Conscious Sedation: Emerging Trends in Pediatric Dentistry

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Abstract

Dental fear and anxiety is a common problem in pediatric patients. There is considerable variation in techniques used to manage them. Various sedation techniques using many different anesthetic agents have gained considerable popularity over the past few years. Children are not little adults; they differ physically, psychologically, and emotionally. The purpose of this review is to survey recent trends and concerning issues in the rapidly changing field of pediatric sedation. We will study the topic from the perspective of an anesthesiologist. It will also provide information to practitioners on the practice of conscious sedation in dentistry and will also outline the route of administration, pharmacokinetics, and pharmacodynamics of various drugs used.

Keywords: Benzodiazepines, dexmedetomidine, ketamine, monitoring, pediatric anesthesia, propofol, sedation, sevoflurane

INTRODUCTION

The term conscious sedation is defined as, “A medically controlled state of depressed consciousness that allows the protective reflexes to be maintained; retains the patient’s ability to maintain a patent airway independently and continuously; and permits an appropriate response by the patient to physical stimulation or verbal command.” In 1992, it was stated that patient could readily progress from one level of sedation to another and one should be prepared to increase vigilance and monitoring.[1] The conscious technique must carry a margin of safety wide enough to decrease the chance of unintended loss of consciousness.[2] The safe sedation of children involves careful pre-sedation evaluation, careful evaluation of airway for large tonsils or any anatomic abnormality, appropriate fasting guidelines for elective procedures, a understanding about pharmacodynamics and pharmacokinetics effects of sedating drugs used, appropriate sized airway equipment and venous access and appropriate intraoperative monitoring, properly equipped staff in recovery area and proper discharge criteria. Sedation drugs can be administered through various routes such as oral, nasal, intramuscular, intravenous (IV), subcutaneous, and inhalational routes.[3]

PROBLEMS OF DENTAL PEDIATRIC ANESTHESIA

Main problems[4] have been divided into:

Surgical factors

As airway is shared by the anesthesiologist and dentist, it may be soiled with blood or debris and stimulation of trigeminal nerve increases chances of arrhythmia during surgery.

Pediatric issues

1. They may have enlarged tonsils and adenoids thus increasing chances of respiratory obstruction
2. They are uncooperative and communication may be challenging
3. Many medical conditions can co-exist such as epilepsy, reflux, and cardiac anomalies
4. They are needle phobic and highly anxious
5. High autonomic activity thus increasing chances of arrhythmias and vasovagal response
6. Gastric emptying may be delayed
7. Problems of ambulatory anesthesia.

Keeping all the above factors, one should thoroughly prepare the patient after complete pre-anesthetic check-up and after proper examination of airways, cardiorespiratory system,

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and any congenital abnormalities. Another one of the most important problems is position in the dental chair. It becomes very difficult to resuscitate the patient if something unwanted happens suddenly. All types of drugs and resuscitative measures should be there in case of any emergency.

**Current Status of Conscious Sedation in Pediatrics**

Sedation for dental procedure carries high risks for both patient and anesthesiologists. The sedation techniques offer alternative for patients where the use of general anesthesia (GA) is unavoidable.[4,5] Oversedation or undersedation is unreasonable or unacceptable in some circumstances.[6] In order to decrease dependency of the patient to sedation other psychological methods can be used, e.g. Cognitive reconstructing, hypnosis, relaxation and distraction techniques, systematic desensitization, and conditioning.[7] Indications for conscious sedation in pediatric age group are:

- Children with low coping capacity
- Behavior management problem
- Dental fear and anxiety
- Mental retardation
- General disorder, psychiatric conditions.
- Treatment need
- Emergency treatment
- Moderate to large and complicated need.

Children <1 year are contraindication for sedation.

**Preparation for Conscious Sedation**

Special consideration should be given because of pediatric patients, the problem of the dental chair and dental setup and because of oral surgery as there are more chances of aspiration in sedated patients.

1. Pre-sedation check-up: Pediatric patients are classified according to American Society of Anesthesiologists class and then considered for sedation.[9] The patient is checked for adenotonsillar hypertrophy and anatomic airway abnormalities. Child with a special need may require individual consideration. Practitioners are encouraged to consult with appropriate specialties for underlying medical and surgical conditions. The pediatric patient should be accompanied by a parent, legal guardian, or other responsible person

2. Back up emergency facilities and emergency services: The institution using sedation should have facilities, equipment and personnel to manage emergency and rescue situation

3. Consent: Preoperative instructions are given to child and parent/guardian in writing. Informed consent is taken. An adult well-known to child should accompany to and from hospital. Only in context to school dental clinics and use of nitrous oxide/oxygen sedation schoolchildren with parents’ consent get treatment without the presence of an adult

4. Fasting guidelines: Prior to conscious sedation it is recommended that the patient has fasted accordingly:
   - No clear liquids 2–3 h before sedation
   - No Breast milk or nonclear fluids 4 h before sedation
   - No formula milk 6 h before sedation
   - No solids 8 h before sedation
   - For emergency, where proper fasting not assured, increased risk weighed against benefits of treatment and the lightest effective sedation is used. If possible patient may benefit by delaying the procedure. It is likely that risk of aspiration during procedural sedation differs from that during GA.[9]

5. Monitoring and rescue equipment: Monitoring equipment are electrocardiography (ECG), size appropriate pulse oximeters, end tidal carbon dioxide equipment, size appropriate noninvasive blood pressure cuffs, precordial stethoscope and defibrillator (size appropriate defibrillator paddles), and must have safety checks on a regular basis. An emergency cart or kit should be available with size appropriate drugs and equipment to resuscitate a nonbreathing and unconscious child

6. Preparation and setting up sedation procedures: Part of safety net of sedation is to use systemic approach, and most common used acronym useful for planning and preparation for procedure is SOAP-ME:
   - S: Size appropriate suction catheter and apparatus
   - O: Adequate oxygen supply and functioning flow meters/other devices to allow its delivery
   - A: Size appropriate airway equipment (nasopharyngeal and oropharyngeal airway, laryngoscopes blades, endotracheal tubes, stylets, face mask, bag-valve-mask)
   - P: Pharmacy - all the basic drugs to support life during an emergency
   - M: Monitors; functioning pulse oximeter with size appropriate oximeter probes[10] and other monitors (e.g.: Noninvasive blood pressure, end-tidal carbon dioxide, ECG, and stethoscope)
   - E: Special equipment or drugs for a particular case (e.g.: Defibrillator).

**Drugs Used for Conscious Sedation**

An IV line should be secured before giving any drugs even if we use inhalation anesthesia. Many sedative drugs are used along with local anesthetics and which are usually sufficient to reduce fear and anxiety among children.

**Nitrous Oxide and Oxygen Mixture**

Nitrous oxide is a gas and used as the inhalational anesthetic agent. It has anxiolytic and sedative properties with varying degree of analgesia and muscle relaxation. Recent studies suggest both gamma-aminobutyric acid type A (GABA A) and N-methyl-D-aspartate (NMDA) receptors are affected.[11] It has a long history of safe use providing moderate sedation
for minimally moderately painful procedures. Care must be taken when used in addition to other sedatives where deep sedation can easily result. Currently, available nitrous oxide/oxygen delivery systems are manufactured with oxygen fail-safe devices that stop the flow of nitrous when the flow of oxygen is stopped, thus preventing this catastrophe. It should be the first choice for pediatric dental patients who are unable to tolerate local anesthesia alone and have sufficient understanding to accept the procedure. It may be offered with mild to moderate anxiety to better accept the treatment which may require a series of visits. It can also facilitate the provision of more complex time-consuming procedures and dental extractions particularly for young and anxious patients undergoing orthodontic extractions.\cite{12} Because of being nonirritant to the respiratory tract, low tissue solubility, and minimum alveolar concentration more than 1 atmosphere, it has a rapid onset, fast recovery and is a poor anesthetic effect. It is very safe because the child remains awake, responsive, and breaths on his/her own. Common cold, tonsillitis, nasal blockage, patients with porphyria, and psychotic patients are few contraindications for N\textsubscript{2}O use.\cite{13} Dose of N\textsubscript{2}O is 50% in 50% oxygen, up to 70% can be given.

**Benzodiazepines**

They provide anxiolysis, sedation/hypnosis, skeletal muscle relaxation, anterograde amnesia, respiratory depression, and an anticonvulsant effect\cite{14} but have no analgesic properties. Mechanism of action is through GABA-mediated opening of chloride channels. Benzodiazepines (BZD) have a wide safety margin between therapeutic and toxic doses. They have high lipid solubility so have a rapid onset of action. They have been widely used in dentistry. They are usually combined with nitrous oxide/oxygen for conscious sedation as additive effect of nitrous oxide to BZD produces analgesic properties.\cite{15} The most common drug used is midazolam, which is having a short duration of action. It is considered as BZD of choice for conscious sedation during treatment in pediatric dentistry.\cite{16-19} It is given in the form of sweetened syrup given either via a drinking cup or drawn in a needleless syringe and deposited in the retromolar area or oral tablets. Syrup can be given 20–30 min and tablets 60 min before the procedure. Dose for under 25 kg is 0.3–0.5 mg/kg but should be administered in hospital setup only.

If given rectally, it should be given 10 min before surgery. It can also be given I/M, I/V, or intranasally. Its effects are enhanced by various drugs such as opioids, anxiolytic, clonidine, erythromycin, antiepileptics, antidepressants, antipsychotics, antihistaminics, and alcohol.

**Ketamine**

Ketamine is NMDA antagonist. It is a dissociative agent, which makes a state of catalepsy that gives sedation, control of pain and amnesia. Ketamine has advantages over other drugs in its relative cardiovascular steadiness and restricted affect on the respiratory mechanics. Recovery occurs in 30–120 min, which allows for patient discharge in a reasonable time after the procedure. It is a dose-related cardiovascular stimulant. Even in children with congenital heart disease, it caused clinically only minor increases in heart rate and mean pulmonary artery pressure during catheterization.\cite{20} More than 11,000 reported cases of its use in children with no reported fatalities have been described in the literature by Green.\cite{21} The most frequently cited disadvantage is the emergence phenomenon, seen more commonly in adults (5–50%) than children (0–5%). Ketamine causes an increase in salivary and tracheobronchial mucus gland secretions, so an antiallogog is recommended for use with ketamine for GA.\cite{22} Emesis is the third most common side effect of ketamine. In Green’s review, he found that the reported incidence of vomiting in children was 10%, and was associated with dental procedures. Atropine tends to lessen the emesis by reducing the increase in salivary flow.\cite{23} Laryngospasm has been reported in only 0.4% of cases, and has been managed with 100% positive pressure oxygen.\cite{24}

Ketamine can be given intramuscularly at 3–4 mg/kg or intravenously at 1–2 mg/kg. Ketamine can be given in doses of 2.5 mg/kg with nitrous oxide/oxygen, promethazine, atropine, and diazepam.\cite{25} Tucker also used IV ketamine at an induction dosage of 0.6 mg/kg and a maintenance dosage of 0.4 mg/kg every 10 min. Diazepam and nitrous oxide/oxygen were administered concurrently in 60 patients with good results.\cite{26} Administering a lower than recommended dose of a drug may be safer than the heavy doses to achieve adequate levels of sedation in some children, with their attending problem of potentially severe respiratory depression.

**Propofol**

Propofol is a water-immiscible oil which is formulated as an emulsion with a soya oil base to facilitate injection. The elimination half-life is between 2 and 24 h. However, its duration of clinical effect is much shorter because Propofol is rapidly distributed into peripheral tissue, and its effects, therefore, wear off considerably within even a half hour of injection. This, together with its rapid effect and the moderate amnesia it induces makes it an ideal drug for IV sedation.\cite{27} Sub-anesthetic doses of propofol used for IV conscious sedation infusion facilitated operative dental treatment in anxious children.\cite{28} IV induction by ketamine or propofol remains a problem because of the difficulty in obtaining vascular access in the awake and frightened child. Potent volatile anesthetic agents are used for induction of anesthesia to avoid the struggle to get IV access before the child is asleep. In a study by Arya and Damle in comparison of propofol with midazolam it was found that propofol exhibit rapid onset while having involuntary movements as side effect while midazolam had an edge over propofol in being good anxiolytic and anticonvulsant.\cite{29} With sevoflurane, dose of propofol used is an initial loading dose, (usually 1 mg/kg body weight) and the maintenance dosage needed to achieve satisfactory sedation, ranging from 0.3 to 4 mg/kg/h.\cite{30}
**Sevoflurane**

Sevoflurane is a potent volatile anesthetic with low blood-gas solubility\(^\text{[31]}\) resulting in fast onset and offset (induction often within 1 min). Sevoflurane is, therefore, ideal for induction before infusion of a total intra-venous anesthetic such as propofol to maintain the sedation.

**Chloral Hydrate**

Chloral hydrate is a chlorinated derivative of ethyl alcohol that can act as an anesthetic when administered in high doses. It is a weak analgesic and psychosedative with an elimination half-life of approximately 8 h. In small doses, mild sedation occurs and in intermediate doses, natural sleep is produced. It depresses blood pressure and respiratory rate. It may cause oxygen desaturation\(^\text{[32]}\) and prolonged drowsiness. Because of gastric irritation nausea and vomiting are also common complications. In larger doses, myocardial depression and arrhythmia can occur. Prolonged sedation and paradoxical reactions are reported so monitoring after sedation required. Generally considered one of the safest sedative agents, chloral hydrate does have the potential for causing unexpectedly deep levels of sedation as well as upper airway obstruction in some patients.\(^\text{[33]}\) Chloral hydrate is contraindicated in children with heart disease as well as those with renal or hepatic impairment. Recently, there has been concern that there is a risk of carcinogenesis, especially when used repeatedly.\(^\text{[34]}\) It has been used for routine sedation for many years; however, the development of safer and more effective agents have largely replaced it. It is rapidly becoming obsolete as a sedative agent in pediatric dentistry.

**Hydroxyzine and Promethazine**

Both the drugs are psychosedatives with an antihistaminic, antiemetic, and antispasmodic effect. Hydroxyzine hydrochloride is a diphenylmethane, which is usually given orally or intramuscularly, singly or in combination with chloral hydrate. There are high rates of oxygen desaturation reported when combined with chloral hydrate and the combination was most effective when deep sedation was produced.\(^\text{[35]}\) Indeed, the addition of hydroxyzine resulted in 21% of children experiencing at least one episode of oxygen desaturation below 95%.\(^\text{[36]}\) Promethazine hydrochloride is a phenothiazine derivative and as such is a potent tranquilizing agent that will potentiate the respiratory depressant effect of narcotics, barbiturates, and other antihistamines. Common side-effects are dry mouth, fever, and skin rash.

**Dexmedetomidine**

An imidazole compound is the pharmacologically active dextroisomer of medetomidine that displays specific and selective $\alpha_2$-adrenoceptor agonism. Activation of the receptors in the brain and spinal cord inhibits neuronal firing, causing hypotension, bradycardia, sedation, and analgesia. In December 1999, dexmedetomidine was approved as the most recent agent in this group and was introduced into clinical practice as a short-term sedative. $\alpha_2$-adrenoceptor agonists have several beneficial actions during the perioperative period. They decrease sympathetic tone, with attenuation of the neuroendocrine and hemodynamic responses to anesthesia and surgery; reduce anesthetic and opioid requirements; and cause sedation and analgesia. They allow the psychomotoric function to be preserved while letting the patient rest comfortably. Dose at 2 $\mu$g/kg administered 45 min prior to the procedure start time.\(^\text{[37]}\) Most commonly occurring side effects such as hypotension, bradycardia, sinus arrest, and treatment-emergent adverse reactions should be kept in mind when using this drug.

**Opioids**

None of the aforementioned sedative agents provide analgesia except ketamine. For painful procedures, an opioid analgesic (e.g., fentanyl) is required. Fentanyl may be administered by parenteral, transdermal, nasal, and oral routes. A “lollipop” delivery system, oral transmucosal fentanyl citrate is more accepted by children than other routes as a premedicant. Fentanyl is strongly lipophilic and is readily absorbed from the buccal mucosa with an overall bioavailability of approximately 30–50%.\(^\text{[38]}\) Dose at 1 mcg/kg/dose IV; if needed, may be repeated by 1-mcg/kg increments; not to exceed a total cumulative dose of 4 mcg/kg. There is increased risk of respiratory depression when combined with sedatives and chest wall rigidity associated with rapid IV push.

**Sufentanil**

Sufentanil is 10 times more potent than fentanyl. Several instances of reduced chest wall compliance have been reported in children after nasal sufentanil, as well as a higher incidence of nausea and vomiting and a prolonged discharge time when compared to nasally administered midazolam.\(^\text{[39]}\) These potential side effects and prolonged hospital stay after nasal sufentanil makes it an unpopular choice for premedication. Most commonly combinations of different drugs e.g., sedatives along with ketamine/opioids or dexmedetomidine is used as these drugs maintain the airway reflexes if given in small doses with precautions. Sometimes a combination of inhaled gasses specially sevoflurane (as it is short acting) along with BZD are given. Propofol is least preferred in our setup because of unprotective airways.

**Summary**

Safe and adequate administration of sedative and analgesic medications can make painful and anxiety provoking situations tolerable. Specifically, conscious sedation is a tool available to physicians in the outpatient setting that can improve patient tolerance and acceptability of unpleasant procedures. In all patients who require sedation, the importance of a preanesthetic assessment and proper monitoring cannot be overemphasized. Knowledge of medications and the ability to address over sedation and side effects is essential for safe and effective outpatient procedural sedation.
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Conflicts of interest
There are no conflicts of interest.

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