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Comparative evaluation of the fracture and bond strengths of CAD-CAM milled posts versus conventional posts in the restoration of simulated young permanent teeth

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Abstract

Success of pediatric dental treatment relies on clinical skills and the ability to manage a child's behavior, often challenged by fear and anxiety. While many children respond to behavior modification, General Anesthesia (GA) is essential for those who are highly uncooperative, have special healthcare needs, or require extensive treatment. GA ensures pain-free, comprehensive care by inducing reversible state of unconsciousness and immobility. With advances in anesthetic agents and safety protocols, GA has become a reliable and effective tool in pediatric dentistry. This article explores the role of GA in providing effective dental treatment and improving the oral health related quality of life for young children.

Introduction

Successful pediatric dental practice not only depends on the dentist's technical skills but also on effectively managing a child's behavior. Fear, anxiety, and phobia are often triggered by needles, separation from parents, or the sound of drills and the dental clinic environment, which can affect a child's cooperation.[1] Various non-pharmacological and pharmacological techniques have been used for behavior management. General anesthesia is particularly useful for managing

disruptive, fearful, or special needs children, enabling pain-free and comprehensive dental care.[2] Way back in 1844 Dr. Horace Wells, also known as "Father of Anesthesia" introduced general anesthesia. In 1935, thiopentone was introduced as the first intravenous anesthetic. These events paved the way for advancements in anesthetic agents. The American Society of Anesthesiologists (ASA) defined General anesthesia as a drug-induced loss of consciousness during which patients are not arousable, even to painful stimulation. The ability to independently maintain ventilatory function and cardiovascular function is often impaired.[4] Consequently, patients often require assistance in maintaining a patent airway, and positive ventilatory pressure may be required because of depressed spontaneous ventilation or drug-induced depression of neuromuscular function.

General Anesthetic Agents

General anesthetics can be classified into inhalational and intravenous based on their routes of administration. Commonly used drugs are listed in Figure 1.

Need for GA In Pediatric Dental Practice

The American Academy of Pediatric Dentistry (AAPD) emphasizes the importance of GA for patients who cannot cooperate due to emotional, psychological, or developmental challenges (Special Health Care Needs) as well as those with extensive dental needs like severe early childhood caries, severe anxiety, or urgent conditions like trauma or infection.[5] GA also helps in effective anxiety management, providing better airway protection, and allowing treatment completion in a shorter duration of time. All these factors led to an increase in the number of pediatric patients requiring dental rehabilitation under general anesthesia (GA).

Preparing Patients for Dental Treatment Under GA

A) Protocols

The following protocols are the essential steps to ensure safe, effective, and well-coordinated care during pediatric dental procedures.

- Assessment of Parental Compliance: The decision to admit a child before or after surgery should be based on a thorough assessment of the parent's emotional readiness, understanding, and ability to manage postoperative care. If there is any doubt about the parent's competence or the child's safety, hospital admission is recommended to ensure proper care and outcomes.[6]
- Informed Consent: It is a mandatory process before administering GA, as it involves more than routine dental care. Since the child cannot provide consent, it must be obtained from a responsible adult, typically a parent or caregiver. It includes clear communication with parents or legal guardians, ensuring that they fully understand the procedure with its associated risks, and possible outcomes.[7]

B) Pre-anesthetic evaluation

A thorough pre-anesthetic assessment by a qualified anesthesiologist is crucial for all pediatric patients, particularly those with underlying medical conditions, neurodevelopmental disorders, or genetic syndromes, who should ideally be evaluated in advance of the scheduled procedure. Early assessment ensures proper planning for both preoperative and postoperative care, reducing the risk of last-minute cancellations or delays. In addition to the standard medical history and physical examination, the key areas that require particular attention are: behavioral considerations, detailed airway assessment, and NPO guidelines.

- Behavioral considerations: A child's behavior in the dental clinic is influenced by various factors, making it crucial to assess their ability to tolerate procedures. Children with severe behavioral challenges, and those with developmental disorders like Autism Spectrum Disorder, Cerebral Palsy, and Down Syndrome often require treatment under general anesthesia, necessitating careful pre-anesthetic planning. Anxiety before procedures is common, especially in neurodivergent children, due to fear, separation from parents, and limited understanding. To ensure smoother anesthesia induction, both pharmacological and non-pharmacological strategies—such as parental presence, calm environment, including items of their likes and dislikes, distraction techniques like video games, and personal comfort items. These all can help the anesthesiologists in planning a smoother process of intubation and induction.
- Airway assessment: It is the most critical aspect of this preparation, as dental procedures often require shared access to the airway between the anesthesiologist and the dental surgeon. A thorough evaluation of the airway, particularly the nasal passages, since nasal intubation is usually preferred over the oral route to secure the airway. Additionally, assessing tonsillar size based on the Mallampati score (Figure 2) helps in determining airway patency and can guide the intubation strategy during general anesthesia.

Before general anesthesia, it is essential to acquire clearance from an anesthesiologist before the commencement of the procedure, with a detailed explanation of the diagnosis and treatment planning.

- Fasting (Nil Per Oral)- Before general anesthesia, Nil per Oral (NPO) guidelines should be followed to minimize the risk of regurgitation and pulmonary aspiration.[10] Often, the pediatric patient is admitted the night before the scheduled surgery, and the procedures are done early in the morning as it allows the patient to be in a sleep state, minimizing potential irritability upon waking up. NPO guidelines as recommended by the

American Society of Anesthesiologists (ASA) are mentioned in Table 1.

C) Premedication

Children often experience anxiety and distress before dental procedures under general anesthesia due to fear of pain, hunger, separation from parents, and a limited understanding of the situation. These challenges are even more pronounced in children with neurodevelopmental disorders. To ease this transition and support a smoother induction of anesthesia, pharmacological methods can be employed.

It involves the use of sedatives, anxiolytics, and agents with amnestic properties to reduce anxiety and ease separation.[12] Midazolam is commonly used for its effectiveness in otherwise healthy, uncooperative children. Dexmedetomidine induces a calm, sleep-like state without causing respiratory depression, making it suitable for pediatric dental patients. It reduces emergence delirium without prolonging recovery or discharge times. Singh et al in a study stated that Dexmedetomidine is required in lower doses, had better control over hemodynamics when given as a premedication, and the duration of the post-operative analgesia was also longer.[13] Recently, a newer drug, Remimazolam an ultra-short-acting BZD, with a property of high clearance, minimal tissue accumulation, faster onset, and quick recovery has gained popularity and can also be used in pediatric patients.[14] Ketamine, an NMDA receptor antagonist, is especially beneficial in children with congenital heart disease due to its cardiovascular stability and minimal respiratory impact.

D) Induction and maintenance

- Intubation: Endotracheal intubation ensures airway protection, with micro-cuffed tubes preferred for children.[15] Nasotracheal intubation offers better surgical access but requires vasoconstriction agents.[16] Traditionally, uncuffed endotracheal tubes (ETTs) are preferred for children under 8 years old, but now newly designed micro-cuffed tubes are being used for pediatric patients.
- Induction: It is commonly carried out via inhalation, using sevoflurane for its rapid onset and tolerability. Initial high concentrations of sevoflurane result in quicker induction with similar complication rates.[17] Alternatively, intravenous induction using propofol is preferred when IV access is readily available. Inhalation induction involves oxygen and nitrous oxide, followed by a volatile anesthetic to achieve unconsciousness.

- Maintenance: This phase ensures stable anesthesia, using drugs like propofol for smooth induction and remifentanil for rapid analgesia. Dental procedures under general anesthesia (Figure 3) prioritize thorough treatment to avoid repeat visits, with extractions favored over pulpectomies for abscessed teeth. Anesthesia plans emphasize early recovery and discharge, often incorporating adrenaline infiltration to minimize bleeding. Postoperative pain is typically mild and managed with short-acting opioids, NSAIDs, acetaminophen, and local anesthetics to optimize comfort.

E) Reversal of General Anesthesia

The process of reversing general anesthesia involves carefully restoring consciousness, muscle function, and airway reflexes while ensuring patient safety and comfort. Several drugs, including sugammadex, glycopyrrolate-neostigmine, and opioid antagonists like flumazenil, are used to reverse anesthesia effects.[18] Sugammadex enables faster recovery compared to succinylcholine[19], while glycopyrrolate-neostigmine can be a preferred choice in pediatric cases due to its safety profile.

Before awakening from anesthesia, the anesthesiologist must carefully remove any throat packs or gauze and perform oropharyngeal suctioning to clear the airway. Awake extubation is carried out after the return of consciousness and muscle function, to ensure a safe recovery with restored airway reflexes.

F) Postoperative Complications and Management

Despite its several advantages, GA also has some post operative complications such as an increased risk of surgical complication and longer recovery times.[5] Emergence delirium, nausea, and pain in children after dental procedures under GA are common, though manageable. Dual antiemetic therapy with ondansetron and dexamethasone is effective for nausea, while dexmedetomidine helps to reduce delirium. Physical symptoms like toothache, sore throat, fever, and difficulty eating typically resolve within a few days, though psychological effects such as anxiety, sleep disturbances, and excessive crying may persist longer and require additional support. Clear liquids should be introduced after 4 to 6 hours, gradually transitioning to a normal diet by the second day.

G) Discharge Criteria

The post-anesthesia recovery time ranges from 25 to 65 minutes, with a mean time of approximately 40 minutes.[19] Patients

can be discharged once they are stable, alert, and show no signs of complications, and appropriate medications along with clear follow-up instructions, should be provided to parents and caregivers.

Dental Anesthesia Beyond the Operating Room

Administering anesthesia in a dental operatory presents the unique challenges due to the absence of standard operating room facilities, such as adjustable tables (Figure 4) and dedicated recovery areas. Close collaboration between dental and anesthesiology teams is crucial for patient safety, following ASA guidelines for Non-Operating Room Anesthesia and equipment checks like the SOAP-ME protocol (Table 2).[20]

Breaking New Ground: The Future of Anesthesia Innovations

Innovations in intravenous anesthetics, including remifentanil and Ciprofol, along with advanced infusion pumps and pharmacokinetic modeling, have improved total intravenous anesthesia (TIVA). Technologies like target-controlled infusion (TCI) and closed-loop anesthesia delivery systems enhance dosing precision, stability, and recovery, ensuring safer anesthesia management, particularly in pediatric patients.[21]

Conclusion

As the demand for dental procedures under general anesthesia continues to rise in pediatric patients, a well-rounded approach is essential for ensuring safety and effectiveness, keeping in mind the risk versus benefit ratio. This involves meticulous preoperative evaluation, strategic anesthetic planning, and proactive management of complications, especially in children with cognitive impairments. While most procedures can be safely performed on an outpatient basis, careful screening is crucial to identify cases requiring hospitalization for optimal care.

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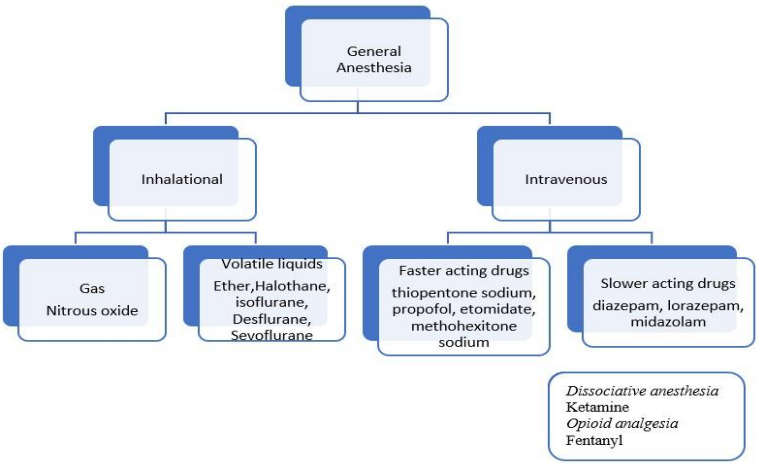

Figure 1 – Drugs used in General Anesthesia

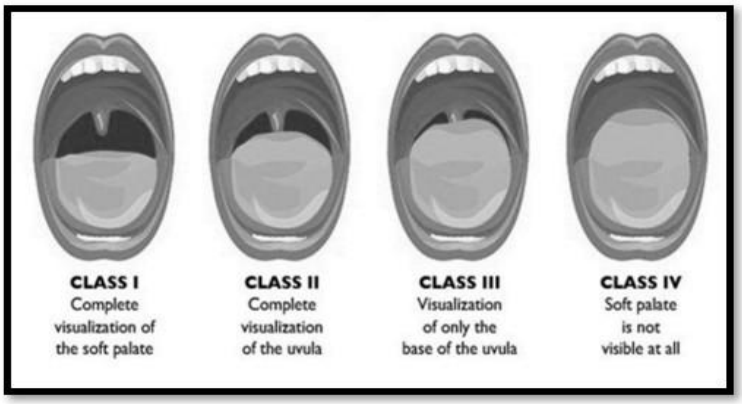

Figure 2- The Mallampati Score

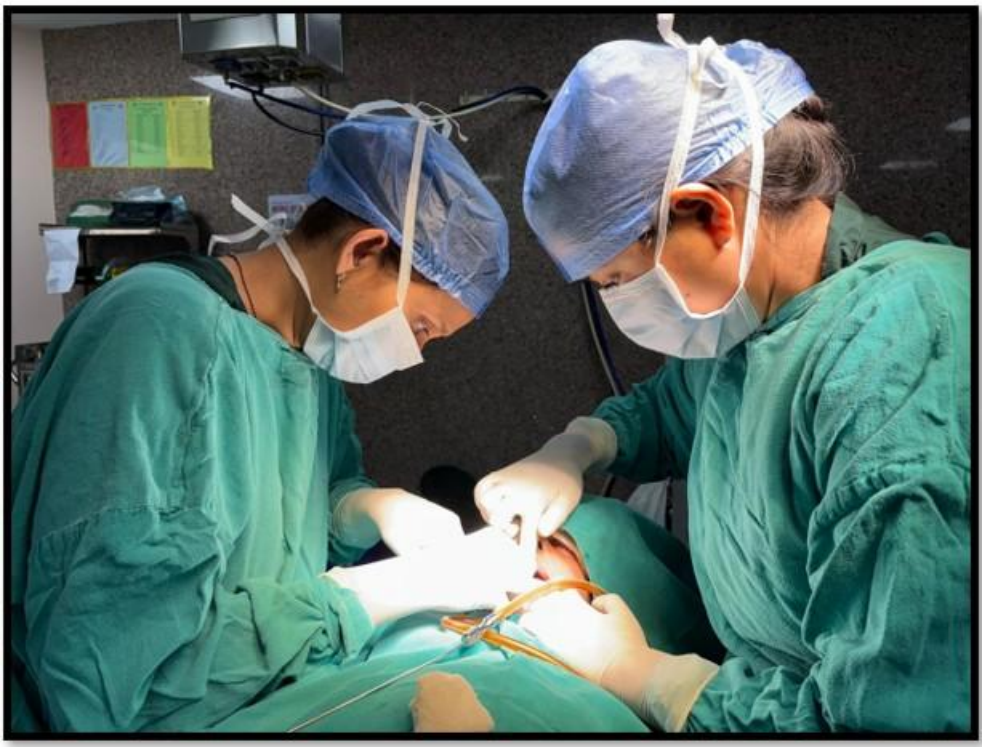

Table 1- NPO Guidelines

FOOD ITEM	**MINIMAL FASTING TIME**
Clear, sweet liquids	2 hours
Breast milk	4 hours
Infant formula, fruit juices and jello	6 hours
Solid food	8 hours

As recommended by American Society of Anesthesiologists

S suction	A functioning suction apparatus and age appropriate suction catheters.
O oxygen	Reliable oxygen source, with at least one spare oxygen cylinder.
A airway	Age appropriate airway equipment.
P pharmacy	Basic anesthetic drugs and their antagonist; emergency drugs.
M monitors	Standard ASA monitors- electrocardiography, blood pressure, pulse oximetry, end-tidal carbon dioxide, and temperature.
E equipment (special)	e.g., defibrillator.

Table 2- Mnemonic (SOAP ME) for checklist for Non-Operating Room Anesthesia

LEGENDS

Figure 1- Classification of General Anesthetics
Figure 2- The Mallampati Score

Figure 3- Dental Treatment Under General Anesthesia
Figure 4- Adjustable Table for Operating Room

Table 1- NPO Guidelines
Table 2- Mnemonic (SOAP ME) for checklist for Non-Operating Room Anesthesia