

Pros and Cons of Anesthetics use among Pediatrics During Dental Therapies

Abstract

This paper aims to outline the pros and cons of many types of anesthesia used in dental pediatrics: local anesthesia, topical anesthesia, nitrous oxide, and general anesthesia. There can be pain from local anesthesia during injection; distraction, needle-less devices, or topical anesthetic can be used to help in relief of that pain. Benzocaine and other ester anesthetics can cause methemoglobinemia. Nitrous oxide administration needs safety precautions, and it has a risk among patients who have non-treated vitamin B12 deficiency. The risk of overdose of inhaled gases during general anesthesia in children can be more than in adults. Before reaching final decision about general anesthesia, basic behavior management approach to be performed (which should be applied to all pediatrics in dental visits); in addition, alternative options, and postponing of treatment to be considered. Management protocols and supplies of emergency cases related to dental anesthetics use need to be available.

Keywords

Local anesthesia, Nitrous oxide, General anesthesia, Pediatric, Dental

Introduction

Pain during dental procedures was experienced among children and adolescents (range of age of participants: 3-19 year's old) in more than 30% of their dental visits [1]. As determined by the American Academy of Pediatric Dentistry (AAPD), pediatric dentistry includes children and adolescents in addition to people who have special healthcare needs and infants [2]. When Pediatrics have dental visits, it is crucial that they undergo continuous (throughout the visit) assessment of their behavior and pain expressions [2]. There are forms for that assessment, as Frankl Behavioral Rating Scale [3]

Research Article

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and revised Face, Legs, Activity, Cry, Consolability (r-FLACC) Scale which can be used for patients with developmental impairment [4].

There are factors affecting the occurrence of behaviors of pediatrics in dental settings. Using basic behavior guidance by staff can aid in reducing patients' anxiety [2]. Anxiety was found that it impacted pain significantly before and during dental interventions [5]. Experiences in a dental visit could influence behavior negatively in subsequent visits, and this would require behavioral management approaches such as memory restructuring [2]. Also, among the approaches is Desensitization to dental procedures, where required dental interventions can be done gradually through subsequent sessions instead of one appointment [2]. Furthermore, before reaching a final decision about the need for operation under general anesthesia due to non-cooperativeness of the patient, there can be a possibility of using preventive treatment modalities if needed (as using topical fluoride) and postponing the treatment which caused the anxiety [2] and taking into account that conditions of dental emergencies require immediate management [6].

Documentation of observed behaviors [2], and

anesthetics given was recommended by AAPD [7,8], and the dose of anesthetic medications to be calculated based on body weight [8]. It was recommended that vital signs be taken at the start of each appointment [9]. Other recommendations include: (1) clinical staff in dental settings to have the needed life support certification [7,10]; (2) availability of protocols for management of related emergency cases such as Local anesthetic systemic toxicity LAST [7], allergic [8], and outcomes due to sedation level deeper than expected [7,10]; (3) availability [7,8,10]. and maintenance [7] of the needed supplies for management of emergency cases; (4) and also to carry out simulation exercises [7]. There are helpful tables including: many age limitations [8], concentrations conversion into mg/ml [10], and maximum recommended doses per body weight [8,10].

To summarize the advantages and disadvantages of several types of anesthesia used in dental procedures of pediatrics, this review was done, including the pros and cons of local anesthesia, topical anesthesia using anesthetic medication, nitrous oxide, and general anesthesia.

Local Anesthesia

Pros

1. Analgesia [8,11].
2. If there was pregnancy related to subgroups of pediatric dentistry, there are safe options of local anesthetics that can be used, and there is safe local anesthetic for lactating women [8].

Cons

1. There can be ineffectiveness of local anesthesia, failure rate of first shot of local anesthesia among children and adolescents was 13% [12].
2. Patients of some medical conditions are not suitable for receiving local anesthesia:
 - Patients who have bleeding disorders, or on anticoagulation therapy, there can be complications (but the technique of choice is local infiltration) [11].
 - Vasoconstrictors containing local anesthetics might not be suitable for patients who have comorbid conditions (e.g. cardiovascular diseases), and there can be interaction with some

medications [8,11].

- Ester aesthetics or prilocaine in patients who have a history of methemoglobinemia have risk of methemoglobinemia occurrence [11]. There are diseases and medications which can increase the risk [8].
3. Local anesthesia can lead to complications, such as hematoma, trismus, intravascular injection (which can lead to palpitation), toxicity, allergic reaction, Injury to nerves [11]
 - Allergic reactions can occur [8]. Metabisulfite is a preservative in many anesthetic agents (in epinephrine containing anesthetics [8], and it could be one of the causes of allergic reaction occurrence [11,8]. Allergy can result in anaphylaxis which needs immediate management [13].
 - Among the manifestations of LAST: there can be cardiovascular effects (as bradycardia), central nervous system effects (as convulsion) [8]. Intravenous lipid emulsion 20% can be used to treat cases of LAST [14], there is a checklist about steps of treatment [14]. injecting gently and correct calculation of needed dosage can help in preventing LAST occurrence [8]. The First line parenteral medication for convulsion is benzodiazepines, after stabilizing the patient [15].
 4. Postoperative soft tissue injury by the patient [8]; this effect can be more with long-acting anesthetics [11].
 5. Needle fracture [8,11]. In mandibular block Needle of 27 gauge or less is recommended for administering local anesthesia to prevent needle fracture [11].
 6. Pain during administration of local anesthesia [8]. It was reported that it differs by the technique used during injection; in a study among adolescents (mean age: 16.5 year's old, SD: 1.25) the pain during injection through inferior alveolar nerve block (IANB) was significantly more than when local infiltration (LI) was used [16]. A study which included four to eight year's old children also revealed this difference [17].
 7. There can be a risk if used when the patient is under general anesthesia "When halogenated gases are used, the myocardium is sensitized to epinephrine, and such situations dictate caution with use of a local anesthetic" [8].

N.B

1. Dose of some local anesthetics need to be reduced in patients who have impairment of kidney or liver [11].
2. There are age restrictions for Benzocaine, Articaine, Bupivacaine [8].
3. Examples of the techniques for controlling administration (as rate and pressure) of local anesthetics are: needleless system, computer-controlled local anesthetic delivery [8]. But also, with computer-controlled administration technique, there is a need to maintain the cooperativeness of the patient; there was a case study of a child who has autism, and during the injection of computer controlled local anesthesia, the patient movement lead to breakage of the needle [18].
4. Distraction (by audio-visual aids for example) can help in shifting the focus of the patient during dental visits [8]. In a non-randomized experiment which included three intervention groups about distractive methods effect on pain scores, among cooperative children aged four to eight year's old who needed the use of local anesthesia during their dental visits, mean pain score was less among patients who had screen distraction at dental clinic than those who were given verbal notes by the dentist, virtual reality group showed the least pain score [19]. In a study among children who had down syndrome, 30% were cooperative in using audiovisual distraction [4].

Topical Local Anesthesia using an anesthetic medication on the oral mucosa**Pros**

1. Can be effective in reducing the pain caused by provision of local anesthesia [8].
2. There is a type of topical anesthetics agents which was acceptable (regarding taste of the anesthetic), by pediatric patients [20]

Cons

1. There should be cautiousness when administering topical anesthesia to prevent giving higher dose which can result in toxicity [10].

2. Some topical anesthetics onsets of action might start after up to ten minutes [21].
3. Benzocaine to be used with caution in patients having risk of methemoglobinemia; a significant relationship was found in an analytical observational study (where adolescents were among participants in the sample) between use of benzocaine containing anesthetic and this outcome [22]. It was reported that overdose of ester anesthetic agents or prilocaine might cause methemoglobinemia [11].
4. Could lead to allergic reaction [11].

N.B

1. It was reported that the use of topical local anesthetics is common [10].
2. The amount of topical anesthesia to be applied depends on the manufacturers' directives [20].
3. Lidocaine 5% topical anesthetic was found that it could be effective in alleviating the pain of needle penetration within one minute of its application (but the effect on the pain caused by injection needed ten minutes) [21]. The time needed for Eutectic mixture of local anesthetics (EMLA) to be effective ranges between two and ten minutes [21].
4. In a randomized clinical trial among 21 dental patients, pain perception from injection was lower by virtual reality use, but not significantly (no statistically significant difference), than by topical benzocaine gel [23]; There are some points regarding the result: the sample size was small which could had led to type 2 error, the effect of topical anesthetic might be enhanced if the waiting time was more than two minutes, and this study was among adults so it might be not generalizable to children).
5. It was revealed through a survey among 72 dentists that the cause for not using topical anesthesia when treating children, among those who did not use it, is that they did not think that topical anesthesia is effective [24]; it was also found that most of the participants reported that they use topical anesthesia [24], but there could be selection bias due to low response rate in that cross sectional study.
6. Taste of topical anesthetics differs which affects the favorability by the patient. Benzocaine was

less favored than Lignocaine by four to ten year's old children [20].

7. There are some conditions that make the use of a topical anesthetic as benzocaine, contraindicated [21].
8. The dose of lignocaine (also known as lidocaine) for topical use for children older than three year's old is based on body weight, but for younger children the dose is specific (1.2 ml of 2% solution) [25]. The maximum recommended dose per body weight is 4.4 mg/kg of 2% Lidocaine [8].
9. Benzocaine (in all forms: as topical, injectable) is contraindicated in children whose age is below two year's old [26]. Benzocaine (in all forms: as topical, injectable) as being an ester anesthetic is more associated with allergic reactions [11]

Nitrous Oxide

Pros

1. Anxiolytic [7], and as a relative analgesia [27].
2. In minimal sedation, ventilation and cardiovascular system functions will be sustained [10].
3. The patient can respond to verbal instructions [10].
4. Not associated with irritation of airways [7].
5. Decrease movement of the patient [9].
6. Reduce gag reflex [9].
7. Can be used if the effect of local anesthesia was not reached [9].
8. Can be used for cooperative children undergoing a lengthy dental procedure [9].
9. Effective for patients who have intellectual special health care needs [28].

Cons

1. Failed sedation due to agitation of the patient was the outcome in 37.8% of the patients who had been nitrous oxide for dental procedure [29].
2. Would be difficult for patients who are used to breathing through their mouths (mouth breathers) [7].
3. There is a risk on patients who have vitamin B12 deficiency (which is not managed), [7]. There was a case report of child mortality after recent surgeries and there was use of nitrous oxide

60% [30]. There was a suggestion of vitamin B12 prophylactic supplementation if nitrous oxide will be used with general anesthesia [7].

4. Challenging to be used for procedures in anterior part of maxillary area [7].
5. There can be occurrence of side effects, such as vomiting, hypoxia [7]. After session, provision of oxygen alone can help to prevent hypoxia [7]. Adverse effects (as effect on airways) can occur if the concentration of nitrous oxide was high [7].
6. Can be shifted to moderate sedation [10].
7. When local anesthesia is given with sedative medications, the sedation effect might be increased, it is recommended to document the used medications and anesthetics with including their doses and the time they were given [8].
8. The equipment for administration of nitrous oxide needs regular monitoring and maintenance [7].
9. There can be exposure of clinic staff to nitrous oxide (occupational hazard) [7].
10. Risk of fire, so there is a need for staff of the clinic to be aware about possible ignition sources [7].

N.B

1. Nitrous oxide can be used for patients who have physical Classification I and II (according to American Society of Anesthesiologists (ASA) Physical Status Classification system) [10] (but if used with general anesthesia, the classification would be regarding general anesthesia).
2. The recommended concentration: maximally 50% [10].
3. Patients who are at risk of having vitb12 deficiency include (but not limited to): pernicious anemia, celiac disease, crohn's disease, history of gastrointestinal (GI) surgery of parts related to vitb12 absorption, vegetarians [31].
4. There are contraindications for nitrous oxide use, such as some respiratory diseases [7].
5. Regarding patients who have significant co morbidities, there is a need for consultation of related specialty before its use [7].
6. severe low levels of meth-ylene tetrahydrofolate reductase (MTHFR) gene, might need to get medical opinion of a geneticist before use of nitrous oxide [7].

7. Might not be suitable for children who have claustrophobia [7].

Sedation

During pediatric procedures, sedation can: lessen the pain and overcome anxiety, control movement, diminish psychological trauma, and it has an amnestic effect [10]. There is minimal sedation (e.g. nitrous oxide), moderate sedation, deep sedation, and general anesthesia [10]. Regarding the terminology "conscious sedation", it was revealed that moderate sedation was previously called by that name [10], but it was also indicated that this term can be used for nitrous oxide [7]. Deep sedation and general anesthesia have some differences, such as: in deep sedation, the patient doesn't need support of respiration [32],

There are some disadvantages of sedation. In a review of patient's records of two to 17 year's old children, adverse events occurred due to sedation such as: agitation, aggressive behavior, hypoxia, laryngospasm, and allergic reaction [32]. Agitation is defined as: 'any manifestation of discomfort, stress, and anxiety including but not limited to mood changes, irritability, restlessness, excessive cognitive and motor activity, aggressivity, and combativeness' [29]. Failed sedation, which could be due to agitation, was observed among 14.7% of patients when were sedated by parenteral sedatives, and this percentage was 35.9% among who were sedated through oral sedatives [29]. Oversedation was also reported as a possible adverse event related to sedation (whether nitrous oxide, some oral sedatives, or some parental sedative) [29]. Furthermore, among patients who were sedative through an oral sedative medication, there were effects such as blood pressure fluctuation, hypoxia, and vomiting [29].

N.B

1. When local anesthesia is given with sedative medications, the sedation effect might be increased, it is recommended to document the used medications and anesthetics with including their doses and the time they were given [10].
2. The duration of action of sedative agents, needs to be taken into consideration (because some agents might not have adequate duration of action to complete dental procedure [33].

3. Informed consent and documentation of the sedation given are needed [10].
4. There is a leaflet by Royal College of Anesthetists to help patients understand the types of sedation [34]

General Anesthesia

According to AAPD [2], general anesthesia in pediatrics was indicated in the following: (1) if local anesthesia was not effective (e.g. anatomic variation), (2) need for comprehensive immediate management (e.g. dental trauma), (3) inability of cooperation, (4) disorders affecting cooperativeness ability (e.g. mental disability), (5) tremendous lack of cooperation, very anxious, extreme fear, (6) to reduce exposure to anesthesia among patients who will also have other surgical procedures, (7) if general anesthesia might "protect the developing psyche and/or reduce medical risk" [2]. There should be a comparison of the benefit and risks of general anesthesia before choosing it [2], given that deferral of treatment, and alternative approaches were considered, and basic behavioral management approaches were done [2].

Contraindications [2] include: (1) if the patient is cooperative, in good health, and the needed interventions dentally are fewest; (2) in youngest (very young) age groups who have fewest needed dental interventions and could benefit from postponing therapy and/or methods such as: Fluoride varnish, and Interim Therapeutic Restoration (ITR); (3) if it was chosen based convenience (of the dentist or patient); (4) if the patient has underlying health issue that would be negatively affected by general anesthesia. When searching among studies about very young children, they were less than six year's old [35,36]. To help in determining the level of needed dental treatment (minimal or not), there is an assessment known as "restorative dentistry: index of treatment need" "complexity assessment" [37], but it is not specified for pediatrics.

There are disadvantages of general anesthesia as the following

1. There is a difference between adults and children in the respiratory system anatomy and physiology and this can lead to cardiac complications by general anesthesia [32].

2. Perioperative Respiratory Adverse Events PRAEs due to general anesthesia for surgical procedures were reported from some of the children (median age of participants in the study: 4, interquartile range: 1.1-8), examples of reported PRAEs included: hypoxia, laryngospasm, bronchospasm [38].
3. Croup after removal of intubation was reported [33].
4. General anesthesia in children might affect brain functioning [39]; there was a warning about the multiple and lengthy exposure of children younger than three year's old, and pregnant women while in third trimester, due to the possibility of affecting brain development of children [40].
5. Needs recovery time, the median time was 40 minutes among children two to six year's old, and 39 minutes among children six to 13 year's old [33], but interquartile range was not written.
6. When local anesthesia is given with sedative medications, the sedation effect might be increased, it is recommended to document the

used medications and anesthetics with including their doses and the time they were given [10].

Conclusion

There are many advantages and disadvantages of local anesthesia, topical anesthesia, nitrous oxide, and general anesthesia. Assessment of pediatric behavior during dental visits, and performing basic behavioral approaches were recommended. The risks, benefits, and alternative options should be considered before determining general anesthesia need. There might be an opportunity for future researches to better understand the criteria regarding an indication of general anesthesia which is: the protection of psyche of the child (developing psyche).

The following are suggested: (1) availability of the necessary information about the anesthetics and sedatives which are used within the clinic; (2) the regular update of protocols for management of potential adverse events related to the types of anesthesia and sedation used within the clinics, and the agents (anesthetics, sedatives).

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