Sedation in pediatric dentistry, an overview and current update

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Abstract

Introduction: Conscious sedation is a technique of administering sedatives or dissociative agents with or without analgesics to induce a state that allows the patient to tolerate unpleasant procedures.

Objective: To analyze the literature on the types of sedation and the different drugs that can be used such as midazolam, dexmedetomidine, propofol, and nitrous oxide.

Methodology: A comprehensive search was performed in PubMed, SCOPUS and Google Scholar using keywords such as sedation, pediatric dentistry, midazolam, dexmedetomidine, propofol, nitrous oxide.

Results: The types of sedation are minimal, moderate, and general anesthesia, the most used anesthetic agents, administered individually or in combination, are diazepam, midazolam, propofol, ketamine, opiate agonists such as fentanyl or remifentanil, and dexmedetomidine, and on the other hand, the most used inhalation agents are nitrous oxide and sevoflurane.

Keywords: Sedation, pediatric dentistry, propofol, nitrous oxide, midazolam, dexmedetomidine

1. Introduction

Pediatric dentists have always faced the difficult task of managing dental fear and anxiety, which is an obstacle to successful treatment of children and even impedes the quality of care by the dentist [1]. Patients with particular medical conditions and extensive dental complications tend to show greater fear and lack of cooperation in their treatment, mainly due to physical problems, mental disabilities, or behavioral management problems [2]. Nowadays, there are different techniques used to manage them, among which sedation with different anesthetic agents has become popular [3].

Conscious sedation is a technique of administering sedatives or dissociative agents with or without analgesics that induce a state that allows the patient to tolerate unpleasant procedures while maintaining cardiorespiratory function. This achieves a depressed level of consciousness that allows the patient to maintain oxygenation and airway control independently [4]. It is considered the most used technique for children with dental anxiety [5], as consciousness is minimally depressed, but the ability to maintain an open airway, protective reflexes and a response to verbal and physical stimulation is maintained [6].

Sedation can be performed by different methods, either orally, through parenteral route with benzodiazepines, inhaled with nitrous oxide, or intravenously [7]. The most used anesthetic agents, administered individually or in combination, are diazepam, midazolam, propofol, ketamine, opiate agonists such as fentanyl or remifentanil, and dexmedetomidine; and on the other hand, the most used inhalation agents are nitrous oxide and sevoflurane [8].

© 2022 IJADS
ISSN Online: 2394-7497
ISSN Print: 2394-7489
IJADS 2022; 8(2): 176-180
Accepted: 23-12-2021
Received: 20-10-2021
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DOi: https://doi.org/10.22271/oral.2022.v8.i2c.1507

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In pediatric dental practice we encounter multiple complications that reduce the success rate of treatment. Therefore, conscious sedation is considered an effective technique, since it reduces patient anxiety, can be used in patients with disabilities, avoids abrupt movements, dental treatment is carried out in a short period of time, and is safe. The aim of this research is to analyze the literature on the types of sedation used and the different medications that can be used for conscious sedation in pediatric dentistry, such as midazolam, dexmedetomidine, propofol and nitrous oxide.

2. Materials and Methods
Articles on the subject published through the PubMed, SCOPUS and Google Scholar databases were analyzed, with emphasis on the last 5 years. The quality of the articles was evaluated using guidelines, i.e., identification, review, choice and inclusion. The quality of the reviews was assessed using the measurement tool for evaluating systematic reviews. The search was performed using Boolean logical operators AND, OR and NOT. The search was performed using Boolean logical operators AND, OR and NOT; with the keywords: “sedation”, “conscious sedation”, “pediatric dentistry”, “midazolam”, “dexmedetomidine”, “propofol” and “nitrous oxide”. The keywords were used individually, as well as each of them related to each other.

3. Results and Discussion
3.1 Types of sedation
Drugs must provide sedative, analgesic, and amnesic properties, as well as a rapid onset of action and a short duration to allow safe and rapid recovery [6]. There are different types of sedation, established by the guidelines of the American Academy of Pediatric Dentistry (AAPD), the American Academy of Pediatrics (AAP), and the American Dental Association (ADA) [9]. Minimal sedation, i.e., the lowest depth of sedation can be easily obtained using oral sedatives, requires no special equipment or tools, and does not affect ventilatory and cardiovascular function [10]. This type of sedation is also called anxiolysis and the patient is awake and relaxed and able to respond normally to verbal stimuli [11].

Moderate sedation is drug-induced, during which patients respond with determination to verbal commands, no interventions are required to maintain a patent airway, spontaneous ventilation is adequate and cardiovascular function is usually maintained [12]. Deep sedation is a drug-induced depression of consciousness during which, patients cannot be easily awakened, as there is a loss of protective reflexes; however, they respond purposefully after repeated verbal or painful stimulation. Cardiovascular function is maintained, but it is necessary to keep the airway patent [13,14].

General anesthesia (GA) involves a drug-induced loss of consciousness during which patients cannot be awakened, even by painful stimulation. The ability to maintain ventilatory function independently is often impaired as its cardiovascular function [15]. This type of analgesia is used because of the extensive and complex treatment requirements and insufficient cooperation often related to the patient's age [16].

In the oral route agents administered that are absorbed through the gastrointestinal (GI) tract or oral mucosa are referred to as enteral sedation, and are subject to enterohepatic circulation and first-pass effect before the drug is released into the systemic circulation. The parenteral route bypasses the GI tract and enters directly into the systemic circulation; within this, administration via the inhaled route has become increasingly popular in pediatric dentistry [9].

It is important to know the types of sedation (minimal, moderate, deep, and general anesthesia) used in pediatric dentistry so that professionals in this area can offer the best option according to the age of the patient and the level of anxiety they present, as well as knowing the type of sedation suitable for patients with special conditions, since sometimes airway and/or cardiovascular assistance is required.

3.2 Midazolam
It is one of the benzodiazepines used for perioperative conscious sedation [17]. Midazolam can be administered orally, intranasally and through parenteral route, but has an unpredictable response, it can be safely used as an oral premedication for intravenous (IV) sedation of pediatric dental patients [18,19]. Oral administration of midazolam in doses of 0.5 mg per 1 kg body weight of the child is safe [20], as it does not produce any respiratory depression in children, decreases the need for analgesics, increases the recovery rate in children undergoing general anesthesia for dental treatment [21] and makes patients more cooperative [22]. One of the advantages of midazolam is that it can be combined with other drugs such as ketamine, which provides moderate dental sedation when administered intranasally, and presents minor adverse events, with marked variability in the behavior of children during dental treatment [23]. The combination of midazolam and chloral hydrate also shows improved cooperation for dental treatment in children [24]. Midazolam is often used as a sedative preoperative medication in pediatric dentistry, with benefits of good behavior, patient cooperation and decreased anxiety.

3.3 Dexmedetomidine
Dexmedetomidine (DEX) is a highly selective α-2 agonist that produces sedative, anxiolytic and analgesic effects without causing respiratory depression and with a low incidence of postoperative agitation [25]; it is an effective and safe drug and that is why it is gaining importance in pediatric sedation. This drug can be administered orally, intravenously, intranasally and intramuscularly [26]. Oral DEX is often used as a premedication, provides satisfactory levels of sedation, ease of separation from parents and mask acceptance in children [27]. In addition, it decreases unexpected patient movements during dental surgery compared to sedation with Propofol and Midazolam [28]. It can be combined with other oral medications such as Ketamine and Fentanyl, serving as an alternative in pediatric sedation, as the combination of dexmedetomidine and oral fentanyl also promises to be a potential sedative agent for children with respect to their successful anxiolysis during treatment procedures [29]. It has been reported that this intravenous drug can be combined with a low dose of Midazolam, being useful for dental treatment of an uncooperative pediatric patient requiring minimal treatment [30]. Intranasal DEX also has satisfactory and effective premedication regimens for uncooperative children [31]. The intravenous moderate sedation regimen with DEX has been shown to produce a milder sedation event. This method of anesthesia may be effective in reducing the waiting time for GA treatment as well as the morbidity associated with GA [32].

This drug has been shown to be a good choice as a sedative in pediatric dentistry due to its anxiolytic and analgesic effects and low postoperative agitation. One of the advantages of this
sedative is the reduction of unexpected movements of the patient during treatment and its combination with other drugs.

3.4 Propofol
Propofol is an intravenous anesthetic used for sedation during monitored anesthetic care or as an induction agent for general anesthesia [33]. It has a short duration of action, rapid elimination and dose-dependent effects leading to changes in blood pressure and heart rate at higher doses [34]. It allows dental procedures in uncooperative pediatric patients to be performed safely and effectively in an outpatient setting by qualified personnel in the management of any complications [3]. This anesthetic can be combined with Midazolam, offering acceptable side effects as an advantage. Lin et al, reported that the factors associated with the combined use of Propofol and Midazolam are young age, male sex, recognition problems and type of dental procedure in the dental treatment of patients with special needs [35]. It can also be administered together with Ketamine (ketofol) achieving adequate sedation and good hemodynamic stability [36], a 1:2 ratio dose of ketofol is related to a decreased side effect profile and high parental satisfaction with rapid recovery, however, dentists' satisfaction is lower [37]. The use of Propofol with remifentanil is contraindicated due to changes in drug concentration over time, non-uniform mixing of these two, risk of bacterial contamination and potential for drug administration errors [38]. However, better parental satisfaction is observed after total intravenous anaesthesia (TIVA) with Propofol. In addition, TIVA results in a more comfortable postoperative period due to reduced postoperative pain, extubation time and recovery time [39]. Propofol is a commonly used anesthetic for sedation in pediatric dentistry due to its rapid effect, short duration, and rapid elimination, helping dentists to effectively carry out dental treatments, as well as making the patient's parents feel satisfied.

3.5 Nitrous Oxide
Nitrous oxide is an anesthetic gas also known as an inhaled anesthetic. It is administered as a primary treatment for preoperative sedation and maintenance of anesthesia adjunct to intravenous anesthetic agents in the perioperative setting [40]. It is a safe, practical, and effective drug with minimal side effects for emergency dental treatment of uncooperative pediatric patients [41]. It is administered through specific vaporizers that transform liquids into gases, and these decrease, or at higher doses eradicate, the patient's consciousness [42]. It is a useful technique to add to the arsenal used in the treatment of teeth with symptomatic irreversible pulps [43]. Sedation with this drug has become the advanced technique of choice for parents [44], and no significant differences in the behavior of children under conscious sedation have been detected using different nitrous oxide gas delivery systems [45]. It can be administered in conjunction with oxygen in patients with behavioral disorders, mental retardation or excessive anxiety about dental care, and patient cooperation has been shown to improve [46].

One study found that this drug can be administered in conjunction with Midazolam and Promethazine, resulting in physiological parameters within normal limits; however, children given Midazolam were significantly more sedated and had superior behavior compared to children given Promethazine. Despite these results, there was no difference in the final phase of treatment between the two drugs [47]. Nitrous oxide is an anesthetic gas very frequently used in pediatric dentistry and preferred by parents. It is a safe sedative that provides good working time and has the advantage of being administered to patients with mental retardation, excessive anxiety, and behavioral disorders.

4. Conclusions
From a practical point of view, the best drug for conscious sedation in pediatric dentistry is nitrous oxide. Nitrous oxide is generally preferred by the parents of patients because it is safe, effective, and has minimal side effects, in addition, it provides a good working time, and can be used in patients with special needs, excessive anxiety or behavioral disorders, making it a good alternative for pediatric conscious sedation.

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