

(CASE REPORT)



Anaesthesia policy in dentistry - A step towards enhancing patient safety in dental practice

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Abstract

There are a variety of options for use of dental anaesthetics. Anaesthetics can be used on their own or combined for improved effect. More dentists are offering newer types of anaesthesia and sedation in their own offices but the lack of inspection, inadequate training of para dental staff and unavailability of necessary emergency measures in the dental clinics is causing more accidents. A policy to govern the use of anaesthesia in dentistry is an increasingly controversial topic. Anaesthesia awareness among the dentist community leaves a lot to be desired. One reason there has been no urgency for framing a Dental Anaesthesia Policy is because there is very little data related to mishaps attributable to use of anaesthesia in dental practice. Dental practice does not have a systematic or scientific type of reporting to enable practitioners to predict or examine outcomes. When a procedure has adverse results, the dental practitioner is most likely to decide not to try it again or worse, decide to keep the failure to themselves so as not to harm the growth of their practice. An important aim of having a Dental Anaesthesia Policy is to pay adequate attention to the patient once dental anaesthesia is administered and to prioritise medical care, in case of any emergency.

Keywords: Dental anaesthesia; Policy; Regulations; Toxicity; Patient Safety; Guidelines

1. Introduction

Dental treatment over the years has made advancements by leaps and bounds. The use of anaesthesia is an important adjunct to help patients feel tension free and comfortable during various dental treatment modalities, especially those which involve noise and pain. Local anaesthetic agents have been used in dental practice to eliminate pain associated with invasive operations as early as the nineteenth century [1]. As the use of local anaesthetics in dental practice increase, the scope for complications also increase.

Anaesthesia and sedation failures can lead to patient injury and deaths since regulations on how anaesthesia is administered in dentistry vary widely. There is little oversight required, and even less data is recorded on the frequency of anaesthesia mishaps. Criminal charges were recently filed against a dentist in the USA who gave improper anaesthesia to a two-year-old girl, which caused her to have cardiorespiratory issues and then Hypoxic Ischemic Encephalopathy (HIE), which resulted in her death the same day [2]. Although adverse effects are rare, it is the standard of care to closely monitor young children when they are given local anaesthesia, including lidocaine. One of the reasons for the extra care and close monitoring is because it is easy to overestimate the dose to weight ratio in young children. Anaesthesia events like these are not isolated, however since they are seldom reported, they go unnoticed. These errors can cause a patient to have severe adverse reactions which can cause heart damage, hypoxic brain injury and even death.

Anaesthesia means a loss or lack of sensation. This can be with or without consciousness. Local anaesthetics are among dentistry's most important and widely used drugs [3]. Estimates suggest that a dentist on an average administers 1600

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cartridges of dental local anaesthesia in a year [4]. Factors which determine the type of anaesthetic to be used are the age of the patient, present health status, type of dental procedure and any previous adverse reactions to anaesthetics. Anaesthesia can be short acting or long acting depending on whether they are directly applied to an area or injected into a nerve when extraction of teeth or more widespread surgery is required.

Dental anaesthesia has been around now for close to two hundred years. Since it was first introduced in the 18th century, anaesthesia has remained an inseparable part of dental practice. Ether was among the first anaesthetics to be used in dentistry in the year 1846. The practice of anaesthesiology in dentistry has not been smooth with many difficulties being recorded over the years. Arguably, the most notable of these was the use of hypoxic mixtures of nitrous oxide. Despite the lack of complete understanding, it was clearly established that nitrous oxide was particularly useful in pain and anxiety control in dentistry. Dental Anaesthesia techniques underwent gradual transformation in the middle of the 20th century when Drs. Morgan Allison, Adrian Hubbell and Leonard Monheim advanced the training of dentists in the practice of general anaesthesia for dentistry.

2. Types of Anaesthesia

There are three main types of anaesthesia: local, sedation, and general. Each has specific uses.

2.1. Local Anaesthesia (LA)

Local anesthesia refers to the usage of an anaesthetic to temporarily numb a small area of the body. Local anesthesia is used for simpler, uncomplicated procedures like a simple tooth extraction or Root Canal Treatment, which requires a shorter time to complete.

There are two main types of local anaesthetics, depending on how they are administered – Topical and injections. Most local anaesthetics start their effect quickly (within 10 minutes) which lasts 30 to 60 minutes. Sometimes a vasopressor such as epinephrine is added to the anaesthetic to increase its effect and to prevent the anaesthetic effect from spreading to other areas of the body. Local anaesthetics work by preventing the nerves in the affected area from communicating sensations of pain to the brain. Examples of local anaesthetic are Articaine, Bupivacaine, Lidocaine, Mepivacaine and Prilocaine.

2.2. Sedation

In children and adult patients who are anxious prior to dental procedures, conscious sedation is an effective method of reducing preoperative anxiety and significantly brings down patient pain and anxiety. Conscious sedation also improves patient cooperation and makes the patient receptive to invasive dental procedures thereby enhancing overall patient satisfaction with dental treatment. There are several levels to conscious sedation which may be used as required to relax a patient who may have anxiety or help with pain.

There are a variety of drugs, and these medications might be given orally (tablet or liquid), inhaled, intramuscularly (IM), or intravenously (IV). There are more risks with IV sedation. There are also varying clinical protocols that can be used to induce conscious or deep sedation. Benzodiazepines are the class of drugs most often used to induce a state of anxiolysis, sedation, or amnesia [5]. Other medications used for sedation are Diazepam (Valium), Midazolam (Versed), Propofol (Diprivan) and Nitrous Oxide.

2.3. General Anaesthesia

General anaesthesia (GA) is a drug-induced loss of consciousness during which the patient cannot be aroused, even through painful stimulation. General anesthesia is mostly used for non-co-operative patients needing extensive dental treatment. Research conducted by Helsinki Public Dental Service in Finland concluded that the main reasons for treatment under general anesthesia were extreme non-cooperation (65%), dental phobia (37%) and an urgent need for treatment (26%) [6]. For the pediatric group and patients with special needs, general anaesthesia should be the ultimate mode of choice to provide comprehensive, high-quality care where normal dental treatments do not evolve as an option. The medication is given through a face mask or IV. The level of anesthesia depends on the procedure and the individual patient. General anaesthesia medications are Propofol, Ketamine, Etomidate and Midazolam.

The use of GA has been advocated for the oral rehabilitation of patients with special care needs or young children or anxious children in one session, with the aim of reducing the need for repeated treatment and hence a second anaesthesia later. In the planning of general anaesthesia, the current concept is to encourage more radical treatment to reduce the need for future repeated general anaesthetic administration. Dental treatment under GA has several

advantages: it does not require a patient's cooperation, the patient is unconscious and non-responsive to pain, certain degree of amnesia is present after the procedure and drugs can be titrated to an optimal dose. The disadvantages of dental general anaesthesia are patient's protective reflexes are absent, depression of vital signs and higher incidence of complications during and after the procedure. Thus it requires specialized equipment, adequate facilities and an adequately trained team of professionals [7].

3. Pharmacology and mechanism of action of local anaesthetics

Local anaesthetics all act in the same manner – they bind to cellular sodium channels and inhibit the influx of sodium into the cell which prevents cell depolarisation and subsequent transmission of the previously propagating action potential [8]. Protein binding of the local anaesthetic is an inherent drug characteristic – the more protein-bound a drug is, the longer the duration of action [9]. For optimal duration of action and a pain free procedure, the local anaesthetics require to be deposited in close vicinity of the nerve. Research also shows that inflammation can have a negative impact on the success of anaesthetics [10]. In terms of jaws, teeth in the mandibular arch are more difficult to numb than those in the maxillary arch.

4. Complications of Local Anaesthesia

In general practice overall, local anaesthesia has been reported to have a failure in seven percent of cases, and failure of about ten percent of cases of an inferior alveolar block is seen [11]. Infection and wrong selection of local anaesthetic solutions, mistakes on the technical side, variations in anatomy with accessory innervation, and patient anxiety are the probable causes of failure of LA. Paresthesia, ocular complications, allergies, toxicity and methemoglobinemia are a few complications of local anaesthesia. Complications and adverse reactions to local anaesthetics occur mostly due to epinephrine, vasovagal syncope, or overdose toxicity and are usually attributed to additives such as metabisulfite or methylparaben. True allergy to amide-type local anaesthetics is exceedingly rare with a documented incidence from 0.1% to 1% [12]. In contrast, ester-type local anaesthetics, like benzocaine, which is used in topical anaesthetics, is one of the more allergenic agents found in a dental clinic after latex, non-steroidal anti-inflammatory drugs, and penicillin-type antibiotics.

Though uncommon in dental practice, Local Anaesthetic Systemic Toxicity (LAST) is a life-threatening adverse event that may occur after the administration of local anaesthetic drugs through other routes. The evolution of newer LA techniques, like the emergence of high-volume fascial plane approaches, continuous catheter techniques, using numerous LA techniques in the same patient and tumescent anesthesia all contribute to the ongoing risks of LAST [13].

5. When does Local Anaesthetic Toxicity occur?

Table 1 Recommended maximum dose of commonly used local anaesthetics

Drug	Maximum dose
Articaine with vasoconstrictor	7 mg/kg (up to 500 mg) 5 mg/kg in children
Bupivacaine with vasoconstrictor	2 mg/kg (up to 200 mg)
Lidocaine with vasoconstrictor	7 mg/kg (up to 500 mg)
Mepivacaine with vasoconstrictor	6.6 mg/kg (up to 400 mg)
Prilocaine with vasoconstrictor	8 mg/kg (up to 500 mg)
Mepivacaine without vasoconstrictor	6.6 mg/kg (up to 400 mg)
Prilocaine without vasoconstrictor	8 mg/kg (up to 500 mg)

The maximum recommended dose may vary from country to country. Many countries advocate a maximum dose of lidocaine 2% with 1:100,000 epinephrine as 4.4 mg/kg but there is no consensus on the issue [14]. There are other clinicians who oppose the idea of maximum recommended doses and instead take patient and clinician factors into consideration such as the patient's age, the site of injection, the speed of injection, and the existence of other

comorbidities [15]. The recommended maximum dose of some commonly used local anaesthetics are as given in the table above [16].

Despite clinicians adopting the best efforts, errors occur when the patient receives too high a dose of local anaesthetic, or an intravascular administration occurs, and the patient demonstrates an abnormal reaction of systemic toxicity despite no pre-existing medical condition or perhaps the patient had an unknown medical condition that predisposed them to local anaesthetic systemic toxicity [17].

6. Signs and symptoms of Local Anaesthesia Overdose

Manifestations of local anesthetic allergy or toxicity typically appear 1 to 5 minutes after the injection, but onset may range from 30 seconds to as long as 60 minutes. The toxicity of local and infiltration anesthetics can be local or systemic. Local adverse effects include neurovascular manifestations such as prolonged anesthesia and paresthesia, which may become irreversible. Systemic toxicity of an anaphylactic reaction most often involves the central nervous system (CNS) or the cardiovascular system. Important signs and symptoms include nausea, vomiting, constriction of pupils (miosis), drowsiness, lethargy, sedation, unconsciousness, and if unattended or untreated lead to coma, respiratory depression, respiratory arrest, depressed cardiac conduction, ventricular arrhythmias, atrioventricular block, and even cardiac arrest in extreme cases.

7. Reasons for Local Anesthetic Overdose

Evidence of lignocaine toxicity may commence at concentrations more than 5 µg/mL, but convulsive seizures require concentrations more than 10 µg/mL. Local anaesthetic concentrations of 2% or 3% carry negligible risk, but 4% articaine and prilocaine formulations most certainly introduce added risk. There is a possibility of ischemic necrosis of tissues following administration of local anesthetics. The risk is the greatest especially when injecting into attached mucosa such as the hard palate. Systemic toxicity linked to local anesthetics is dose dependent, however an understanding of these doses is not always easy. While the local anaesthesia cartridges used in dental practice save time and are convenient to dispense, it often results in carelessness in appreciating the actual amount of anesthetic that is administered to the patients. It is essential to keep in mind that a dental cartridge represents a volume, not a dose that is more properly expressed as milligrams or micrograms. Also, dental cartridges often contain two drugs: a local anaesthetic and a vasopressor, each having a separate dose. Further complicating matters, dental cartridges are packaged in peculiar volumes like 1.7 or 1.8 mL. All these issues put together make actual dosage calculations mathematically confusing and lends itself to memorization of amounts per cartridge rather than actual appreciation of proper doses. This practice becomes further complicated when cartridges contain various concentrations of local anaesthetics and vasopressors.

It is important to bear in mind that local anaesthetics are CNS depressants, and they are likely to potentiate any respiratory depression associated with sedatives and opioids. The dangerous effects of this drug interaction have been reported in pediatric patients receiving procedural sedation, along with excessive dosages of local anaesthetics [18]. Although all local anaesthetics carry comparable risk for CNS toxicity, the greatest possibility for direct cardiac toxicity is associated with bupivacaine [19].

It has been observed from research that lidocaine, when administered alone reaches peak serum levels between 20–30 minutes following its injection [20]. It has also been reported that regardless of the route of administration, peak levels of lidocaine were reduced, and its rate of absorption delayed by adding epinephrine 1 : 100,000 to the local anaesthetic solution. However, this complication is not known to occur when prescribed doses are used. It is also important to remember that systemic effects of various drug combinations follow principles of summation and calculation of maximum dosage should take this factor into consideration.

8. Common types of Dental Anaesthesia errors

The possible reasons for occurrence of dental local anaesthesia errors include the following:

- Giving too much or an improper combination of sedatives, analgesics, narcotics, benzodiazepines, and anesthesia agents
- Failure to verify that the patient has a patent airway prior to administering medications that can cause respiratory depression and respiratory arrest

- Failure to timely recognize when a patient starts to have cardiopulmonary compromise, and failure to take appropriate action when compromise occurs
- Giving a medication, such as Benadryl, which can enhance the depressive effects of certain sedatives, analgesics, narcotics, and anesthesia agents
- Failing to give reversal agents to reverse the adverse effects of benzodiazepines and/or narcotics
- Failure to give the patient an appropriate airway prior to administration of sedatives, analgesics, narcotics, benzodiazepines, and anesthesia agents
- Failure to timely intubate a patient who is experiencing respiratory depression.

9. Model of Anaesthesia in Dentistry

A cursory look at contemporary medical practice will reveal that medical practitioners operate under one model and set of guidelines that are highly regulated by several government and state agencies, but there are no such guidelines for use of dental anaesthesia. It is now the need of the hour to devise a policy and work under specific guidelines or recommendations that will apply to any dental surgeon who performs sedation in any situation or location. The benefit is that the more guidelines that are out there, the harder it is to justify a different practice model, particularly if there is a bad outcome.

The model of anaesthesia in dentistry is one that is unique and different from that practiced in medicine. The anaesthesia model practiced in dentistry is the single operator or dental surgeon/anaesthetist model. This is when the Dental Surgeon is providing the anaesthesia and performing the dental procedure or procedures as well. In medicine, it is rare that a physician will perform a procedure and supervise or be responsible for the anaesthesia, since they have at the very least a trained nurse to assist them. While a Dental Surgeon may have a Dental Assistant to help monitor the patient, a Dental Assistant has limited medical training. In medical procedures involving use of anaesthesia, the focus is on the ability to rescue. If a patient were to have a problem with their breathing, blood pressure, heart rate or cardiac system during the procedure, the foremost priority would be to have trained personnel on standby in the room who can help resuscitate the patient. On the contrary, in dental practice, this is not the case and one person, no matter how good or well trained, will find it difficult to do this alone.

In medical procedures, there has been a gradual shift from the practice of fixing the blame on one individual and later punishing them for this, to one which involves identifying systemic factors thus providing a higher benchmark of care for the patients, every time. In dental practice, since the dental professional works in isolation without any specialized assistance, all complications are attributed to the individual practitioner. There are also no structured Dental Anaesthesia Assistant certifications and any personal training given to the Dental Assistant do not actually train them to help care for a patient under sedation or anaesthesia. At the most, Dental Anaesthesia assistants are trained to gather the instruments and look for electrical/electronic errors, and not to assist in rescuing a patient if there is a complication. Specifically, the training the Dental Assistants receive is highly variable, inconsistent, and based upon the experience and current practices of the practitioner who is delivering the training.

10. Need for Anaesthesia Policy in Dentistry

An important aim of having a Dental Anaesthesia Policy is to pay adequate attention to the patient once dental anaesthesia is administered and to prioritise medical care, in case of any emergency. One reason there has been no clamor for a Dental Anaesthesia Policy is because there is very little data related to mishaps attributable to use of anaesthesia in dental practice. In dentistry, while the accomplishments are prominently published in journals, there is, at present, no record of how many adverse outcomes there have been which may be attributed to use of dental anaesthesia. This is not reported because unless an event results in something adverse like death or admission to emergency room, there is no requirement of any report to be made to any authority. There may be many "near misses," which can be educational and lead to practice improvements. The patient may not die but he or she may just not be quite right afterwards, which never gets reported. In medicine, anaesthesiologists and quality improvement scientists recognise the value of reporting near misses as well as complications, developing data collection systems and training personal to critically evaluate these reports and help guide improvements in outcome.

In the medical field, there are many organisations involved and there is encouragement for anyone to report anything, whether positive or negative. Presently, there are highly coordinated efforts towards change in the field of anaesthesiology and medicine like the American Society of Anesthesiology (ASA) American Patient Safety Foundation (APSF) which is committed to improving safety. They have developed resources and committed funding to collecting, examining, and analysing quality improvement data. There are voluntary programmes for self-monitoring that have

remarkably high participation, in addition to mandatory requirements. In reporting all problems that occur, including adverse events or side effects such as a new allergy to a drug, a group can learn a great deal about its practice and how to improve it. Unfortunately for dentistry, news about sedation and anaesthesia mishaps come to notice only when the media gets hold of it. And, unfortunately, they become sensationalised to the detriment of all those who are involved.

11. Guidelines for inclusion in Dental Anaesthesia Policy

- Suggested guidelines for dentists and oral surgeons to follow when providing local anaesthesia are as follows:
 - Prior, precise knowledge of the patient's weight, the maximum dose per kg (absolute dose) of the local anaesthesia and proper calculation of the drug dose to prevent systemic overload and disruption of cell membrane function in the patient.
 - With the intention to simplify dosage calculations, it is recommended to consider each local anaesthesia cartridge to contain 2 mL of volume. This will overestimate the amount administered to a patient, which is a safe practice. For example, when three and half cartridges have been administered, it is better to estimate it as seven (7) mL.
- Suggested guidelines for dentists and oral surgeons to follow when providing deep sedation or general anesthesia to children:
 - At least two people should always be present in the room who are trained to provide advanced life support measures in case there are any problems. One of these will be the dentist or oral surgeon performing the procedure and the other will be an anaesthesia professional or another dentist or oral surgeon who is licensed and trained in anaesthesia.
 - It is important for parents to know all available options before a specific type of anaesthesia is selected.
 - Patient care for a procedure or surgery requiring sedation and/or anesthesia should be based on nationally accepted standards, guidelines and levels of care consistent in a dental office, hospital, ambulatory surgery center (ASC) or clinic.
 - The individual providing sedation and/or anaesthesia care in the dental office-based setting should:
 - ✓ Successfully complete approved formal education, whether incorporated in the core curriculum or as post-graduate education, consistent and equivalent with the level of sedation and anesthesia required.
 - ✓ Successfully complete approved education and training in airway maintenance and management of complications from sedation and anaesthesia care rescue from deeper than the intended level of sedation.
 - Continuing education in age-appropriate resuscitation knowledge and skills must be maintained on a biennial basis.
 - For dental office-based sedation and/or anesthesia care, availability and use of appropriate monitors and safety equipment should be ensured.
 - Age-appropriate equipment and medications for use in resuscitation and related emergency care should be available for immediate use. These emergency care and transfer processes should be incorporated into the office's emergency protocols.
 - A designated individual, other than the individual performing the procedure, should be continuously present to monitor the patient throughout procedures performed with minimal or moderate sedation. During deep sedation and/or general anesthesia, this individual should have no other responsibilities.
 - All equipment should be checked and maintained at routine intervals.
 - Prolonged and extensive procedures with longer periods of sedation and anesthesia care are of concern in the office-based setting and qualified anesthesia providers, in consultation with patients and parents, should consider more suitable facilities for the procedure.
 - All dental office settings where sedation and/or anesthesia care is performed must have appropriate equipment and supplies immediately available. Equipment and medications and emergency age-appropriate airway equipment must be always available and functional.
 - Selection of reportable events and outcomes should be based on published guidelines, clinical registries, patient safety organization guidance, and legal regulations.

12. Conclusion

Dentistry has always been very reactionary when it comes to adverse outcomes. When it comes to harmful events or clinical failures, market forces drive the reaction. The occurrence of severely adverse outcomes during anaesthesia use in dentistry has resulted in more intense scrutiny of the process and outcomes of sedation and anaesthesia in dentistry. The adoption of a dental anaesthesia policy will be a step in the right direction towards minimising anaesthesia errors and instilling confidence in patients.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest.

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