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Revolutionizing Pediatric Sedation: Conscious Sedation Techniques and Agents

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ABSTRACT

Conscious sedation is a technique used in pediatric dentistry to manage anxiety and pain in young patients undergoing dental procedures. The use of sedatives such as nitrous oxide, midazolam, and ketamine can help children remain calm and cooperative during dental treatments. The aim of this abstract is to provide an overview of conscious sedation in pediatric dentistry, including the pharmacology, indications, contraindications, and potential risks and complications associated with its use. The importance of proper patient selection, preoperative evaluation, and monitoring during the procedure is highlighted. In addition, alternative management strategies such as behavioural techniques, local anaesthesia, and general anaesthesia are briefly discussed. Ultimately, conscious sedation can be a valuable tool in pediatric dentistry, but its use should always be carefully considered and implemented by trained and experienced dental professionals.

Keywords: *Conscious sedation, pediatric dentistry, novel, pharmacokinetics. psychology*

INTRODUCTION

The term conscious sedation refers to a controlled state of reduced consciousness, where the patient's protective reflexes remain intact, they can maintain an open airway independently, and respond to physical or verbal stimuli appropriately [1] . In 1992, it was noted that patients can easily move from one level of sedation to another, so healthcare providers must be prepared to monitor them closely and increase vigilance as needed [2]. The conscious sedation method should have a broad safety margin to minimize the risk of unintended loss of consciousness [3].

When administering safe sedation to children, healthcare providers should conduct a thorough evaluation beforehand, assess the airway for any anatomical abnormalities, follow appropriate fasting guidelines for elective procedures, have an understanding of the pharmacodynamics and pharmacokinetics of sedative drugs, use appropriately sized airway equipment and venous access, and provide adequate intraoperative monitoring4,5. The recovery area should have properly equipped staff and follow appropriate discharge criteria6,7.

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Sedative drugs can be administered through different routes, including oral, nasal, intramuscular, intravenous (IV), subcutaneous, and inhalational routes [8,9.10]

Problems With Sedation In Pediatric Dentistry

The problems associated with dental pediatric anesthesia can be categorized into surgical factors and pediatric issues [11]. One surgical factor is that the airway, which is shared by the anesthesiologist and dentist, may become soiled with blood or debris, increasing the risk of arrhythmia during surgery due to stimulation of the trigeminal nerve [12]. Pediatric issues include enlarged tonsils and adenoids, which can lead to respiratory obstruction, and uncooperative behavior and difficulty in communication. Additionally, many medical conditions such as epilepsy, reflux, and cardiac anomalies may coexist with the need for dental anesthesia. Children may also be needle-phobic and highly anxious, have high autonomic activity, delayed gastric emptying, and are at increased risk of arrhythmias and vasovagal response. Ambulatory anesthesia also poses challenges, and proper preparation of the patient through a thorough pre-anesthetic check-up and airway and cardiorespiratory system examinations is crucial. Furthermore, the patient's position in the dental chair is important, and measures for resuscitation and emergency situations should always be readily available [13].

Current Status Of Sedation In Pediatric Dentistry

Sedation is a high-risk procedure for both patients and anesthesiologists, and it is typically used as an alternative to general anesthesia for unavoidable dental procedures [14]. However, over-sedation or under-sedation can be unacceptable in some situations. To reduce the need for sedation, psychological methods such as cognitive reconstructing, hypnosis, relaxation and distraction techniques, systematic desensitization, and conditioning can be used. Conscious sedation may be indicated in pediatric patients with low coping capacity, behavior management problems, dental fear and anxiety, mental retardation, general disorders, psychiatric conditions, emergency treatment needs, or moderate to large and complicated treatment needs [15]. However, sedation is contraindicated in children under one year of age.

Preparation For Conscious Sedation

In addition to the SOAP-ME approach, it is important to have a trained and experienced team to carry out the sedation procedure. The team should include a pediatric dentist or oral surgeon, a trained and licensed anesthesia provider, and a dental assistant or nurse who is trained in sedation monitoring and emergency management. The team should also have a clear plan for communication, including a pre-sedation briefing and post-sedation debriefing, to ensure that everyone is on the same page and any concerns or issues are addressed promptly.

During the sedation procedure, the patient should be continuously monitored for vital signs, level of consciousness, and any adverse reactions to the sedation medication [16]. The sedation provider should be prepared to adjust the level of sedation as needed, and have a plan in place for managing any adverse reactions, such as airway obstruction, respiratory depression, or cardiac arrhythmias.

After the procedure, the patient should be monitored until they are fully recovered and deemed safe for discharge [17]. The sedation provider should provide clear postoperative instructions to the patient and their caregiver, including any medication prescriptions and guidelines for monitoring and managing any postoperative pain or discomfort.

Overall, the key to safe and effective sedation in pediatric dental patients is careful patient selection, thorough pre-sedation evaluation and preparation, proper monitoring and emergency management, and a well-trained and experienced sedation team [18].

Drugs Used For Conscious Sedation

Prior to administering any drugs, it is important to secure an IV line even if inhalation anesthesia is being used. Local anesthetics are often sufficient for reducing fear and anxiety in

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children and are commonly used in combination with sedative drugs. Nitrous oxide, which is a gas, can be used as an inhalational anesthetic agent for its anxiolytic and sedative properties, as well as its varying degree of analgesia and muscle relaxation. Recent research has shown that nitrous oxide affects both GABA A and NMDA receptors 19. Nitrous oxide has a long history of safe use for providing moderate sedation for minimally to moderately painful procedures, but it should be used with caution when other sedatives are also being administered, as deep sedation can occur. Nitrous oxide/oxygen delivery systems now come equipped with oxygen fail-safe devices that stop the flow of nitrous when oxygen flow is stopped, preventing any potential issues [20]. Nitrous oxide is a good option for pediatric dental patients who cannot tolerate local anesthesia alone and have sufficient understanding to accept the procedure. It can also be used for patients with mild to moderate anxiety to better tolerate the treatment and for more complex procedures such as dental extractions. Nitrous oxide has a rapid onset, fast recovery, and is considered very safe because the patient remains awake, responsive, and breathing on their own 20. It is contraindicated for patients with colds, tonsillitis, nasal blockage, porphyria, or psychosis. The dose of nitrous oxide is typically 50% in 50% oxygen, but up to 70% can be given.

Benzodiazepine

Benzodiazepines are medications that provide anxiolysis, sedation/hypnosis, skeletal muscle relaxation, anterograde amnesia, respiratory depression, and an anticonvulsant effect [21]. These drugs do not have any analgesic properties and work by opening chloride channels mediated by GABA. Benzodiazepines have a wide margin of safety between therapeutic and toxic doses and have a rapid onset of action due to their high lipid solubility. They have been widely used in dentistry, often combined with nitrous oxide/oxygen for conscious sedation, which produces an additive analgesic effect.

Midazolam is the most commonly used benzodiazepine in pediatric dentistry, with a short duration of action [22]. It is administered as a sweetened syrup via a drinking cup or needleless syringe deposited in the retromolar area, or as oral tablets. Syrup is given 20-30 minutes and tablets 60 minutes before the procedure. The recommended dose for children under 25 kg is 0.3-0.5 mg/kg and should only be administered in a hospital setup.

Midazolam can also be given rectally, 10 minutes before surgery, or through other routes such as I/M, I/V, or intranasally. Its effects can be enhanced by various drugs, including opioids, anxiolytics, clonidine, erythromycin, antiepileptics, antidepressants, antipsychotics, antihistamines, and alcohol 23.

Ketamine

Ketamine acts as an NMDA antagonist and induces a dissociative state, resulting in catalepsy, sedation, pain control, and amnesia [24]. Compared to other drugs, it has relatively stable cardiovascular effects and limited impact on respiratory mechanics. Recovery time ranges from 30 to 120 minutes, allowing for timely patient discharge after the procedure. Although ketamine is a dose-related cardiovascular stimulant, it has caused only minor increases in heart rate and mean pulmonary artery pressure during catheterization, even in children with congenital heart disease. Green has described over 11,000 cases of ketamine use in children without any reported fatalities [17]. However, the emergence phenomenon is a commonly reported disadvantage, occurring more frequently in adults than children. Ketamine can cause an increase in salivary and tracheobronchial mucus gland secretions, and an antisialogog is recommended for use with ketamine for GA. Emesis is a common side effect of ketamine, with a reported incidence of 10% in children, usually associated with dental procedures [25]. Atropine is used to reduce the increase in salivary flow and lessen emesis. Laryngospasm is a rare complication, occurring in only 0.4% of cases and can be managed with 100% positive pressure oxygen.

Ketamine can be administered intramuscularly at a dose of 3-4 mg/kg or intravenously at a dose of 1-2 mg/kg 26. It can also be given in combination with nitrous oxide/oxygen, promethazine,

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atropine, and diazepam at a dose of 2.5 mg/kg. Tucker used IV ketamine at an induction dosage of 0.6 mg/kg and a maintenance dosage of 0.4 mg/kg every 10 minutes, with concurrent administration of diazepam and nitrous oxide/oxygen in 60 patients, resulting in good outcomes. Administering a lower-than-recommended dose of ketamine may be a safer option than administering high doses to achieve sedation levels in some children, particularly those at risk of severe respiratory depression [27].

Propofol

Propofol is an emulsion with a soya oil base that is water-immiscible and used for injection. Although its elimination half-life is between 2 and 24 hours, its clinical effect duration is shorter because it is rapidly distributed into peripheral tissue, and its effects wear off within approximately 30 minutes of injection. Due to its rapid effect and moderate amnesia, Propofol is an ideal drug for IV sedation 28. In anxious children, sub-anesthetic doses of propofol are used for IV conscious sedation infusion during operative dental treatment. IV induction by ketamine or propofol poses a challenge due to the difficulty in obtaining vascular access in awake and frightened children. Therefore, potent volatile anesthetic agents are used for induction of anesthesia to avoid the struggle of getting IV access before the child is asleep. A study by Arya and Damle found that propofol exhibits a rapid onset with involuntary movements as a side effect, while midazolam is a good anxiolytic and anticonvulsant. When used with sevoflurane, the dose of propofol required for satisfactory sedation ranges from an initial loading dose of 1 mg/kg body weight to a maintenance dosage of 0.3 to 4 mg/kg/h.

Sevoflurane

Sevoflurane is a highly potent volatile anesthetic that has a low blood-gas solubility, allowing for a rapid onset and offset of action (typically within 1 minute of induction). This makes it an excellent choice for induction prior to the administration of a total intravenous anesthetic, like propofol, to maintain sedation.

Chloral Hydrate

Chloral hydrate is an alcohol derivative that can act as an anesthetic when given in high doses [29]. It has a relatively long half-life of around 8 hours and can produce mild sedation in small doses, natural sleep in intermediate doses, and depression of blood pressure and respiratory rate. However, it may cause complications such as nausea, vomiting, prolonged drowsiness, oxygen desaturation, myocardial depression, arrhythmia, and paradoxical reactions. Therefore, monitoring is required after sedation [30].

Although considered safe, chloral hydrate can cause unexpectedly deep levels of sedation and upper airway obstruction in some patients [31]. It is contraindicated in children with heart disease, renal or hepatic impairment. There is also a risk of carcinogenesis, especially when used repeatedly. Although it has been used for routine sedation in pediatric dentistry for many years, safer and more effective agents have largely replaced it, and it is becoming obsolete as a sedative agent.

Hydroxyzine And Promethazine

Both the drugs are psychosedatives with an antihistaminic, antiemetic, and antispasmodic effect 32. Hydroxyzine hydrochloride is a diphenylmethane, which is usually given orally or intramuscularly, singly or in combination with chloral hydrate 32,33. There are high rates of oxygen desaturation reported when combined with chloral hydrate and the combination was most effective when deep sedation was produced. Indeed, the addition of hydroxyzine resulted in 21% of children experiencing at least one episode of oxygen desaturation below 95%. Promethazine hydrochloride is a phenothiazine derivative and as such is a potent tranquillizing agent that will potentiate the respiratory depressant effect of narcotics, barbiturates, and other antihistamines. Common side-effects are dry mouth, fever, and skin rash [17].

Dexmedetomidine

Dexmedetomidine, an imidazole compound, is the active dextroisomer of medetomidine with selective and specific α2-adrenoceptor agonism.

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This leads to inhibition of neuronal firing in the brain and spinal cord, resulting in hypotension, bradycardia, sedation, and analgesia. Dexmedetomidine was approved in December 1999 as a short-term sedative and is part of a group of drugs with beneficial actions during the perioperative period [29]. These drugs decrease sympathetic tone, attenuate the neuroendocrine and hemodynamic responses to anesthesia and surgery, reduce anesthetic and opioid requirements, and provide sedation and analgesia while allowing the preservation of psychomotor function. The usual dose is 2 μg/kg given 45 minutes prior to the start of the procedure. However, care should be taken with possible side effects such as hypotension, bradycardia, sinus arrest, and treatment-emergent adverse reactions when administering the drug.

Opioids

All of the sedative agents mentioned previously, except for ketamine, do not provide analgesia. Therefore, for painful procedures, an opioid analgesic such as fentanyl is necessary. Fentanyl can be administered through various routes such as parenteral, transdermal, nasal, and oral 29,34. For children, an oral transmucosal fentanyl citrate delivered via a "lollipop" system is a more preferred option as a premedicant. Fentanyl is highly lipophilic and can be easily absorbed from the buccal mucosa with an overall bioavailability of approximately 30-50% 35. The recommended IV dose is 1 mcg/kg/dose, which may be repeated in 1-mcg/kg increments if necessary, but the total cumulative dose should not exceed 4 mcg/kg. It is important to note that when combined with sedatives, fentanyl can increase the risk of respiratory depression, and rapid IV push may cause chest wall rigidity.

Sufentanil

Nasal sufentanil has been reported to have reduced chest wall compliance, as well as higher rates of nausea, vomiting, and prolonged hospital stay when compared to midazolam administered nasally 35,36. Therefore, it is not a popular choice for premedication. Instead, a combination of different drugs, such as sedatives with ketamine/opioids or dexmedetomidine, is commonly used with precautions to maintain airway reflexes. In some cases, inhaled gasses like sevoflurane along with benzodiazepines may also be administered. Propofol is not preferred in some setups due to the risk of unprotective airways [37].

Summary

Administering sedative and analgesic medications in a safe and appropriate manner can alleviate the discomfort and anxiety associated with medical procedures. Conscious sedation is a valuable technique used by physicians in outpatient settings to improve patients' ability to tolerate unpleasant procedures. In all cases where sedation is necessary, it is crucial to conduct a thorough pre-anesthetic evaluation and provide adequate monitoring. Understanding medication properties and being able to manage potential over-sedation and side effects is critical for ensuring safe and effective procedural sedation in outpatient settings.

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Nil

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