REVIEW ARTICLE

Assessment of the Safety of Sedative Anesthesia in Pediatric Dentistry: A Systematic Review

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Received: 21-09-2024 **Accepted:** 11-11-2024 **Published:** 23-12-2024

ABSTRACT

Children are undergoing diagnostic and therapeutic procedures outside of the operating room on an increasing basis. To accomplish the cooperation and immobilisation necessary for the successful completion of these procedures, a variety of methods, including conscious and profound sedation, and in some circumstances general anaesthesia, have been advocated.Safety and well being of the child is the utmost priority while undergoing sedation. Awareness of the choice of the sedative and the dosage required and the potential side effects and hazards of using sedative anesthesia needs to be updated regularly.This systematic review aims to evaluate the safety and effectieveness of commonly used sedative anesthetics for children.

The PICO, population, intervention, comparator and outcomes strategy used was as follows: population, children requiring dental surgical procedures; intervention, oral sedation; comparator, placebo group or other oral drug administered; and outcomes, effectiveness: anxiety, sedation and satisfaction with the treatment and safety: adverse effect, heart rate, respiratory rate, blood pressure and oxygen saturation.

9 articles were selected out of a total of 1135 searched articles from various databases and all 9 were assessed for risk of bias.Findings of our systematic review implies that to produce a deeper level of sedation, the combination of nitrous oxide, oxygen, and a hypnotic drug is effective, allowing pediatric patients to tolerate with low untoward incidents reported.

KEYWORDS: propofol, sedative anesthesia, ketamine, pediatric dentistry

INTRODUCTION

Children are undergoing diagnostic and therapeutic procedures outside of the operating room on an increasing basis. To accomplish the cooperation and immobilisation necessary for the successful completion of these procedures, a variety of methods, including conscious and profound sedation, and in some circumstances general anaesthesia, have been used.Safety and well being of the child is the utmost priority while undergoing sedation. Awareness of the choice of the sedative and the dosage required and the potential side effects and hazards of using sedative anesthesia needs to be updated regularly.

Various patient management strategies have been employed during complex dental procedures that include behavioral techniques, oral sedatives, inhaled nitrous oxide (N2O), and general anesthesia.(1,2) Although widely used, minimal or moderate sedation (for example using oral sedatives and N2O) is unpredictable especially in young children. General anesthesia is more successful, but is invasive and higher-risk. For a number of non- and semi-invasive procedures in children, deep sedation provided by non-anesthesiologist specialists has shown to be safe, effective and cost effective. (2)

According to the Scottish Dental Clinical Effectiveness Program Sedation Guidelines, inhalation sedation (IHS) with nitrous gas is the recommended initial step for patients who require conscious sedation. According to IACSD (2015) data, sedation is effective, safe, and well-tolerated for children as young as four years old. However Sedation brings with it cost, time, and safety concerns.

The efficacy of IHS is backed by a foundation of fundamental behavioural management techniques and the safest, most effective amount of nitrous oxide, which enables patients to accept dental treatment.

In adolescents, however, success may be limited by significant oral anxiety and/or complex dental treatment , and these patients may require alternative sedation or general anaesthesia(1). For anxious adolescent patients, it is best to select the most effective treatment with caution,appropriate pharmacological technique for the individual patient to avoid progressing through a range of techniques that may possibly fail based on their clinical and dental need (SDCEP 2017).Many sedative agents including midazolam,temazepam,sevoflurane have been used over a period of time. However propofol remians the most used and most studied agent.

This systematic review aims to evaluate the safety and effectieveness of commonly used sedative anesthetics for children.

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MATERIALS AND METHODS

The PICO, population, intervention, comparator and outcomes strategy used was as follows: population, children requiring dental surgical procedures; intervention, oral sedation; comparator, placebo group or other oral drug administered; and outcomes, effectiveness: anxiety, sedation and satisfaction with the treatment and safety: adverse effect, heart rate, respiratory rate, blood pressure and oxygen saturation.

Inclusion criteria

Participant Children requiring dental surgical procedures, such as dental extraction, surgery for orthodontic purposes, pulpotomy and pulpectomy procedures and other dental surgical interventions.

Exclusion criteria

Studies involving adults and studies involving children with respiratory diseases,were excluded.
Outcomes assessed

Primary outcomes 1. Effectiveness measured by improvement in anxiety by using the Dental Anxiety Scale (DAS), Oral Surgery Confidence Questionnaire (OSCQ) and/or other scales for anxiety symptoms. 2. Safety measured by the number of participants that reported side effects, number of adverse effects (or adverse drug reactions) and number of participants that dropped out due to side effects.

Secondary outcomes 1. Secondary outcomes of effectiveness were sedation and satisfaction with the treatment. 2. Secondary outcomes of safety were heart rate, respiratory rate, blood pressure and oxygen saturation.

Data Extraction

Electronic database search The following databases were searched: Cochrane Central Register of Controlled Trials (CENTRAL), which includes Dentistry and Oral Health Group's Specialized Register, MEDLINE, Excerpta Medica Database (EMBASE) without restrictions on language or publication date, with the search encompassing articles published between inception and June 2022.

Data management

After performing the search strategies on each electronic database, the researchers imported the results from each search into an EndNote library. Duplicate entries were identified and removed. Study eligibility determination Relevant data from the eligible studies were independently extracted into Microsoft Excel, using a standardised data extraction form. Four reviewers , working in pairs and independently, selected potentially relevant titles and abstracts and applied the eligibility criteria. Full texts of the potentially eligible articles were obtained. Similarly, the reviewers checked the eligibility of each study. Disagreements were resolved by consensus and, when necessary, arbitrated by a third reviewer.
The same reviewers working in pairs and independently, used a standardised and pretested form for data extraction. Subsequently, the reviewers extracted the patient data, methods, interventions and outcomes. We contacted the authors for articles with incomplete methods and results data, if necessary. Disagreements were resolved by consensus and, when necessary, arbitrated by a third reviewer.

Risk of bias

A modified version of the Cochrane collaboration approach for assessing the risk of bias was used.The same reviewers, again in pairs and independently, evaluated the risk of bias for each clinical trial according to randomisation; allocation concealment; blinding of patients, health professionals and outcome assessors incomplete outcome data; selective outcome reporting; and major baseline imbalance characterising the sample. The same reviewers attributed the standard answers 'definitely yes', 'probably yes', 'probably no' and 'definitely no' for each domain, with 'definitely yes' and 'probably yes' denoting a low risk of bias and 'definitely no' and 'probably no' attributing a high risk of bias. Disagreements were resolved by consensus and, when necessary, arbitrated by a third reviewer.

Data synthesis and analysis of the quality of evidence

A narrative synthesis of the findings was carried out. The extracted data were summarised in the tables with the measures (mean, SD and absolute and relative frequency). Heterogeneity was explained by drug doses (higher vs lower) with greater effect than expected at higher doses and treatment time (longer vs shorter).Due to the divergences between the drugs prescribed and the doses used and measured outcomes, a meta-analysis was not performed, and the Grading of Recommendations, Assessment, Development and Evaluation could not be produced.
Some research lacked sufficient information on the randomisation method, precluding assessment, and selection bias was present.Patients, according to some were randomly assigned to groups, but no information about the groups' utilized technique

Results

Figure 1 is a flowchart of the search and selection procedure for articles based on PRISMA 2020 guidelines. According to the SIGN checklist, cohort studies are acceptable and case-control studies are of good quality, while all selected publications are acceptable according to the JBI checklist. All ten studies from the selected databases meet the age requirement of 18 years old. Two of the ten studies have descriptive cross-sectional study designs, seven has case-control study research designs, and one has retrospective cohort study designs. RDC/TMD was utilised to assess and diagnose TMD in six of the investigations, RDC/TMD and Fonseca Index in one study, and FAI index in one study (Fonseca Anamnesis Index).
In this systematic review authors followed the PRISMA 2020 flow diagram as represented in figure 1. In the identification stage, 1135 articles were found in the initial search. Duplicates found simultaneously between multiple databases were removed. In the screening stage, 630 articles were removed according to the titles and abstract summaries, a total of 119 articles remained after elimination. Further removal was done after reading the whole articles and relating them with the inclusion and exclusion criteria. Finally 9 articles were selected and all were assessed for risk of bias.

DISCUSSION

Although general anesthesia (GA) is generally considered to be safe in a hospital setting, it is now accepted that GA should be avoided wherever possible due to an increased risk of complications, need for highly skilled personnel and equipment,and being expensive.

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Using deep sedation to carry out pediatric dental treatments is an alternative strategy. However, because potential and real risks, it is often carried out in dental settings where other support resources are not immediately available.

In a study published in Lancet journal in the year 2001, In a variety of non-specialized settings, Olivier et al investigated the prevalence of adverse events in children sedated with 50% nitrous oxide and oxygen. A mean of 0.33% (SD 0.10%) of children experienced serious adverse effects. As a result, a mixture of 50% nitrous oxide and 50% oxygen appeared to be a safe option for paediatric procedural sedation(12).

However in recent years, the number of paediatric surgeries requiring sedation or analgesia has increased significantly, as have reports of adverse events.Although various guidelines have been published, there is limited consensus regarding which medications may be administered safely in a non-specialist setting. Sury and colleagues(13) have demonstrated that for diagnostic imaging, oral sedation with chloral hydrate or benzodiazepines under the supervision of specialised nurses is effective and safe. However, the safety of regimens appropriate for painful procedures appears to be less proven. (14-16)
The sedation of children for the delivery of dental care has been successfully executed using different drug regimens. These are currently the most common sedation techniques used by paediatric dentists:Nitrous oxide inhalation sedation using only oxygen, Midazolam (benzodiazepine) alone, or A mixture of both substances.(17-19)
In-office sedation is also less expensive and safer than conscious sedation and general anaesthesia. Other alternatives include Dexmedetomidine hydrochloride, 2-adrenergic agonist, Chloral hydrate with inhibitory action on the cerebral hemisphere of the central nervous system, and General anaesthesia.

Nitrous oxide
As a sedative, nitrous oxide (N2O) gas, also known as laughing gas, is utilised. N2O2 appears as an odourless, colourless gas. The procedure is helpful because it produces a pleasant sensation, which calms the patient. The medicine is fast-acting, and its effects can be reversed quickly and easily when necessary. Because of this, it is considered a safe type of sedation. (20-22)

Midazolam
Midazolam is a short-acting benzodiazepine derivative used to induce drowsiness and reduce anxiety before to surgery or other operations. When Midazolam is administered prior to surgery, the patient will not recall certain aspects of the process. (23,24)

Propofol
Propofol is a powerful sedative characterized by rapid onset and short duration of action. Adverse effects include transient hypotension and dose-dependent respiratory depression.(25) Propofol has been shown to allow rapid recovery, making it an ideal agent for minor procedures outside operating suites. Bradycardia has been described as a possible adverse effect of propofol when administered alone or in combination with opioids.(26) The successful use of propofol in dentistry is widely reported. (27)

Fentanyl
Fentanyl is often co-administered for pain control during procedural sedation. (28) However, this may have an additive respiratory depressant effect with propofol. (29) Similarly, a sub-dissociative dose of ketamine has been used for its analgesic effects as an adjunct to propofol, and has been shown to be effective in procedural sedations for painful procedure with less respiratory and hemodynamic depressant effects. (30,31)

Administering an adjunct analgesic during propofol procedural sedation is not a routine practice. However, recently, recommendations were made to use propofol following achievement of analgesia with an opioid. Although sedated patients may not clearly recall procedural pain, painful stimuli can sensitize the nervous system of clinically- unresponsive patients and may lead to increased post-operative pain and hyperalgesia. (32) The use of intravenous analgesics including opioids and ketamine has been encouraged to avoid this phenomenon.(33,34) Therefore, it is important to differentiate between sedation and analgesic effect and to treat expected intraoperative pain adequately during procedural sedation.

A variety of drugs have been used for moderate sedation for dental procedures. The efficacy and safety of IV midazolam, ketamine and propofol was assessed in 350 uncooperative children in multiple studies aged 3-6 years requiring oral rehabilitation.(35,36) Ketamine was most effective without adverse events followed by propofol and midazolam. The latter two drugs were not able to control body movement and crying throughout the procedure. Oral chloral hydrate and I/M Ketamine were compared by Campbell in 15 patients. Satisfactory completion of restorative dentistry longer than 40 minutes was obtained in the group with intramuscular ketamine.(37) In four studies, high-dose propofol, (alone or in combination with ketamine or fentanyl) was equally effective and safe for dental procedures.

CONCLUSION

Providing exceptional dental treatment to pediatric kids can be a challenge. The primary goal of paediatric dental sedation and treatment is to preserve the child's confidence by delivering minimal stress. To explicitly establish a high safety standard and apply it in clinical practice, practitioners should attempt to limit patient risk by selecting medically fit patients for sedation. Behavior management and sedation are two of the most common methods used to treat anxious youngsters. Typically, when behavioral strategies are insufficient to control a child, pharmaceutical medications are employed. Findings of our systematic review implies that to produce a deeper level of sedation, the combination of nitrous oxide, oxygen, and a hypnotic drug such as Midazolam is effective, allowing pediatric patients to tolerate unpleasant treatments by lowering discomfort, anxiety, and/or pain. Given the preference of parents and the rising prevalence of pediatric dental disease, it is projected that the demand for safe dental sedation would increase in the future.

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How to Cite: Ahmed S, Alnajem SA, AlAmeen AM,Ghandoora FM, Alsayegh YHM et al.Assessment of the safety of sedative anesthesia in pediatric dentistry. A systematic review. *Radiol Med*. 2024 Dec;18(3): 95-99

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