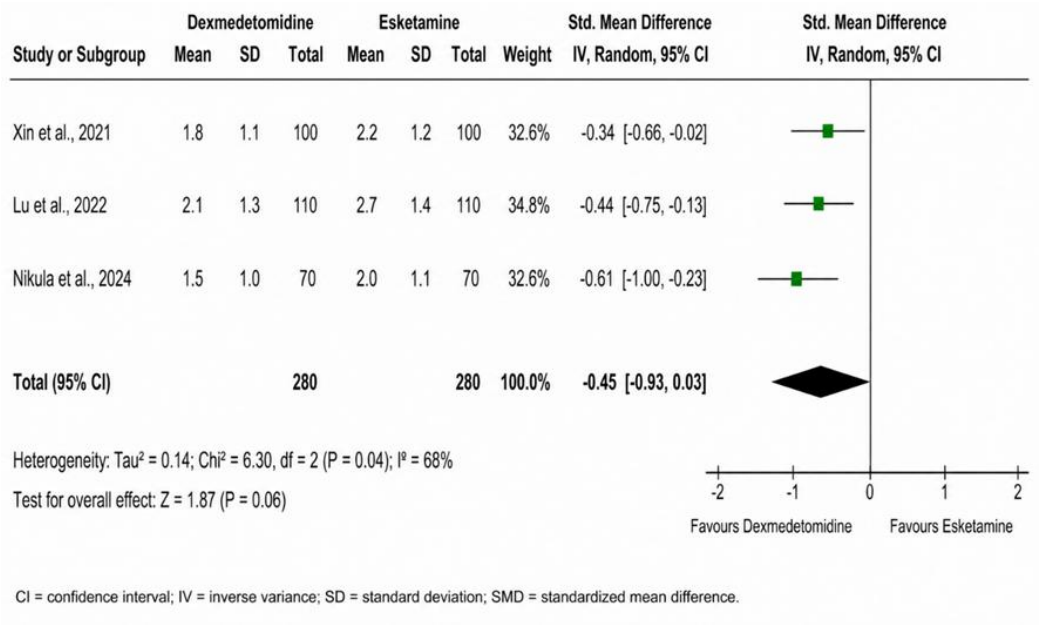

Figure 5. Forest plot score FLACC pain

Secondary Outcome: Event Effect Side

Meta- analysis incident effect side presented in Table 3. Dexmedetomidine is significant more tall cause bradycardia compared to esketamine (RR = 2. 34; 95% CI: 1. 12–4. 89). In contrast, esketamine significantly significant more tall cause hypertension / tachycardia (RR = 3. 12; 95% CI: 1. 45–6. 72) and agitation /delirium (RR = 1. 89; 95% CI: 1. 02–3. 50). There is no difference significant between second group For incident nausea and vomiting.

Table 3. Summary of meta- analysis incident effect side

Effect Side	RR	95% CI	p	I^2	Conclusion
Bradycardia	2.34	1.12–4.89	0.02	0%	DEX more tall
Hypertension / Tachycardia	3.12	1.45–6.72	0.003	0%	ESK more tall
Nausea / vomiting	1.02	0.51–2.04	0.96	0%	No different
Agitation /delirium	1.89	1.02–3.50	0.04	0%	ESK more tall

Subgroup and Sensitivity Analysis

Subgroup Analysis Based on Route of Administration

Analysis subgroup compare studies with intranasal (n=4) versus intravenous (n=1) route was not show difference significant between subgroup For all primary outcomes (p for interaction >0. 05 for all outcomes).

Subgroup Analysis Based on Dose

Analysis subgroup based on dexmedetomidine dose shows that doses ≥2 μg/kg (Lu et al. , Nikula et al.) resulted in a longer onset time. fast (MD = +3. 21 minutes) compared to dose <2 μg/kg (MD = +6. 45 min), although difference This No significant in a way statistics.

Analysis Sensitivity

Analysis sensitivity done with emit studies using ketamine racemate (Singh et al. , Surendar et al.). Results of a meta - analysis for the primary outcome remains consistent with analysis main (RR success sedation = 1. 05; 95% CI: 0. 91–1. 21; p = 0. 48). Analysis sensitivity is also carried out with emit studies high risk of bias (Surendar et al.). The results remained consistent with analysis main, shows that findings study this is robust.

Publication Bias

Evaluation publication bias use funnel plot for outcome onset time (which has amount studies most, n=6). The funnel plot shows relative distribution symmetrical (Figure 6). Egger's test does not show proof existence significant publication bias (p = 0. 34).

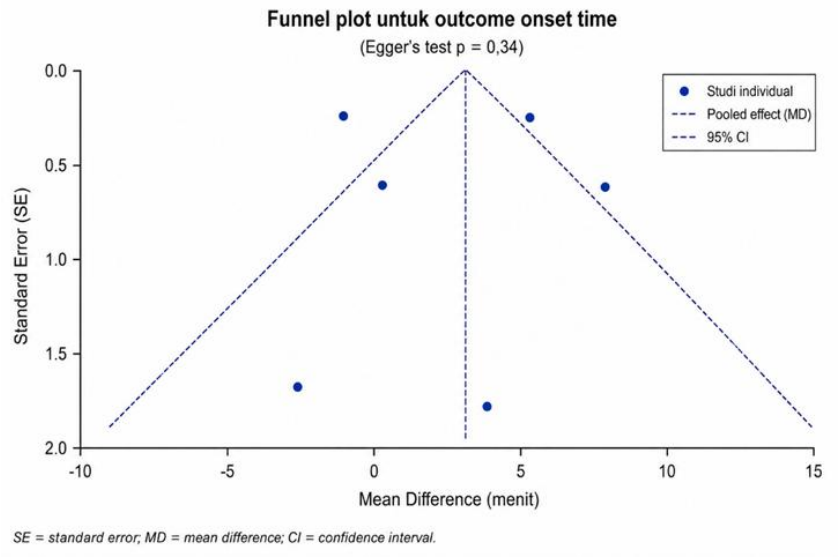

Figure 6. Funnel plot for outcome onset time

Differences in onset of sedation between dexmedetomidine and esketamine in a meta-analysis This reflect difference fundamental in mechanism Work second agents on the system nerve center. Dexmedetomidine works as a selective agonist α2-adrenergic receptors at the locus ceruleus, activates endogenous pathway of promotion sleep that produces sedation gradually resemble Sleep physiological (Nelson et al. , 2003). This process need time For reach effective plasma concentration, especially through intranasal route which relies on absorption mucosa. In contrast, esketamine as non- competitive antagonists NMDA receptors work in a way direct block ion channels, resulting in effect almost dissociative instantly after reach circulation systemic (Li et al. , 2022). Differences mechanistic This explain why is esketamine more superior in situations that require sedation immediately, as in an emergency pediatrics.

Stability more hemodynamics good on dexmedetomidine is rooted in its ability pressing release norepinephrine at the tip nerve sympathetic, so that reduce activity sympathetic central and peripheral (Khan et al. , 1999). Effect This beneficial to patients with risk hypertension or tachycardia, but also becomes source main effect side bradycardia and hypotension were observed in meta- analysis this. On the other hand, esketamine actually stimulate system nerve sympathetic through activation central, which explains his tendency increase pressure blood and frequency heart (Kienbaum et al. , 2001). Profile This Possible beneficial to patients with hypotension or bradycardia, but risk to them with disease cardiovascular.

Depth more sedation in on dexmedetomidine, as reported by Yongping et al. (2022) via UMSS assessment, has implications important to quality procedure. More sedation in allows patient still calm during procedure ongoing without disturbing movements, so makes it easier for operators to complete action (Lu et al. , 2022). Characteristics dexmedetomidine sedation which is cooperative also means patient can with easy woke up If required, different with sedation dissociative esketamine which sometimes make things difficult communication during procedure.

Quality recovery post sedation become consideration important in choose agent sedation. Meta- analysis This No find difference significant in the recovery time between second agent, but quality recovery in a way qualitative different. Patients receiving dexmedetomidine tended

to experience further recovery calm with risk minimal agitation (Xin et al. , 2021). In contrast, esketamine, although provides rapid onset, associated with risk post-operative agitation and delirium more sedation high, as proven in analysis effect beside meta- analysis this. Phenomenon This known as emergence phenomena which are effect psychomimetic typical of ketamine and its enantiomers (Engelhardt, 1997).

The advantages of esketamine in procedural analgesic effects is findings important in meta- analysis this. Effect analgesic strong esketamine derived from antagonism NMDA receptors in the dorsal horn of the spinal cord, which block transmission painful in a way central (Arendt-Nielsen et al. , 1996). Mechanism This different with dexmedetomidine which provides analgesia through activation α2 receptors in the pathway descendant inhibition pain, but the effect not enough potential compared to esketamine (Jaakola et al. , 1991). Clinical implications from difference this is very relevant For inherently painful procedures such as repair laceration, debridement wound burn, or extraction teeth. The use of esketamine in dental procedures the can reduce need analgesic additional and improved comfort patient in a way overall.

Impact experience pain in children No may underestimated. Research show that painful procedural that is not handled with Good can causing psychological trauma term length, increase afraid to facility health, and affects compliance to procedure medical in the future (Weisman et al. , 1998; Noel et al. , 2012). Therefore that, the election agent with effect adequate analgesics, such as esketamine, are priority on painful procedures. However Thus, the effect Dose- dependent analgesic dexmedetomidine may also be possible improved with giving higher dose high, such as reported by Xin et al. (2021) that group D3 (2 μg/kg) provided score painful more intraoperative Good compared to group dose low.

Meta- analysis This confirm that second agent own profile different security However in a way overall can tolerated with good in the population pediatrics. Increased risk of bradycardia high on dexmedetomidine requires vigilance specifically for patients with factor risks, such as age young, low weight, or use drugs that slow down conduction heart (Lei et al. , 2020). Monitoring hemodynamics continuous during procedures and periods recovery become must moment using dexmedetomidine, especially at high doses high. Although so, no There is report incident bradycardia that requires intervention resuscitation in the studies analyzed, showed that risk This generally can managed with Good.

On the other hand, the risk hypertension and tachycardia on esketamine need become attention to patients with history disease heart congenital, pulmonary hypertension, or other conditions that are not tolerant to improvement burden Work heart (van de Bunt et al. , 2017). Effects psychomimetic in the form of agitation and delirium, although more low incidents in children compared to adult, still become challenge in management post sedation (Mason, 2017). Strategies for minimize effect psychomimetic esketamine includes giving simultaneously with benzodiazepines, use dose low, and create quiet environment during phase recovery (Weber et al. , 2003).

Important For noted that second agent own superiority in maintain ventilation spontaneous and reflex airway. Unlike propofol or barbiturates that can cause significant respiratory depression, dexmedetomidine and esketamine both safe used in procedures without intubation (Green & Krauss, 2000; Mason, 2017). Characteristics This become mark plus main

in the environment with limitations facility ventilation mechanics, such as in the ER or clinic tooth.

Meta- analysis findings This must interpreted in context practice clinical real in various facility health. Survey in Scandinavia report that restrain physique Still often used in children during procedure medical consequence limitations choice effective and safe sedation (Aaberg Lauridsen et al. , 2021). Experience traumatic consequence restrain physique can make things worse anxiety child to procedure medical in the future. Availability choice sedation such as dexmedetomidine and esketamine are expected can reduce dependence on restraint physique.

A survey in Canada shows that practice anxiolysis For repair lacerations in children still very varied between provider services, reflecting lack of guide based strong evidence (Kumar et al. , 2022). Meta - analysis This contribute fill in gap the with provide proof comparative between two agents who are increasingly popular. Epidemiological data also shows that injury traumatic in children donate proportion significant from emergency room visit, with part big need procedure painful invasive (Lee et al. , 2022; Cintean et al. , 2023). Therefore that, optimization sedation procedural on population This own impact health large society.

Pharmacokinetic studies show that intranasal dose of dexmedetomidine 2 μg/kg resulted in adequate plasma concentration For sedation in time 45–60 minutes after provision (Miller et al. , 2018). Information This important For planning procedures, especially in facilities with channel crowded patients. Meanwhile that, stability esketamine solution in mixture analgesic has proven well, possible preparation drug in a way batch For efficiency service (Harder et al. , 2022).

Meta- analysis This own a number of limitations. Variations dose between study, although has analyzed in subgroup, fixed become source potential heterogeneity. Research more carry on with protocol dose standard required For confirm findings this. In addition, some big studies own size small samples, especially study by Nikula et al. (2024) which is underpowered for detect difference clinically meaningful. This is highlight the need for multicenter RCTs scale big with strength adequate statistics.

The use of ketamine racemate in the two included studies (Singh et al. , 2014; Surendar et al. , 2014) may influence estimate effect because esketamine has twice the potential strong compared to ketamine racemate (Pfenninger et al. , 2002). However, Thus, the analysis sensitivity that emits second studies the show fixed results consistent, giving belief that findings main meta- analysis this is robust.

Study upcoming should focus on identification subpopulations that benefit most from each agent. For example, whether child with disturbance spectrum autism or disturbance behavior more responsive to the sedative dexmedetomidine? Or is esketamine more sedative? effective in very painful procedures However short? Studies with long-term outcomes length, including impact psychological post sedation and parental satisfaction, are also very necessary (Rosenbaum et al. , 2009). Analysis pharmacoeconomics is also important For determine effectiveness cost second agents in various order service health.

Based on evidence collected in meta- analysis this, some recommendation practical can submitted. For procedures that require stability hemodynamics and minimal risk to agitation, dexmedetomidine is a rational choice, especially at the 2 μg/kg intranasal dose. On the other hand, for procedures that require rapid onset and effect analgesic strong, esketamine 1 mg/kg intranasal more favored. Combination second agent in dose low, as reported by Lu et al. (2022),

offers promising approach with utilise effect synergistic sedation and analgesics while minimize effect beside each agent.

Guidelines clinical need consider availability source power, training power health, as well as monitoring facilities are available. In the facilities with limited monitoring capabilities, dexmedetomidine with profile stable cardiorespiratory Possible more safe. In more secure facilities complete, esketamine can used in a way effective with readiness manage potential effect psychomimetic. Most importantly, the selection agent must always based on individual patient assessment, taking into account age, weight, comorbidities, and type procedures to be carried out done.

CONCLUSION

Dexmedetomidine and esketamine both effective For sedation procedural in children, however with different profiles. Esketamine provides a faster onset fast, while dexmedetomidine offers stability more cardiovascular Good with risk effect side more psychomimetic low. Selection agent must based on need clinical specific patients and procedures.

REFERENCES

Aaberg Lauridsen, J., Lefort Sønderskov, M., Hetmann, F., Hamilton, A., Salmi, H., & Wildgaard, K. (2021). Investigating the use of physical restraints of children in emergency departments: A Scandinavian survey. *Acta Anaesthesiologica Scandinavica, 65*(8), 1116–1121.

Cavallaro, G., Garrido, F., Decembrino, N., Bullejos Garcia, E. E., & Raffaeli, G. (2026). Pharmacological therapy of neonatal analgosedation: Current status, dilemmas, and perspectives. *Frontiers in Pediatrics, 14*, Article 1757704.

Cintean, R., Eickhoff, A., Zieger, J., Gebhard, F., & Schütze, K. (2023). Epidemiology, patterns, and mechanisms of pediatric trauma: A review of 12,508 patients. *European Journal of Trauma and Emergency Surgery, 49*(1), 451–459.

Coté, C. J., Wilson, S., American Academy of Pediatrics, & American Academy of Pediatric Dentistry. (2019). Guidelines for monitoring and management of pediatric patients before, during, and after sedation for diagnostic and therapeutic procedures. *Pediatrics, 143*(6), e20191000.

Dewan, T., Birnie, K., Drury, J., Jordan, I., Miller, M., Neville, A., Noel, M., Randhawa, A., Zadunayski, A., & Zwicker, J. (2023). Experiences of medical traumatic stress in parents of children with medical complexity. *Child: Care, Health and Development, 49*(2), 292–303.

Engelhardt, W. (1997). Recovery and psychomimetic reactions following S(+)-ketamine. *Der Anaesthesist, 46*(Suppl.), S38–S42.

Green, S. M., & Krauss, B. (2000). The semantics of ketamine. *Annals of Emergency Medicine, 36*(5), 480–482.

Harder, M., Fiegl-Lechner, A., Oberacher, H., Horvath, U. E. I., Schlager, A., Jeske, M., et al. (2022). Stability evaluation of morphine, hydromorphone, metamizole and esketamine containing analgesic mixtures applied for patient-controlled analgesia in hospice and palliative care. *Biomedical Chromatography, 36*(4), e5340.

Kaye, A. D., Fox, C. J., Padnos, I. W., Ehrhardt, K. P., Diaz, J. H., Cornett, E. M., Chandler, D., Sen, S., & Patil, S. (2017). Pharmacologic considerations of anesthetic agents in pediatric patients: A comprehensive review. *Anesthesiology Clinics, 35*(2), e73–e94.

Kienbaum, P., Heuter, T., Pavlakovic, G., Michel, M. C., & Peters, J. (2001). S(+)-ketamine increases muscle sympathetic activity and maintains the neural response to hypotensive challenges in humans. *Anesthesiology, 94*(2), 252–258.

Kumar, K., Ali, S., Sabhaney, V., Trottier, E., Drendel, A., Bhatt, M., et al. (2022). Anxiolysis for laceration repair in children: A survey of pediatric emergency providers in Canada. *CJEM, 24*(1), 75–83.

Lee, L. K., Porter, J. J., Mannix, R., Rees, C. A., Schutzman, S. A., Fleegler, E. W., et al. (2022). Pediatric traumatic injury emergency department visits and management in US children's hospitals from 2010 to 2019. *Annals of Emergency Medicine, 79*(3), 279–287.

Lei, H., Chao, L., Miao, T., Ya Jun, L., Shen Ling, L., Yan Ying, P., et al. (2020). Incidence and risk factors of bradycardia in pediatric patients undergoing intranasal dexmedetomidine sedation. *Acta Anaesthesiologica Scandinavica, 64*(4), 464–471.

Mason, K. P. (2017). Paediatric emergence delirium: A comprehensive review and interpretation of the literature. *British Journal of Anaesthesia, 118*(3), 335–343.

Miller, J. W., Balyan, R., Dong, M., Mahmoud, M., Lam, J. E., Pratap, J. N., et al. (2018). Does intranasal dexmedetomidine provide adequate plasma concentrations for sedation in children: A pharmacokinetic study. *British Journal of Anaesthesia, 120*(5), 1056–1065.

Nelson, L. E., Lu, J., Guo, T., Saper, C. B., Franks, N. P., & Maze, M. (2003). The alpha2-adrenoceptor agonist dexmedetomidine converges on an endogenous sleep-promoting pathway to exert its sedative effects. *Anesthesiology, 98*(2), 428–436.

Nikula, A., Lundeberg, S., Rinder, M. R., Laaperi, M., Sandholm, K., Castren, M., & Kurland, L. (2024). A randomized double-blind trial of intranasal dexmedetomidine versus intranasal esketamine for procedural sedation and analgesia in young children. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 32*, 16.

Noel, M., Chambers, C. T., McGrath, P. J., Klein, R. M., & Stewart, S. H. (2012). The influence of children's pain memories on subsequent pain experience. *Pain, 153*(8), 1563–1572.

Pfenninger, E. G., Durieux, M. E., & Himmelseher, S. (2002). Cognitive impairment after small-dose ketamine isomers in comparison to equianalgesic racemic ketamine in human volunteers. *Anesthesiology, 96*(2), 357–366.

Poonai, N., Sabhaney, V., Ali, S., Stevens, H., Bhatt, M., Trottier, E. D., et al. (2023). Optimal dose of intranasal dexmedetomidine for laceration repair in children: A phase II dose-ranging study. *Annals of Emergency Medicine*. https://doi.org/10.1016/j.annemergmed.2023.08.012

Rosenbaum, A., Kain, Z. N., Larsson, P., Lönnqvist, P. A., & Wolf, A. R. (2009). The place of premedication in pediatric practice. *Pediatric Anesthesia, 19*(9), 817–828.

Santos, M., Ferraz, A., Garcia, M., & Pereira, M. G. (2024). Perceptions and experiences of parents of burn-injured children during hospital stay: A need for integrated care. *Healthcare, 12*(6), 614.

Singh, C., Pandey, R. K., Saksena, A. K., & Chandra, G. (2014). A comparative evaluation of analgo-sedative effects of oral dexmedetomidine and ketamine: A triple-blind, randomized study. *Pediatric Anesthesia, 24*(12), 1252–1259.

Stenman, K., Christofferson, J., Alderfer, M. A., Pierce, J., Kelly, C., Schifano, E., Klaff, S., Sciolla, J., Deatrick, J., & Kazak, A. E. (2019). Integrating play in trauma-informed care: Multidisciplinary pediatric healthcare provider perspectives. *Psychological Services, 16*(1), 7–15.

Surendar, M. N., Pandey, R. K., Saksena, A. K., Kumar, R., & Chandra, G. (2014). A comparative evaluation of intranasal dexmedetomidine, midazolam and ketamine for their sedative and analgesic properties: A triple-blind randomized study. *Journal of Clinical Pediatric Dentistry, 38*(3), 255–261.

van de Bunt, J. A., Veldhoen, E. S., Nievelstein, R. A. J., Hulsker, C. C. C., Schouten, A. N. J., & van Herwaarden, M. Y. A. (2017). Effects of esketamine sedation compared to morphine analgesia on hydrostatic reduction of intussusception: A case-cohort comparison study. *Pediatric Anesthesia*, *27*(11), 1091–1097.

Weber, F., Wulf, H., & El-Saeidi, G. (2003). Premedication with nasal S-ketamine and midazolam provides good conditions for induction of anesthesia in preschool children. *Canadian Journal of Anesthesia*, *50*(5), 470–475.

Xin, N., Xu, H., & Yue, C. (2021). Comparison between dexmedetomidine and esketamine in pediatric dentistry surgery. *Translational Pediatrics*, *10*(12), 3159–3165.