RESEARCH PAPER

Sensory Adapted Sedation - A Synergy of Sensory Modulation and Sedation: A Case Report

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ABSTRACT

Background: Dental fear and anxiety (DFA) pose significant challenges in pediatric dentistry, often impeding effective treatment delivery and shaping negative long-term attitudes toward oral care. Among children with heightened sensory sensitivities, environmental modifications and sedation techniques can profoundly influence cooperation and comfort.

Methods: This case report describes the successful management of an anxious 5-year-old pediatric patient requiring pulp therapy through the combined use of a Sensory-Adapted Dental Environment (SADE) and nitrous oxide–oxygen (N_2O/O_2) inhalation sedation. The integration of sensory modulation with conscious sedation created a calming, child-centered clinical setting.

Results: The multimodal strategy effectively reduced anxiety, improved behavior, and facilitated treatment completion in a single visit. By addressing both sensory and physiological components of anxiety, this approach enabled comprehensive care delivery.

Conclusions: This multimodal strategy exemplifies a comprehensive, compassionate approach to pediatric dental care. To the best of our knowledge, this is the first case report of its kind incorporating the synergy of both techniques as a novel approach in managing pediatric dental anxiety.

Keywords: Pediatric dentistry, dental anxiety, Sensory-Adapted Dental Environment (SADE), nitrous oxide sedation, pulp therapy.

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INTRODUCTION

The conventional approach to oral healthcare is often hindered by dental phobia and anxiety, especially among children with sensory sensitivities or special healthcare needs. Dental fear and anxiety (DFA), defined as fear or apprehension specifically associated with dental treatment and the dental setting, remains one of the most significant barriers to effective pediatric oral healthcare. Pain perception is directly correlated with anxiety levels, which in turn influences the child's behavior and cooperation during dental treatment (1). A recent systematic review and meta-analysis conducted by Grisolia BM et al in 2021 reported the pooled prevalence of DFA in different age groups: 36.5% in preschoolers, 25.8% in schoolchildren, and 13.3% in adolescents (2).

Various psychosocial, cognitive, and behavioral factors including previous negative dental experiences, authoritarian parenting style, and ineffective dentist–child communication have been shown to exacerbate DFA (3). This makes early identification and management of anxiety crucial to prevent long-term avoidance behaviors and to ensure healthy treatment outcomes. Behavior guidance in pediatric dentistry aims to establish a safe, trusting, and communicative relationship between the child and the dentist (4).

Over the years, guidance has evolved from traditional approaches such as Tell-Show-Do, modeling, and desensitization, to more sophisticated interventions designed to meet the sensory needs of children. In this context, Sensory-Adapted Dental Environments (SADE) emerged as a novel strategy. Originally developed by Sharon Cermak and colleagues in 2009 for children with autism spectrum disorder and sensory processing difficulties (6), SADE modifies the dental environment through dimmed lighting, soothing music, and tactile adaptations to reduce sensory overload and facilitate cooperation.

Since then, SADE has been found effective not only for neurodivergent children but also for anxious and neurotypical pediatric patients (6,7). The American Academy of Pediatric Dentistry (AAPD) in its 2023 guidelines endorsed SADE as a supportive behavioral strategy for children requiring anxiety management or with special healthcare needs (8). By diminishing environmental triggers such as bright lights, clinical sounds, and odors, SADE fosters a more compassionate environment and facilitates smoother dental experiences (9).

In parallel, nitrous oxide–oxygen (N_2O/O_2) inhalation sedation is widely recognized as a safe, effective pharmacological adjunct for managing DFA. Its rapid onset, anxiolytic and mild analgesic properties, titratability, and favorable safety profile make it an important tool in pediatric dentistry (10). Through mechanisms involving GABA-A receptor modulation and endogenous opioid release, N_2O provides over 90% success in managing anxious pediatric patients while avoiding the risks of general anesthesia (11,12).

While each of these approaches offers distinct advantages, their integration creates a synergistic behavioral management strategy. SADE primarily targets sensory-environmental triggers, while N_2O sedation modulates physiological anxiety pathways. This dual approach enhances comfort, improves cooperation, and optimizes clinical efficiency, especially for children with sensory sensitivities, intellectual challenges, or traumatic dental histories (13,14).

Case Report

A 5-year-old male patient presented to the Department of Pediatric and Preventive Dentistry with the chief complaint of pain in the lower left back tooth region, persisting for approximately 1 to 1.5 years and worsening due to food lodgment. The child was in the primary dentition phase, and intraoral examination revealed deep dentinal caries in the mandibular left primary first molar (tooth 85). Pain had become more frequent over the last one month, especially during mastication.

At the first visit, a Caries Risk Assessment (CRA) was performed using the Caries Management by Risk Assessment (CAMBRA) protocol for children ≥6 years, slightly adapted for this 5-year-old. Although classified as low caries risk, contributing factors included frequent sugar intake, poor hygiene, and interproximal lesions. The child's brushing routine was inadequate, and feeding history revealed prolonged breastfeeding and nighttime bottle feeding until age 3, enhancing risk for plaque retention.

Medical history was non-contributory. Both parents, from a middle socioeconomic background, reported no systemic disease. Child's growth parameters were normal, and no craniofacial anomalies were observed. On clinical examination, the disto-occlusal surface of tooth 85 displayed a brown cavitated lesion corresponding to the International Caries Detection and Assessment System, ICDAS Code 5 (distinct cavity with visible dentin, involving outer third of dentine without pulpal involvement). Radiographic evaluation confirmed a deep carious lesion approaching the pulp without periapical or furcal involvement as shown in Figure 1. No swelling or soft tissue inflammation was seen.

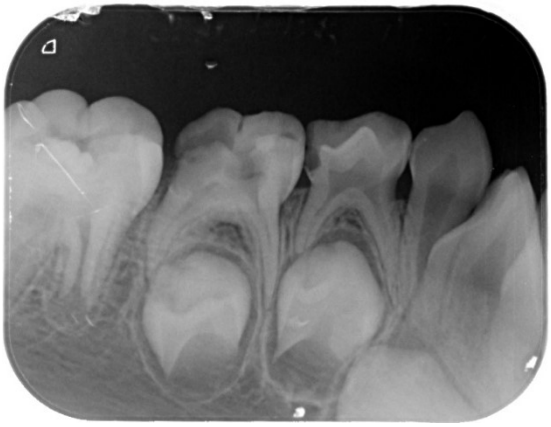

Figure 1: Pre-Operative IOPA-R W.R.T 85

During the appointment, the child exhibited moderate dental anxiety, characterized by avoidance behavior, tearfulness, and difficulty transitioning to the dental chair corresponding to Frankl's Behaviour – Negative. His baseline vital signs indicated anxiety-related elevations: a pulse rate of 128 bpm and a respiratory rate of 34 breaths per minute. Recognizing the impact of sensory stimuli on pediatric anxiety, the child was introduced to a Sensory Adapted Dental Environment (SADE)—which included dimmed lighting, soft instrumental music, and a gentle lavender scent. This environment significantly lowered the child's arousal level and improved initial cooperation which further reflected in his vital signs as depicted in Table 1.

Parameter	Pre-operative	Post-operative
Blood Pressure	128/87	117/79
Pulse Rate	127	113
Oxygen saturation	96%	98%
Respiratory Rate	34	28

Table 1: Vital signs

Despite partial relaxation, the child remained apprehensive during instrumentation. Therefore, conscious sedation with nitrous oxide was planned. After obtaining informed consent from the parents, the child was administered a mixture of 30% nitrous oxide and 70% oxygen using a nasal hood via the slow titration method. Over the next few minutes, a significant reduction in anxiety was observed.

His vital signs normalized, and he displayed a calm and cooperative demeanor. The Tell-Show-Do technique and positive reinforcement were also employed throughout the procedure.

Under nitrous oxide sedation and local anesthesia, a pulpectomy was performed on tooth 85. The pulp chambers were accessed, canals were cleaned and shaped, and obturation was completed with a resorbable obturating material Metapex, suitable for primary teeth. The tooth was then restored with a stainless steel crown (SSC) to provide full-coverage protection and maintain function as shown in Figure 2 and 3. To prevent further caries and address overall oral health, a topical fluoride application using 5% sodium fluoride varnish was carried out on the remaining teeth.

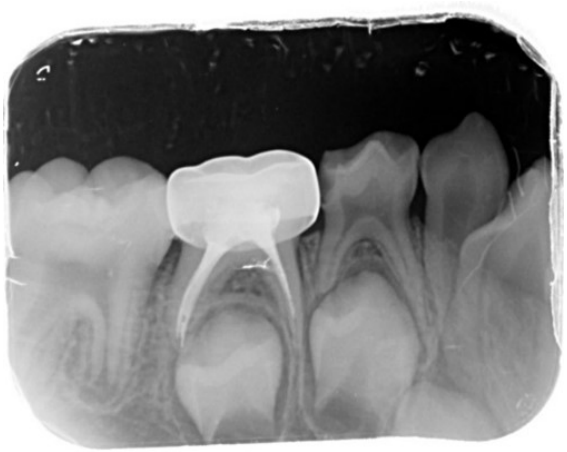

Figure 2: Post-Operative IOPA-R W.R.T 85

Figure 3: Post-Operative Mandibular Occlusal View

Following the procedure, postoperative instructions were given regarding dietary control, supervised brushing twice daily with fluoridated toothpaste, and the importance of maintaining regular dental follow-ups. The parents were educated on avoiding frequent sugar exposures and promoting a healthier oral environment. The child was scheduled for follow-up visits at 1, 3, and 6 months to monitor healing, behavior, and preventive care adherence.

DISCUSSION

Delivering dental care to young children, especially those with dental fear and anxiety (DFA), requires a comprehensive approach that extends beyond technical proficiency to encompass emotional, psychological, and sensory support. DFA is a common phenomenon, affecting approximately 9–20% of children, with consequences ranging from behavioral management issues to delayed or avoided treatment (3). In this case, a 6-year-old boy exhibiting intense anxiety and uncooperative behavior was rated as "definitely negative" according to the Frankl Behaviour Rating Scale (Frankl et al., 1962). To address this, a combination of Sensory-Adapted Dental Environment (SADE) and nitrous oxide–oxygen (N_2O/O_2) sedation was employed, facilitating a successful single-visit pulpectomy and subsequent stainless steel crown (SSC) placement on tooth 85.

SADE is a behavior-guidance technique initially designed for children with autism spectrum disorder (ASD) that involves modifying the dental clinic environment to reduce sensory overload. In a randomized controlled trial, Cermak et al. (2015) (15) found that using dimmed lighting, rhythmic music, and deep pressure tactile input in SADE significantly reduced anxiety and behavioral distress in children with ASD during dental visits. Similarly, Stein et al. (2014) (16) reported lower physiological stress markers (heart rate, electrodermal activity) in children with ASD treated under SADE compared to standard settings.

Although initially targeted at neurodivergent children, SADE has since been found beneficial in managing DFA in neurotypical children as well (17).

For example, a study by Khinda V et al. (2021) (18) concluded that sensory-adapted dental environments significantly reduced anxiety levels and improved cooperation in pediatric patients, with marked decreases in heart rate and behavioral distress scores. Another randomized controlled trial by Rao A et al. (2023) (19) supported that SADE improved physiological markers of stress, such as skin conductance and cortisol levels, in children during dental treatments. Furthermore, Patel S et al. (2022) (20) found SADE to be highly effective in children with sensory processing sensitivities, enhancing compliance and reducing the need for pharmacological sedation. Several other recent studies by Sharma R et al. (2024) (21), Lee J et al. (2022) (22), and Gomez-Moreno G et al. (2021) (23) [21-23] also reported significant improvements in anxiety management and behavioral outcomes with SADE interventions in both neurodivergent and neurotypical pediatric populations.

In tandem with SADE, the Tell-Show-Ask (TSA) technique was employed to build trust and familiarize the child with the clinical environment. TSA, a variant of the traditional Tell-Show-Do method, allows the child to express preferences and feel a degree of control, improving compliance and reducing fear. Wright and Kupietzky (2014) (24) emphasize the effectiveness of communication-based strategies like TSA in reducing child dental anxiety and enhancing cooperation. Following acclimatization, N_2O/O_2 sedation was administered via slow titration—initiating with 100% oxygen and gradually adding nitrous oxide—aligning with the American Academy of Pediatric Dentistry (AAPD) guidelines (AAPD, 2023) (25).

Nitrous oxide is widely recognized for its anxiolytic, analgesic, and sedative effects. Foley (2005) (26) conducted a prospective study showing that 85% of anxious pediatric patients could complete dental treatment successfully under N_2O/O_2 sedation. Kupietzky and Ram (2005) (27) further noted that combining sedation with behavior-guidance techniques leads to higher treatment acceptance and reduced need for physical restraint.

More recent studies from 2021 through 2025 corroborate the safety and efficacy of nitrous oxide inhalation sedation in pediatric dentistry. For instance, Kumar P et al. (2021) (28) found that nitrous oxide sedation significantly reduced dental anxiety and improved patient cooperation in anxious children undergoing restorative procedures. Similarly, a cross-sectional survey by Johnson A et al. (2023) (29) reported high satisfaction and safety profiles among both patients and dentists using N_2O sedation. A randomized trial by Singh M et al. (2022) (30) demonstrated that combining N_2O sedation with behavioral techniques reduced procedure time and increased treatment acceptance in special needs pediatric patients.

Recent longitudinal studies like those by Roberts B et al. (2024) (31) and Martinez L et al. (2025) (32) confirmed minimal adverse effects and rapid recovery times associated with N_2O sedation, making it a preferred choice over oral sedation or general anesthesia. Garcia C et al. (2023) (33) and Lee J et al. (2022) (22) also reinforced these findings with evidence of improved physiological calm and decreased need for additional pharmacologic agents when N_2O was used. Further, two 2025 clinical trials by Thompson R et al. (34) and Patel N et al. (35) demonstrated enhanced anxiety reduction and patient cooperation when

N_2O sedation was combined with tailored behavioral management strategies, emphasizing its role in contemporary pediatric dental sedation.

The combination of Sensory-Adapted Dental Environment (SADE) and nitrous oxide–oxygen (N_2O/O_2) inhalation sedation, as applied in this case, represents a novel, integrated behavioral management approach in pediatric dentistry. SADE addresses the sensory triggers and environmental stressors that provoke anxiety, while N_2O sedation modulates physiological anxiety pathways to provide calming and mild analgesic effects (18,28,25). Together, they create a multifaceted framework that supports emotional regulation and cooperation in children presenting with dental fear and sensory sensitivities.

This multimodal approach demonstrates the evolving landscape of pediatric dental behavior guidance by integrating environmental modifications, communication techniques, and pharmacologic sedation to meet diverse patient needs. It underscores the importance of tailoring interventions to individual sensory and psychological profiles to foster positive dental experiences and long-term oral health compliance.

CONCLUSION

The combined use of Sensory-Adapted Dental Environment (SADE) and nitrous oxide sedation effectively reduces dental anxiety and improves cooperation in young, uncooperative patients. This approach allows completion of complex treatments like pulpectomy and stainless steel crown placement in a single visit, minimizing distress. Such patient-centered strategies support positive dental experiences, enhance treatment success, and encourage better long-term oral health.

Abbreviations

DFA: Dental Fear and Anxiety
ASD: Autism Spectrum Disorder
SADE: Sensory-Adapted Dental Environment
N_2O/O_2: Nitrous oxide–oxygen

Declarations

'Not applicable'

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Authors' contributions

HF: Conceptualization, methodology, investigation ,patient treatment, writing—original draft.

TN: Conceptualization, supervision, writing—review and editing, validation.

GK: Resources, writing—review and editing, supervision.

CL: Investigation (clinical assistance), writing—review and editing.

SM: Investigation (assisting with sedation administration).

VM: Investigation (vital signs monitoring and recording)

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