REVIEW ARTICLE

CONSCIOUS SEDATION IN DENTISTRY : A REVIEW

Dr. Rachita Arora*, Dr. Sayan Chattopadhyay**
Dr. Kanad Chaudhuri***, Dr. Debanti Giri**
Dr. Debasree Boral***, Dr. Rritam Ghosh***

ABSTRACT

Dental sedation practices have become an integral part of modern dental practice, providing patients with the comfort and relaxation they need when facing procedures that can be stressful and uncomfortable. In this review, we examine the evolution of conscious sedation, the various medications and methods employed, essential safety considerations, and the latest advances in this field. The focus of this review is to bring together experts from multiple fields to collaborate, integrating pharmacological, psychological, and technological innovations to optimise patient outcomes.

KEY WORDS

Benzodiazepines, Conscious Sedation, Nitrous Oxide, Patient Monitoring, Sedation Techniques

ABOUT THE AUTHORS

* Associate Professor
Department of Paedodontics and Preventive Dentistry
**Associate Professor
Department of Oral Medicine and Radiology
***Assistant Professor
Department of Oral Medicine and Radiology
Dr. R. Ahmed Dental College and Hospital, Kolkata

CORRESPONDING AUTHOR

Dr. Rachita Arora
Associate Professor
Department of Paedodontics and Preventive Dentistry
Dr. R. Ahmed Dental College and Hospital, Kolkata
Phone No.: 9431342682
email id : rachita.arora1@gmail.com

INTRODUCTION[1-7]

Many people-about 10 to 20 per cent globally-struggle with dental anxiety or even phobia, which can make it difficult for them to seek the care they need. Conscious sedation, which keeps patients relaxed but still awake and able to respond, has become a valuable way for dentists to help patients feel at ease and comfortable during their visits. Unlike general anaesthesia, conscious sedation preserves protective reflexes and enables faster recovery, aligning with the shift toward minimally invasive, patient-centred care. With the introduction of nitrous oxide by Horace Wells in the mid-19th century, the development of painless dentistry took a significant step forward. As a result of advances in pharmacology and patient monitoring, conscious sedation has been revolutionised and improved in terms of safety and efficacy.

Conscious Sedation and Pharmacological Agents

The procedure, patient health, and the desired depth of sedation guide the choice of sedative agent in dentistry. Various pharmacological classes are available, each with unique properties and clinical considerations.

Benzodiazepines

Benzodiazepines are the mainstay of pharmacological sedation in dentistry due to their anxiolytic, sedative, muscle relaxant, and amnesic effects[8-10]. Midazolam and diazepam are the most commonly used agents in this class.

- Midazolam is favoured for its rapid onset (within 5-10 minutes intravenously, 15-30 minutes orally), short duration of action, and water solubility, which reduces injection site discomfort[8,9]. It is highly predictable and can be reversed with flumazenil in case of overdose or prolonged sedation.
- Diazepam is effective but less commonly used due to its longer half-life and potential for prolonged sedation and residual drowsiness[10].
- Benzodiazepines are particularly useful for managing preoperative anxiety and are often the first choice for paediatric and special-needs patients, as

they can provide both sedation and amnesia for the procedure [9]

Clinical considerations:

- Oral midazolam (0.25–0.5 mg/kg) is effective for children, while adults may receive oral or intravenous doses titrated to effect 8,9.
- Benzodiazepines are generally safe but can cause respiratory depression when taken in high doses or when combined with other CNS depressants.

Nitrous Oxide

Nitrous oxide (N_2O), commonly known as "laughing gas," is the most widely used inhalational sedative in dentistry [6]

- It acts rapidly, with effects seen within minutes, allowing easy titration to the desired sedation level3,6
- The mechanism involves NMDA receptor inhibition and enhancement of GABAergic neurotransmission, providing mild analgesia and anxiolysis[6]
- Nitrous oxide is especially suitable for anxious adults and children, as it is non-invasive and its effects are quickly reversible by administering 100% oxygen at the end of the procedure [7]

Clinical considerations:

- Side effects, though uncommon, include nausea and diffusion hypoxia; however, providing oxygen after the procedure effectively prevents these issues.[7]
- Nitrous oxide should not be used in patients with specific respiratory problems or who cannot comfortably wear a nasal mask.

Opioids

Opioids such as fentanyl and morphine are potent analgesics that may be combined with other sedatives for procedures requiring moderate to deep sedation.[11,12]

- They act on central opioid receptors to provide substantial pain relief and sedation but carry a risk of respiratory depression, mainly when used with other CNS depressants[12]
- Opioids are typically reserved for more invasive dental surgeries and are rarely used as sole agents for conscious sedation.

Clinical considerations:

- Opioids require close monitoring of respiratory function and the availability of naloxone for reversal in case of overdose[12]
- Their use is generally limited to hospital or specialist settings due to the need for advanced monitoring.

Barbiturates

Barbiturates such as thiopental and pentobarbital were historically used for deep sedation but have primarily been replaced by safer alternatives.[3]

- They have a narrow therapeutic index and a higher risk of respiratory depression and cardiovascular instability.
- Their use today is rare and generally limited to cases where other agents are contraindicated.

Ketamine

Ketamine is a unique sedative that induces a dissociative state by blocking NMDA receptors and stimulating opioid receptors.[6]

- It provides profound analgesia, sedation, and amnesia while preserving airway reflexes and spontaneous breathing.[6]
- Ketamine is especially valuable in pediatric dentistry and for patients with special needs who may not tolerate other sedatives.[6]

Clinical considerations:

- Side effects can include postoperative hallucinations and confusion, which can be minimised by co-administration of benzodiazepines.[6]
- It is contraindicated in patients with certain psychiatric disorders or uncontrolled hypertension.

Non-Benzodiazepine Sedatives

Propofol and dexmedetomidine are newer agents increasingly used in dental sedation:

- Propofol is a short-acting intravenous anaesthetic that potentiates GABA activity, resulting in rapid onset and recovery.[13] It can be used for procedures that require more profound sedation, but airway management skills are necessary due to the risk of apnea and hypotension.[13,14,15]
- By activating alpha-2 adrenergic receptors, dexmedetomidine provides mild pain relief, sedation, and mild sedation without significant respiratory effects. As a result, it serves as a valuable option for specific patient groups.[14,16]

Clinical considerations:

- Both agents require continuous monitoring and are generally administered by anaesthesiologists or dentists with advanced training.[13,14]

Other Sedatives

Agents such as clonidine and additional alpha-2 agonists are under investigation for their sedative effects with minimal impact on respiratory function.[14,17] These may offer alternatives for patients with contraindications to traditional sedatives.

Combination Therapy

Combining sedative agents is a common practice to maximise efficacy and minimise side effects.[3] For instance, benzodiazepines and opioids may be combined to achieve both analgesia and anxiolysis at low doses of each drug.

Typically, nitrous oxide is administered in conjunction with oral or intravenous sedatives to enhance patients' comfort and cooperation.[3]

Considerations for clinical practice:

- Each combination therapy should be customised for each individual, considering their medical history, the type of procedure and potential drug interactions.
- Lower doses are typically used to reduce the risk of adverse effects.

Techniques of Conscious Sedation

Conscious sedation in dental care employs various techniques to help patients feel calmer and more comfortable while remaining awake. The main approaches include:

1. Oral Sedation

Oral sedation includes administeringsedative medications, namely, benzodiazepines like diazepam or midazolam, in pill or liquid form. These agents are absorbed through the gastrointestinal tract and induce a state of relaxation and calmness. The onset of sedation is slower than other methods, and its depth can vary based on the dose.[9] Oral sedation is advantageous in managing dental anxiety but requires longer preparation time before the procedure.[3]

2. Inhalation Sedation

Inhalation sedation primarily involves inhaling nitrous oxide (N_2O) through a nasal mask. The effects of nitrous oxide, resulting in mild to moderate sedation, are caused by blocking NMDA receptors and enhancing GABA activity, a natural sedative chemical in the brain.[6] With this technique, you can adjust the level of sedation at any point in the process, allowing for a precise and flexible degree of sedation throughout the procedure. A special advantage of this therapy is that it can be used with children and adults with anxiety issues.[18]

3. Intravenous Sedation (IV Sedation)

Intravenous sedation offers a deeper level of relaxation than oral or inhaled sedation, making it suitable for procedures that require intense pain relief or profound relaxation. The most common medications used aremidazolam, propofol, and fentanyl. As these drugs are given directly into the bloodstream, they produce a more rapid effect and are more precise in controlling sedationdepth. Monitoring the patient's vital signs is carried out by experienced anaesthesiologists or dentists during the procedure.[5] Typically, this option is chosen for dental surgeries involving complex anaesthesia and maintaining the patient's alertness while still maintaining comfort.

4. Intramuscular Sedation

As with intramuscular sedation, the sedative medication is administered directly into the muscle. Benzodiazepines and opioids are usually used in this procedure. This technique is sometimes preferred when intravenous access is difficult or not feasible. Diazepam or midazolam are typically used for its anxiolytic effects. As a general rule, this method works as well as intravenous sedation, but takes longer to produce its effects and may cause discomfort at the site where the injection is given.[13]

5. Combined sedation

Combining nitrous oxide and oral or intravenous sedatives may be necessary for some procedures. As a result, a synergistic effect is created, allowing the medications to be taken at lower doses and thereby enhancing overall sedation.[8] For example, combining nitrous oxide with midazolam can increase patient comfort and reduce anxiety with minimal side effects.

6. Advanced Conscious Sedation Techniques in Dentistry

Several advanced techniques have been adopted in modern dentistry to enhance patient comfort, alleviate anxiety, and improve treatment efficiency beyond traditional methods, including oral, inhalant, and intravenous sedation. A patient who experiences high levels of anxiety, suffers from medical conditions, or needs a lengthy procedure might benefit most from these methods.

i) Target-Controlled Infusion (TCI)[19]

Target-controlledinfusion(TCI)isacomputer-driven technique for administering intravenous sedatives, such as propofol or remifentanil, to achieve precise control over the administration of these medications.

Pharmacokinetic models ensure a steady and consistent level of sedation throughout the procedure, using pharmacokinetic models to calculate and maintain an accurate drug concentration in the bloodstream.

Benefits : This approach offers improved accuracy, rapid onset and recovery times, as well as a reduced risk of overdosing.

Challenges : To perform this technique safely and successfully, specific equipment and trained professionals are required

ii) Patient-Controlled Sedation (PCS)[20]

A patient-controlled sedation system (PCS) uses an IV pump programmed with safety limits to enable an individual to self-administer small amounts of sedatives like midazolam or propofol in a controlled manner. Sedation is adjusted to ensure the patient's comfort and needs are met.

Benefits : Enhances the patient's autonomy and reduces the need for more profound sedation.

Challenges : It is not recommended for children or patients with cognitive impairments.

iii) Intranasal Sedation[21]

Intranasal administration of sedatives like midazolam or dexmedetomidine offers a fast, non-invasive alternative to injections. A mucosal atomiser device is used for quick absorption through the nasal lining.

Benefits : Rapid onset (within 10 minutes), excellent for pediatric and needle-phobic patients.

Challenges : Variable absorption and possible nasal irritation.

iv)Sedation with dexmedetomidine[22]

An alpha-2 adrenergic agonist, dexmedetomidine, induces a calm, sleep like sedation without significantly affecting breathing. It can be administered intravenously or intranasally.

Benefits : Stable cardiovascular and respiratory profile. Ideal for elderly or medically fragile patients.

Challenges : Slower onset and higher cost.

v) Computer-Controlled Local Anaesthetic Delivery (CCLAD)[23]

Devices like The Wand enable the pain-free delivery of local anaesthesia and are often used in conjunction with nitrous oxide sedation for added comfort.

Benefits : The reduction of needle anxiety, especially in children, is particularly beneficial.

Challenges : Anaesthesia is controlled, but sedation is not.

vi) Audio-visual distraction and hypnosis[24]

Using guided relaxation or virtual reality tools with minimal sedation, this technique can ease dental fear. It is beneficial for children and adults with anxiety.

Benefits : Sedation is enhanced, and there is less need for drug dosage.

Challenges : Individual receptivity plays a key role in effectiveness.

Indications and Contraindications

Indications :

- Management of dental anxiety and phobia.[25]
- Long or invasive procedures (e.g., implant placements, third molar extractions).[26]
- Children and patients with special needs who are unable to cooperate.[27]

Contraindications:

Serious respiratory or heart conditions that increase the risk of complications during sedation.[28]

Known allergies to sedative medications, which could cause adverse reactions.[3]

Pregnancy during the first trimester, when sedation may pose risks to fetal development.[29]

Absence of adequately trained staff or necessary monitoring equipment to ensure patient safety during sedation.[5]

Safety and Monitoring

Pre-Sedation Assessment :

To minimise risks, a thorough review of the patient's medical and dental history, a careful assessment of the airway, and an evaluation of current medications are essential.[3]

Intraoperative

Monitoring : Constant monitoring of vital signs, including oxygen levels, heart rate, and blood pressure, is essential during sedation. For moderate to deep sedation, capnography to track breathing and ventilation is strongly advised to ensure patient safety.[30,31]

Complications and Management :

Common complications include hypoventilation, hypotension, and paradoxical reactions. In the event of an emergency, equipment and reversal agents (e.g., flumazenil for benzodiazepines) must be readily available, and personnel must be trained to use them.[3]

Future Directions and Advancement:

Remimazolam, a new sedative drug with a rapid onset, short duration of action, and few side effects, represents one of the latest advancements in sedative medications. These qualities make it especially suitable for children and elderly patients. Additionally, improved monitoring tools-such as real-time tracking of end-tidal CO_2 and heart rate variability-enable more accurate and personalised sedation management, particularly for patients at higher risk. Clinicians are beginning to explore the use of digital sedation records and artificial intelligence to help tailor sedation plans by analysing factors such as a patient's medical history, anxiety levels, and the complexity of the procedure. In addition, virtual reality and augmented reality technologies are being studied as supportive tools to enhance the patient's experience and help reduce anxiety during treatment.

DISCUSSION ON CONSCIOUS SEDATION IN DENTISTRY

The use of conscious sedation in dentistry is essential for easing anxiety, controlling pain, and keeping patients co operative during treatments. To ensure that sedatives are used correctly, they must be tailored to each patient's age, medical background, and situation.[8]

The development of improved sedation drugs like remimazolam and dexmedetomidine offers potential alternatives to traditional agents like midazolam because of their safety, faster onset, and shorter recovery times.[9]

A significant concern with conscious sedation is over-sedation or low oxygen levels, especially in sensitive groups like children and older people.[25] Monitoring vital signs and end-tidal CO_2 during procedures is crucial for reducing these risks. By providing real-time information on the patient's condition, monitoring technologies such as pulse oximetry and capnography have greatly improved sedation safety. During this process, clinicians can adjust the sedation level promptly, thereby preventing complications from occurring.[6]

According to researchers, our genes may influence how we respond to sedation. We are learning more and more about how genetic differences affect the effectiveness and safety of sedatives, making it easier for doctors to predict which sedatives will be most effective and safe for a particular patient based on their genetic characteristics. By reducing the risk of side effects and enhancing the overall success of treatment, this progress could lead to personalised sedation plans.[6,25]

Furthermore, recognising how sedatives interact with other medications-especially in patients taking multiple drugs-will be vital for maintaining patient safety.[23]

Artificial intelligence (AI) and machine learning are expected to play an increasingly important role in conscious sedation in the future. Through these advanced systems, clinicians can determine the most suitable sedation type for a patient based on their medical history, current health status, and the anticipated complexity of the procedure. Artificial intelligence can assist healthcare professionals in making informed decisions about sedation strategies by considering factors such as vital signs, previous medical conditions, and specific procedural needs.[8]

At the same time, it is paramount to ensure patient comfort and satisfaction. Even though technological advancements have made sedation procedures safer, psychological factors, such as anxiety, still play a significant role in the patient's overall experience. The use of innovative tools, such as virtual reality (VR) and augmented reality (AR), is being investigated to distract patients and reduce anxiety during procedures.

As a result of immersive technologies, the patient can shift their attention from the dental treatment to the experience in general, making the sedation more effective and the overall experience more pleasant.[6]

Despite significant progress in conscious sedation techniques, ongoing efforts are necessary to further enhance patient outcomes. Any sedation protocol must adhere to patient safety, with continued research aimed at refining and improving practices.[3]

By reducing stress and enhancing patient cooperation, conscious sedation has revolutionised the dental care experience. Still, there are challenges, such as the fact that sedatives respond differently to different patients, the possibility of misuse, and regulatory concerns. The adoption of new sedative agents as well as technological innovations offers promising solutions to these problems.

An interdisciplinary approach involving dentists, anaesthesiologists, and psychologists is crucial to advancing conscious sedation practices. For these advancements to be widely accepted and accessible in dental care, future research must focus on long-term safety, patient satisfaction, and cost-effectiveness.

CONCLUSION

Providing conscious sedation in the dental practice has become an integral part of modern dentistry, providing significant benefits to both patients and dental professionals. A combination of new, safer sedative medications, including remimazolam and dexmedetomidine, along with advanced monitoring technology and tailored sedation strategies, will further enhance patient care. As a result, these innovations offer a greater level of safety and comfort, allowing treatment plans to be

more efficient and personalised. The development of genetic profiling and AI-guided sedation will lead to improved patient outcomes and a more positive overall experience as conscious sedation continues to advance. With these advancements, dentistry will continue evolving, prioritising patient comfort and safety at the heart of care.

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