

Contemporary Approach Towards Painless Dentistry in Children

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Abstract

Dental pain and anxiety remain major barriers to effective dental care in children and may result in poor cooperation, treatment avoidance, and negative attitudes toward future dental visits. Contemporary paediatric dentistry increasingly focuses on painless, minimally invasive, and child-centred approaches to improve treatment acceptance and long-term oral health outcomes. This review discusses current strategies for reducing pain, anxiety, and discomfort during paediatric dental treatment, including behavioural guidance, minimally invasive techniques, local anaesthesia, sedation, and emerging digital technologies. Child-friendly environments, tell-show-do, modelling, positive reinforcement, and distraction techniques can reduce anxiety and improve cooperation. Minimally invasive approaches such as atraumatic restorative treatment (ART) and the Hall technique can reduce the need for conventional drilling and local anaesthetic injections while minimising treatment-related discomfort. Topical anaesthesia and computer-controlled local anaesthetic delivery systems may further improve injection comfort. Nitrous oxide/oxygen inhalation sedation represents a useful and generally safe option for appropriately selected children with mild-to-moderate anxiety when delivered by trained personnel using appropriate monitoring and safety protocols. Emerging digital interventions, particularly virtual reality and interactive distraction tools, show promise in improving children's dental experiences, although their clinical applications and long-term effectiveness require further investigation. A comprehensive approach combining preventive care, behavioural management, minimally invasive dentistry, appropriate analgesia, sedation when indicated, and digital distraction can facilitate more comfortable and positive dental experiences. Future research should emphasise long-term outcomes, cost-effectiveness, personalised anxiety management, accessibility in low-resource settings, and standardisation of paediatric sedation training and safety protocols.

Keywords: Painless Dentistry, Children, Preventive Care, Behavioural Management, Atraumatic Restorative Treatment, Child-Friendly Environments

Introduction

Dental pain and anxiety in children represent major challenges for paediatric dentistry. Children often associate dental visits with fear, discomfort, and negative experiences, which may lead to avoidance of dental care, poor oral health outcomes and long-term dental anxiety. Pain control in paediatric patients is therefore not only a matter of clinical technique, but also of behavioural management, patient experience and shaping a positive attitude toward dental care. In this review we explore the **contemporary approaches** to achieving painless or near-painless dentistry in

children—covering behavioural and environmental strategies, analgesia & anaesthesia innovations, minimally invasive treatment techniques, sedation and advanced technologies. The aim is to present what the current evidence says, how to implement in practice, and where the gaps remain.

Understanding Pain, Anxiety and their Impact in Children

Pain Perception in Children

Pain is a subjective, multi-dimensional experience. In children, the perception of pain is influenced not only by the nociceptive stimulus (for example injection, drilling) but also by emotional, cognitive, and environmental factors (fear of needles, unknown environment, parental cues). Childhood painful experiences can shape future behaviour; e.g., pain during dental treatment can predispose to dental anxiety, avoidance and poorer oral health later.^{1,2}

Dental Anxiety and its Interplay with Pain

Dental fear and anxiety are closely linked with pain. The mere sight of a needle, the sound of a drill, or unfamiliarity with the clinic can raise anxiety, which in turn amplifies pain perception through central sensitisation, heightened arousal and less coping ability. Avoidance of visits due to fear leads to more advanced disease and hence more invasive, painful treatment—creating a vicious cycle.^{2,3}

Why 'Painless' Dentistry Matters in Children

From a clinical standpoint, reducing acute pain during treatment means less disruption, fewer behavioural management issues, and often better outcomes. From a psychological standpoint, a positive, comfortable first dental experience can build trust, reduce future anxiety and improve long-term oral health behaviour. Thus, achieving “painless dentistry” in children is a key goal of modern paediatric dentistry.

Behavioural & Environmental Strategies

Managing the child's behaviour, environment and emotional state is the foundation of painless dentistry. If anxiety is reduced, pain perception often reduces as well.

Child-Friendly Clinical Environment

Creating a child-friendly, fun, safe environment helps lower anxiety before treatment begins. This includes colourful decor, friendly staff, age-appropriate toys or distractions, informational visuals, and allowing the child to explore the operatory in a non-threatening way. These changes help the child feel more at home, less threatened, and more cooperative.

Pre-Visit Preparation and Familiarisation

Allowing children to familiarise with the dental setting and staff, using “tell-show-do” techniques, modelling, positive reinforcement, and sometimes a pre-visit tour, can reduce fear and build rapport. This fosters trust and thereby reduces both anxiety and pain perception.

Distraction, Behaviour Guidance and Communication

Effective communication tailored to the child's cognitive level, along with distraction (e.g., audiovisuals, virtual reality, storytelling) can

significantly reduce their focus on the dental stimulus and thereby pain. Parental and staff behaviour also influences the child's anxiety—so training staff in positive reinforcement, behaviour guidance and anxiety-reducing talk is key.

Non-Pharmacological Pain/Anxiety Control

Techniques such as relaxation, breathing exercises, guided imagery, hypnotherapy, and virtual reality have emerged as adjuncts. For example, immersive VR may help distract children during dental procedures and reduce their perception of discomfort and anxiety.⁴ These non-invasive steps should always be the first line before pharmacologic methods.

Analgesia & Local Anaesthesia Innovations

Even with behavioural management, local anaesthesia remains core to ensuring painless operative dentistry. Fortunately, recent advances are making injections less distressing and more efficient.

Topical Anaesthesia and Infiltration Techniques

Using topical anaesthetic gels or sprays before injection helps reduce the sharp sting of needle penetration. Techniques such as applying pressure to the mucosa, warming the anaesthetic solution, slow injection, and using distraction simultaneously all help lower pain.⁵

Newer Devices: Computer-Controlled and Needle-Free Systems

Computer-controlled local anaesthetic delivery systems allow very slow, consistent flow of anaesthetic, reducing the pressure and discomfort of injection. Jet-injection systems and even needle-free devices (although still limited) are being studied for children.⁶ These devices help lessen the “needle fear” and improve children's comfort.

Eutectic Mixture Topical Agents

Eutectic mixtures of local anaesthetics (for example EMLA) apply topically and penetrate mucosa enough to reduce the pain of a subsequent injection or minor procedure. Studies show good effect in paediatric settings.⁶

Minimising Local Anaesthesia: Strategic Use

Selecting the minimal effective dose, using shorter-acting agents when appropriate, and planning procedures to reduce multiple injections (e.g., bundling multiple treatments under one anaesthetic episode) helps reduce cumulative discomfort and anxiety. The review “Advances in Pediatric Dentistry: new approaches to pain ...” offers a detailed discussion of newer local anaesthetics and techniques to reduce injection-related discomfort.¹

Minimally Invasive and Biologically Oriented Treatment Techniques



One of the most powerful approaches to “painless” dentistry is to reduce the invasiveness of the procedure itself. The less drilling, the less injection, and the less “trauma” occurs—and thus less pain and anxiety.

Atraumatic Restorative Treatment (ART)

ART uses hand instruments rather than high-speed drills, often in conjunction with glass-ionomer restoratives, and avoids or reduces the need for local anaesthesia and multiple visits. It has been shown to produce lower pain and discomfort compared with conventional “drill-and-fill” methods.⁷

The Hall Technique

The Hall Technique (sealing carious primary molars under pre-formed metal crowns without local anaesthesia or drilling) is a notable example of a minimally invasive method in children. This technique has shown better comfort levels and acceptance among children as it avoids injections and much of the fear associated with drilling.⁸

Interim/Shielding Approaches and Selective Caries Removal

Selective caries removal, partial caries removal, and use of biomaterials and sealants allow preserving more tooth structure, reducing need for anaesthesia and reducing procedure time and discomfort. These strategies align with biological dentistry and minimally invasive dentistry concepts.

Use of Lasers, Air Abrasion and other Conservative Tools

The use of high-tech tools such as lasers and air-abrasion can reduce vibrations, noise and the sensation associated with conventional drilling. Though cost and training remain limiting factors, these methods are increasingly being used in paediatrics to enhance comfort.

Preventive and Early Intervention Emphasis

By shifting the focus from invasive treatments to preventive measures (sealants, fluoride varnish,

minimally-invasive fillings), the frequency and severity of painful treatments can be reduced. Prevention is ultimately the least painful approach.

Sedation and Pharmacological Behaviour Management

For children who remain anxious, uncooperative or require extensive treatment, sedation and pharmacological techniques become important components of achieving a painless experience.

Inhalation Sedation: Nitrous Oxide (N₂O)

Inhalation sedation with nitrous oxide/oxygen remains a mainstay in paediatric dentistry. It produces anxiolysis, mild analgesia, and elevates pain threshold. A 2023 overview describes NOIS as rapidly effective and well tolerated in children.⁹ Another review reported success rates around 90 % for N₂O/O₂ sedation in children undergoing dental treatment, showing it is safe and reliable for mild to moderate anxiety states.¹⁰

Indications and Benefits

N₂O is widely considered first-line for children with mild–moderate dental anxiety or those needing comfortable treatment for routine procedures. It allows the child to remain conscious and responsive, while reducing fear and pain.¹¹

Safety and Protocols

Proper patient selection (ASA I–II), adherence to monitoring standards, equipment for scavenging, parental consent and staff training are key to safe use.¹⁰ While safe, surveys indicate gaps in consistent safety practices—highlighting the need for high quality training and protocols.¹²

Oral Sedation, IV Sedation and General Anaesthesia

For more intensive cases (very young children, children with special needs, extensive surgical procedures), oral sedation, IV sedation or general anaesthesia may be required. A 2023 narrative review of procedural sedation in paediatric dentistry summarises evidence for various sedatives (midazolam, ketamine, dexmedetomidine) but emphasises that N₂O remains the first option for simpler cases given its safety profile.¹³

Conscious Sedation Protocols: Combining Behaviour and Pharmacology

The best practice involves combining non-pharmacologic behaviour guidance with sedation, rather than relying solely on drugs. This holistic approach yields better outcomes, less drug dose and fewer adverse effects.

Post-Operative Pain and Analgesia

Even with “painless” techniques, children may experience post-treatment discomfort. Pre-emptive analgesia (NSAIDs, paracetamol) timed appropriately, along with clear parent-child instructions, helps reduce delayed pain and supports a positive experience.

Advanced Technologies and Digital Aids

Modern paediatric dentistry is leveraging technology not just for treatment, but for comfort and experience management too.

Virtual Reality & Immersive Distraction

Recent research explores VR as a distraction modality for children undergoing dental treatment. One study found that children expected VR to provide immediate relief, control and social support during dental procedures — as part of a multi-stakeholder design process.⁴ This technology may reduce anxiety, and by extension pain perception.

Computer-Controlled Delivery Systems & Robotics

Beyond local anaesthetic delivery, digital tingles exist in behaviour guidance (interactive robotic assistants, digital games in waiting room) which helps children engage and feel less threatened by the dental environment.

Enhanced Monitoring and Safety Tech

Newer sedation monitors, closed-loop delivery systems for sedation, digital behaviour assessment tools and remote follow-up tele-tools are helping make paediatric sedation and painless dentistry safer, more efficient and more child-friendly.¹³

Implementation in Clinical Practice: Key Steps for the Paediatric Dentist

Bringing all of this together in a child-friendly private or hospital practice means combining environment, technique, technology and communication. Here are practical steps:

1. Pre-Appointment Child-Friendly Preparation

Pre-visit preparation plays an important role in reducing anxiety and improving cooperation among paediatric dental patients. Parents should be contacted before the dental visit and provided with clear information about what to expect during the appointment, while reassuring them that a child-friendly approach will be used throughout the treatment. Children should be encouraged to ask questions and express their concerns, with the dental team using the “tell-show-do” technique to introduce and familiarise them with dental instruments and equipment in a simple, age-appropriate manner. In addition, providing parents with a short video or photographs of the dental operatory before the appointment may help reduce unfamiliarity, improve the child's sense of preparedness, and facilitate a more comfortable and positive dental experience.

2. Environment and Team Setup

Creating a child-friendly dental environment can significantly improve children's comfort, cooperation, and overall dental experience. The dental operatory should be designed in an inviting and welcoming manner using bright colours, themed dental chairs, cartoons, interactive displays, or virtual reality (VR) goggles as appropriate to provide distraction and reduce anxiety. In addition, all members of the dental team, including receptionists, dental assistants, and clinical staff, should receive appropriate training in child-friendly communication, behaviour management, and empathetic interaction with young patients. Behaviour guidance tools should also be readily available, including distraction aids, reward systems, stickers, positive reinforcement charts, and age-appropriate incentives. These measures can help create a supportive atmosphere, promote cooperation, and encourage positive attitudes toward dental care.

3. Behaviour Guidance during the Appointment

Effective paediatric dental management should incorporate a combination of behavioural and minimally invasive approaches to reduce fear, anxiety, and discomfort. Techniques such as “tell-show-do,” modelling, positive reinforcement and distraction should be used to improve cooperation and create a positive dental experience. When local anaesthesia is required, topical anaesthetic agents should be applied before injections, followed by slow and controlled administration or, where appropriate, computer-controlled local anaesthetic delivery systems to minimise discomfort. For less extensive procedures, minimally invasive approaches such as Atraumatic Restorative Treatment (ART) and the Hall technique may be considered to reduce the need for conventional drilling and injections. In children with significant anxiety or when treatment is expected to be prolonged, inhalation sedation with nitrous oxide (N₂O) or other appropriately selected sedation protocols may be considered based on the child's age, medical status, treatment requirements, and established safety guidelines.

4. Minimally Invasive Treatment Planning

A prevention-focused and minimally invasive approach should be prioritised in paediatric dentistry to reduce the need for extensive and potentially distressing dental procedures. Preventive measures such as regular oral health education, fluoride varnish application, pit and fissure sealants, and early detection and intervention can help prevent or arrest disease progression and minimise the need for invasive treatment. When restorative treatment is necessary, minimally invasive techniques should be preferred to reduce treatment time, tissue removal, trauma, and discomfort while preserving healthy tooth structure. Where appropriate

and available, newer technologies such as air-abrasion systems and dental lasers may also be incorporated, particularly when they offer clinically meaningful benefits and are feasible and cost-effective for the practice and patient.

5. Sedation and analgesia management

Prior to treatment, the child should be carefully assessed for anxiety level, degree of cooperation, medical history including ASA physical status, and the complexity and expected duration of the planned procedure. When clinically indicated, nitrous oxide/oxygen (N₂O/O₂) inhalation sedation may be used to reduce anxiety and facilitate cooperation, with appropriate patient monitoring, scavenging systems, trained personnel, and informed parental consent. For children requiring extensive or complex dental treatment, oral or intravenous sedation or general anaesthesia may be considered in an appropriately equipped hospital or specialist setting with adequate monitoring and emergency preparedness. Following treatment, parents should receive a clear and simple analgesic plan, including instructions regarding medication use, expected postoperative discomfort, warning signs, and when to seek professional advice. Appropriate follow-up should also be arranged to monitor recovery and reinforce preventive oral health practices.

6. Post-Treatment Follow-Up and Reinforcement

Following dental treatment, positive reinforcement should be provided to acknowledge the child's cooperation and successful completion of the procedure. Simple verbal praise, a “bravery certificate,” sticker, or small age-appropriate reward can help strengthen positive associations with dental care and encourage cooperative behaviour during future visits. A follow-up contact with the parent, preferably the following day, can be useful to assess the child's comfort, address any concerns or questions, and reinforce the positive dental experience. In addition, early scheduling of preventive recall visits should be encouraged to maintain oral health, establish familiarity with the dental team, reinforce positive behaviour, and facilitate early detection and management of new lesions before they require more invasive treatment.

7. Audit, Training and Continual Improvement

Continuous evaluation and quality improvement are essential for maintaining effective and child-centred dental care. Dental teams should systematically document pain and anxiety levels before and after treatment, incorporating feedback from both children and their parents to assess the effectiveness of pain and anxiety management strategies. Regular staff training sessions should be conducted to strengthen competencies in behaviour guidance, sedation

protocols, emergency preparedness, and the appropriate use of newer dental technologies. Clinicians should also remain updated with current scientific literature regarding emerging minimally invasive techniques, digital aids, and developments in paediatric sedation safety. In addition, missed, postponed, or avoided dental appointments should be reviewed periodically and correlated with reported anxiety, pain experiences, and treatment-management strategies to identify barriers to care and determine whether improvements in pain and anxiety control are contributing to better attendance and long-term dental engagement.

Evidence Summary and Gaps What the Evidence Supports

Evidence from paediatric dentistry indicates that behavioural guidance and a child-friendly dental environment can substantially reduce anxiety and influence the child's perception of pain, thereby improving cooperation and treatment acceptance. Minimally invasive techniques, including Atraumatic Restorative Treatment (ART) and the Hall technique, can further minimise discomfort, reduce the need for conventional drilling and local anaesthetic injections, and promote greater acceptance among children. Computer-controlled local anaesthetic delivery systems and newer topical anaesthetic agents may also improve injection comfort by reducing the sensation associated with conventional administration. For children with mild to moderate dental anxiety, nitrous oxide (N₂O) inhalation sedation is considered a safe and effective option when appropriately indicated and administered with suitable monitoring and trained personnel.⁹⁻¹¹ In addition, digital and distraction-based technologies, including virtual reality (VR) and interactive audiovisual assistants, show considerable promise in reducing anxiety and improving the dental experience, although further high-quality research is required to establish their long-term effectiveness and optimal clinical applications.

Gaps and Areas for Further Research

Despite advances in painless and minimally invasive paediatric dentistry, several research gaps remain. Long-term studies evaluating newer technologies, such as virtual reality (VR) for reducing anxiety and improving cooperation during paediatric dental sedation, are still limited. Comparative studies assessing different sedation agents, including midazolam, dexmedetomidine, and ketamine, are relatively few and have reported variable outcomes regarding efficacy, safety, recovery, and behavioural response.¹³ Similarly, implementation studies in low-resource settings are scarce, particularly those evaluating the feasibility, accessibility, and cost-

effectiveness of technologies such as dental lasers and computer-controlled local anaesthesia. Further research is also required to understand how cultural, socioeconomic, and parental factors influence children's perception of pain and anxiety and the effectiveness of painless dentistry interventions across different populations. In addition, paediatric sedation safety protocols vary considerably across regions, highlighting the need for standardised training, monitoring, competency assessment, and safety guidelines to ensure consistent and safe delivery of sedation-based dental care.¹²

Practical Challenges and Considerations Cost and Resource Implications

High-tech devices (lasers, air-abrasion, computer-controlled syringes, VR systems) entail cost and training. Smaller practices may struggle. However, many behavioural and minimally invasive strategies require little extra cost but have high return in terms of patient comfort and retention.

Parental Expectations and Involvement

Parents play a key role. Their own dental anxiety, expectations, and ability to coach the child matter. Dentists must spend time discussing procedures with parents, aligning expectation (not “zero pain” but “minimally uncomfortable” and “safe”). Clear pre-visit information helps.

Training and Staff Buy-In

Behavioural techniques and child-friendly communication require training and consistent practice. All staff must be aligned — from receptionist to assistant to dentist. Sedation protocols require staff trained in monitoring and emergency response.

Risk Management and Safety

Sedation always carries risk. Proper patient screening (medical history, ASA status), consent, monitoring equipment, emergency protocols, scavenging for N₂O, and adherence to guidelines are non-negotiable. The Jordanian survey found significant gaps in these safety practices.¹²

Patient selection

Not every child is a candidate for certain techniques (e.g., very young children may not tolerate masks for N₂O; children with certain medical conditions may need hospital referral). Behavioural management must be tailored to the child's age, temperament, previous experience and medical history.

Communication of “Painless” Concept

It is important to manage expectations: “painless” does not always mean *no sensation at all*. The goal is comfort, minimal distress and a positive experience.

Clear communication with child and parent helps avoid misunderstandings.

Future Directions

Future research in paediatric dentistry should focus on the integration of digital health and tele-preparation, including the use of mobile applications and virtual reality (VR) at home to familiarise children with the dental environment and procedures, thereby reducing pre-visit anxiety. The development of personalised sedation and behaviour-management algorithms using predictive models incorporating child temperament, anxiety scales, previous dental experiences, and behavioural responses may help clinicians tailor treatment plans, sedation levels, and equipment to individual needs. Further research should also emphasise cost-effective minimally invasive technologies for low-resource settings, including affordable alternatives to lasers, air-abrasion systems, and computer-controlled local anaesthesia, to improve accessibility to painless and minimally invasive dental care. Large-scale longitudinal studies are required to evaluate children undergoing painless and minimally invasive dental procedures over extended periods, with particular emphasis on long-term oral health outcomes, dental anxiety, and treatment-avoidance behaviours. In addition, standardised global training and safety protocols should be developed to harmonise paediatric sedation practices across countries, supported by regular monitoring, competency assessment, and safety audits. Finally, parental and child co-design of dental experiences should be encouraged by involving children and their parents in the design of dental operatory environments, selection of distraction techniques, and decisions regarding sedation options, thereby improving treatment acceptability, cooperation, and overall clinical outcomes.

Conclusion

Painless dentistry in children is not a single technique, but a **holistic approach** combining environment, behaviour management, minimally invasive treatment, advanced anaesthetic delivery and sedation where appropriate. By focussing on comfort and positive experience, paediatric dentists can reduce pain, dental anxiety and avoid future avoidance of dental care. In your practice, by embracing child-friendly design, investing in behaviour training, using minimally invasive options, having modern anaesthesia delivery and sedation protocols, you can move closer to the ideal of a painless (or near-painless) dental experience for children. The evidence supports many of these strategies, and while challenges remain, the future looks promising. For the practise setting you represent, integrating these steps can increase children's cooperation, reduce chair-time, improve outcomes and

build long-lasting positive relationships with young patients and their families.

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