PEER-REVIEWED

Reducing Injection Discomfort with Cryogenic Topical Anesthesia

Rapid mucosal cooling offers a drug-free approach to patient comfort and clinical efficiency.

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Local anesthetic administration is fundamental to contemporary dental practice; however, the injection itself remains one of the most anxiety-provoking aspects of dental treatment. Needle-related fear and the anticipation of pain can reduce patient acceptance of care, contribute to appointment cancellations, and reinforce avoidance of routine dental treatment.[1-4] These concerns are particularly important in pediatric patients and anxious adults, where the injection experience may influence long-term attitudes toward dental care and patient compliance.

Topical anesthetics have long been used to reduce discomfort associated with needle penetration. Although numerous studies have demonstrated that these agents can lessen insertion pain, their clinical effectiveness is variable because onset time, tissue permeability, and depth of penetration differ among formulations and application sites.[3,5-11] These limitations are especially evident in keratinized tissues, such as the palatal mucosa, where topical anesthetics often provide inconsistent analgesia despite recommended application times.



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Furthermore, the required dwell time of conventional topical anesthetics interrupts clinical workflow and prolongs treatment.

Cryogenic topical anesthesia represents an alternative approach that produces rapid, localized cooling of the mucosal surface, temporarily reducing activation and conduction of superficial nociceptors without the use of pharmacologic agents. By eliminating the need for prolonged application times, this technique has the potential to improve both patient comfort and clinical efficiency while maintaining a straightforward injection protocol.

DentalJect® (VCS Medical, Boca Raton, Florida) is an FDA-cleared, drug-free cryogenic topical anesthetic delivery system designed to provide immediate surface desensitization of intact oral mucosa immediately before local anesthetic injection. The rapid onset of cooling allows clinicians to proceed directly with anesthesia, minimizing workflow interruptions while improving patient comfort, particularly during injections into highly innervated or keratinized tissues such as the palate. This article reviews the scientific rationale for cryogenic topical anesthesia, the mechanism of action of rapid thermal desensitization, the clinical application of DentalJect, and the available evidence supporting its use as an adjunct to conventional local anesthetic techniques.

Background and Clinical Rationale

Fear of the dental injection is common and multi-factorial. Population surveys and clinical investigations have shown that injection fear is often driven by the expectation of pain and bodily injury, and it correlates with broader dental fear and avoidance.[1,2] In clinical studies, higher dental anxiety is associated with greater reported injection pain intensity and longer pain duration.[3] These observations reinforce a practical clinical reality: improving the injection experience, both the physical sensation of penetration and the anticipatory component, can meaningfully influence patient cooperation and acceptance of care.

Patients Experience Challenges with Dental Injections

Patients commonly describe injection discomfort in two phases: (1) initial needle penetration and (2) pressure or burning sensations during anesthetic deposition.[3,4] For pediatric and needle-averse patients, a single negative injection experience may reinforce long-term avoidance; for adults with established dental fear, even minor discomfort may amplify anticipatory stress at subsequent visits.[1-4] Accordingly, injection comfort should be approached as both a pain-management objective and an anxiety-management strategy.

Clinicians Experience Challenges with Dental Injections

For clinicians, delivering local anesthesia is both a technical and interpersonal task, and the goal is consistently to provide injections that are as comfortable

and predictable as possible. Injection discomfort can slow appointments, increase chairside stress for both the patient and practitioner, and complicate behavior management, particularly when treating anxious or pediatric patients. Chairside efficiency also shapes the clinician experience. Anesthetic onset must be reliable, techniques must fit within tight scheduling constraints, and adjunctive methods must be cost-effective and easy to integrate into routine workflows. Palatal injections present a distinct challenge, as many clinicians recognize that these injections are inherently more painful due to the dense, tightly bound palatal mucosa. Some providers may even avoid palatal anesthesia when possible or seek alternative techniques to minimize patient discomfort. Across practice settings, clinicians consistently express a desire for methods that reduce injection pain, improve patient satisfaction, and streamline care without adding complexity or expense.

TABLE 1. Comparative Assessment: Cryogenic Delivery vs Conventional Topical Gels

Parameter	Cryogenic topical delivery (DentalJect concept)	Conventional topical gel (benzocaine/lidocaine)
Onset	Immediate (seconds); no dwell time	Delayed; dwell time required
Dependence on diffusion	Not dependent on drug absorption	Dependent on mucosal absorption/diffusion
Keratinized tissue performance	Designed for predictable surface effect	Variable; can be less effective in keratinized sites
Taste/residue	Subtle mint flavor	Often present
Allergy considerations	Drug-free	Potential hypersensitivity

Conventional Topical Anesthetics: Advantages and Limitations

The most commonly used topical anesthetics are benzocaine and lidocaine preparations, which are used routinely to reduce discomfort during needle penetration. Multiple controlled studies demonstrate that topical anesthetics can reduce needle-insertion pain compared with placebo in specific intraoral sites.

In palatal tissue, topical lidocaine and benzocaine have been shown to reduce needle insertion pain relative to placebo, but performance depends on application time, formulation, and tissue characteristics.[5-9]

Clinical limitations and concerns include:

- Delayed onset requiring dwell time, interrupting workflow.
- Inconsistent performance in keratinized tissues (eg, palatal mucosa).
- Inconsistent performance in deeper target sites (eg, inferior alveolar nerve block regions).
- Dilution by saliva and difficulty maintaining isolation at the application site.
- Taste/residue that can reduce patient acceptance.
- Potential hypersensitivity concerns with pharmacologic agents.
- Topical anesthetics may numb areas beyond where they are applied, such as the throat, making it uncomfortable and concerning for some patients.

These limitations are reflected in the literature, which reports site-dependent variability in the effectiveness of topical anesthesia and differences between formulations and delivery approaches.[5,10,11]

Cryogenic Topical Anesthetic: Rapid Thermal Modulation

A drug-free cryogenic topical anesthetic delivery system, DentalJect is intended for application to intact oral mucosa to lessen injection discomfort. The system delivers a brief, localized cooling spray to the intended injection site, producing rapid surface desensitization within seconds and enabling immediate injection without a waiting period.

The clinical premise of this cryogenic approach is consistent with the broader pain-science concept that brief cooling can modulate superficial nociceptive signaling at the moment it is applied. In dentistry, non-pharmacologic adjuncts that incorporate cold (often combined with other sensory inputs such as vibration) have demonstrated the ability to reduce perceived injection pain and fear in pediatric populations.[12] Unlike pharmacologic topicals that rely on diffusion through mucosa, a cryogenic approach targets the timing of penetration, reducing the salience of the needle event while preserving standard anesthetic technique.

Large, myelinated A-beta fibers transmit nonpainful mechanical sensations such as touch and pressure, whereas thinly myelinated A-delta fibers and unmyelinated C fibers convey sharp, localized pain and slower, dull or burning pain, respectively. Rapid evaporative cooling from the DentalJect gas blend decreases mucosal injection pain via two primary mechanisms. First, the spray rapidly lowers superficial tissue temperature. This is often marked clinically by localized mucosal blanching, which preferentially decreases nerve conduction velocity of the smaller A-delta and C nociceptive fibers, transiently interrupting their firing.[13] Second, the rapid cooling provides

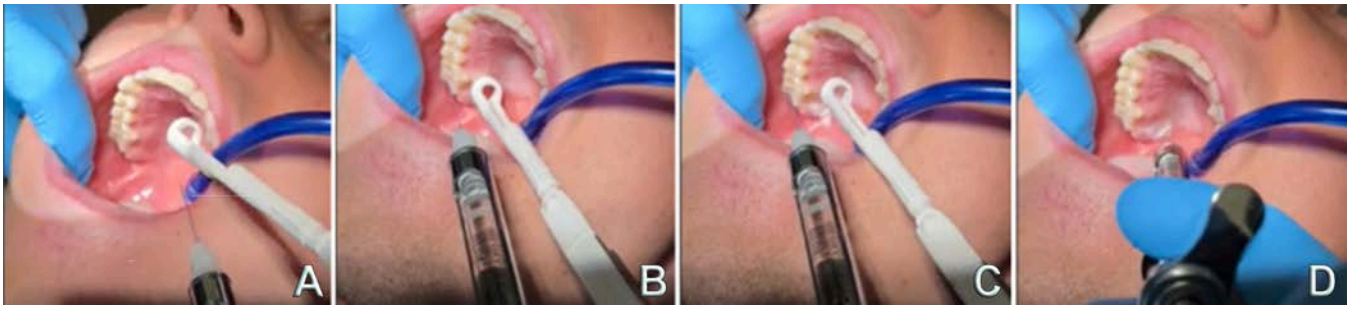


FIG. 1. Palatal injection technique. (A) The guide ring is positioned near the intended injection site, with the syringe needle close to the palate. (B) The spray is activated for 1 second, producing a white spot at the intended injection site. (C) The anesthetic needle is inserted into the white spot immediately after spraying. (D) The anesthetic is injected into the area.

non-noxious sensory input that stimulates fast-conducting A-beta mechanoreceptors. According to the gate control theory of pain, this competitive sensory stimulation inhibits slower nociceptive signals at the trigeminal spinal tract nucleus.[14, 15] Consequently, the perception of intraoral needle-related pain is significantly reduced while pressure sensation may be reduced or remain relatively preserved.

Indications, Contraindications, and Safety Considerations

DentalJect is positioned for use prior to local anesthetic injections where improved needle-penetration comfort is desired, including:

- Palatal, lingual, and buccal soft-tissue injections.
- Pediatric patients.
- Anxious or needle-averse patients.
- Patients reporting inadequate effect from topical gels.
- High-volume practices seeking to reduce topical dwell-time interruptions.

Contraindications and precautions, consistent with cryogenic topical application to oral mucosa, include avoiding use on compromised tissue and avoiding prolonged spray or unintended areas (eyes/lips).

Cryogenic Local Anesthetic Technique

The DentalJect system can be incorporated into existing injection workflows using a straightforward chairside protocol:

1. Position the guide ring on or up to 1 inch (2.5 cm) from the intended injection site, keep the canister as upright as possible (less than a 45° tilt), and orient the nozzle perpendicular to the targeted mucosa.
2. Activate the spray for approximately 1 to 2 seconds. (Note: The recommended duration varies depending on the injection site: 1 second for palatal injections, 1.5 seconds for infiltrations, and 2 seconds for a mandibular block.)
3. Proceed immediately with the local anesthetic injection.

By eliminating topical dwell time, the system supports uninterrupted procedural flow and can yield meaningful cumulative time savings across the clinical day, particularly in multi-operatory or hygiene-driven environments. Providers can use this recovered time to speak more with their patients or shorten appointments.

DentalJect rapidly cools the tissue it is sprayed on. To avoid cold sensitivity, it is recommended that one avoid spraying on the lips and teeth.

Palatal Injection Technique

The DentalJect guide ring is placed on or near the intended injection site (2.5–4 cm [1–1.5 inches] away), and the syringe needle is positioned close to the palate. The site is sprayed for 1 second, after which the anesthetic needle is immediately inserted and the anesthetic is administered (Figure 1).

Inferior Alveolar Technique

The cheek is retracted, and the DentalJect ring is placed on or near the intended

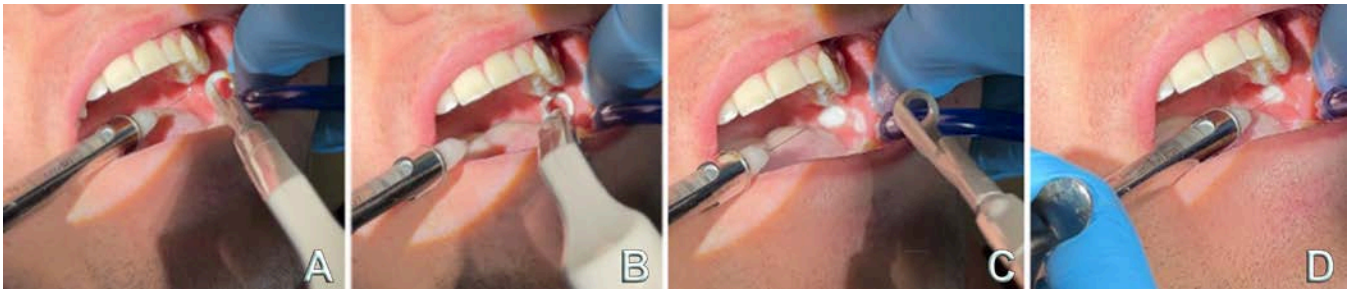


FIG. 2. Inferior alveolar technique. (A) The cheek is retracted, and the guide ring is positioned near the intended injection site, with the syringe needle close to the ramus. (B) The spray is activated for approximately 1.5 seconds, producing a white spot at the intended injection site. (C) The anesthetic needle is inserted into the white spot immediately after spraying. (D) The anesthetic is injected using standard technique.

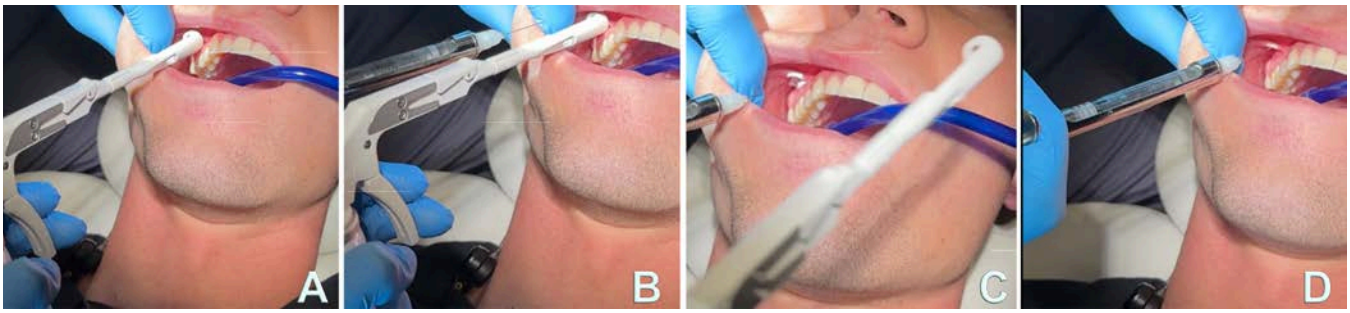


FIG. 3. Buccal posterior injection technique. (A) The cheek is retracted, and the guide ring is positioned near the intended injection site. (B) The spray is activated for 1–1.5 seconds, producing a white spot at the intended injection site. (C) The anesthetic needle is inserted into the white spot immediately after spraying. (D) The anesthetic is injected using standard technique.

injection site (2 cm [approximately 1 inch] away), with the syringe needle positioned close to the ramus. The site is sprayed for approximately 1.5 seconds, after which the anesthetic needle is immediately inserted and the anesthetic is administered using standard technique (Figure 2).

Buccal Injection in the Posterior Technique

The cheek is retracted, and the DentalJect ring is placed on or near the intended injection site (approximately 2 cm [1 inch] away). The site is sprayed for 1–1.5 seconds, after which the anesthetic needle is immediately inserted and the anesthetic is administered using standard technique (Figure 3).

Buccal Injection in the Anterior Technique

The lip is retracted, and the DentalJect ring is placed on or near the intended injection site (approximately 2 cm [1 inch] away), with the anesthetic needle positioned close to the area while avoiding the lips and teeth. The site is sprayed, after which the anesthetic needle is immediately inserted and the anesthetic is administered using standard technique (Figure 4).

Clinical Considerations

Several practical considerations can help clinicians incorporate cryogenic topical anesthesia into existing injection protocols:

- Patient apprehension is often highest with palatal injections, followed by inferior alveolar nerve (IAN) blocks; prioritize techniques that minimize the needle event.
- Maintain the recommended distance; excessive proximity increases the risk of over-cooling, while too great a distance can reduce the effect.
- Pair any topical strategy with slow, controlled anesthetic deposition to reduce pressure sensation. Because the cryogenic approach may also reduce discomfort associated with the low pH of some local anesthetics and tissue expansion during injection, injection speed may be increased somewhat when clinically appropriate.
- For all patients, state the sequence: "cooling spray—then immediate injection" to reduce uncertainty and improve cooperation.

Application Technique

DentalJect is incorporated into the local anesthetic protocol in three simple steps (Figure 5). First, the canister is inserted into the applicator and twisted into the locked position, followed by a brief test spray to verify proper function. The patient should be informed that a brief cooling sensation will be experienced during application. The canister is then held upright with the spray guide positioned on or immediately adjacent to the intended injection site, approximately 1–3 inches from the mucosa and activated for 1–2 seconds before immediate local anesthetic injection.

Optimal cooling is achieved on moist oral mucosa, as the salivary film promotes formation of the characteristic white spot

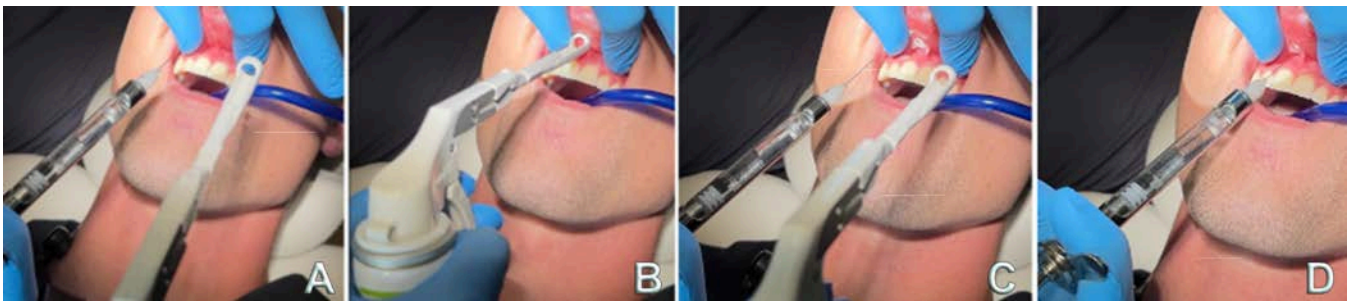


FIG. 4. Buccal anterior injection technique. (A) The lip is retracted, and the guide ring is positioned near the intended injection site, with the anesthetic needle close to the area while avoiding the lips and teeth. (B) The spray is activated, producing a white spot at the intended injection site. (C) The anesthetic needle is inserted into the white spot immediately after spraying. (D) The anesthetic is injected using standard technique.

that identifies the area of maximal surface desensitization. High-volume evacuation (preferred), or alternatively a saliva ejector, should be used to minimize intraoral vapor while the patient is instructed to exhale gently during spray application. Care should be taken to avoid directing the spray toward extraoral tissues, sensitive teeth, or exposed root surfaces, as prolonged cooling of these structures may produce discomfort or frost injury. The rotatable spray guide can be adjusted to help shield adjacent tissues during application.

The appearance of the white spot indicates the optimal location for anesthetic needle insertion, and the injection should be administered immediately because maximal desensitization occurs during the first 3–8 seconds after its appearance. Spray application should not exceed 2 seconds or continue beyond the point of visible frost. Although a visible white spot may not always develop, a brief topical desensitization effect is still produced, with some reduction in sensation potentially persisting for up to one minute.

Following each patient, the applicator should be disassembled, cleaned, and steam sterilized according to the manufacturer's instructions (Figure 6). The reusable applicator is cleaned using standard brushing and ultrasonic enzymatic cleaning before autoclaving. The canister is a non-sterilizable component and should never be autoclaved. Instead, it should be cleaned of visible debris, disinfected with an approved surface disinfectant such as CaviWipes™ for the recommended contact time, and allowed to air-dry completely before reuse.

Cleaning and Sterilization

Proper reprocessing requires different protocols for the reusable applicator and the nonsterilizable canister.

- *Applicator cleaning and sterilization:* After use, the reusable DentalJect applicator should be pre-cleaned by rinsing and brushing to remove visible debris, followed by ultrasonic cleaning in an enzymatic detergent solution according to the manufacturer's instructions. The trigger should be actuated during ultrasonic cleaning to facilitate penetration of the cleaning solution into internal components. After a final rinse and visual inspection to confirm cleanliness, the applicator is placed in a sterilization pouch and steam sterilized in an autoclave before reuse.
- *Canister disinfection:* The DentalJect canister is a non-sterilizable component and should not be autoclaved. After disconnecting it from the applicator, remove any visible debris with a soft brush, then disinfect all external surfaces using an approved disinfectant wipe according to the manufacturer's recommended contact time. Allow the canister to air dry completely before reuse.



FIG. 5. Steps to assemble the DentalJect.

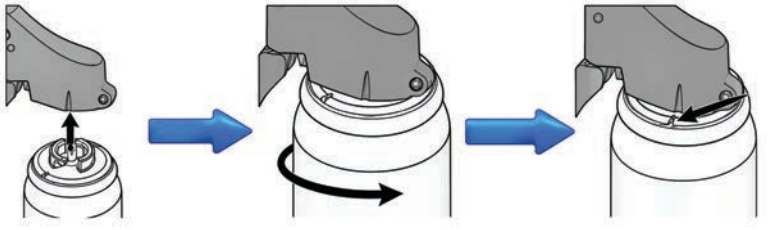


FIG. 6. Steps to attach and detach the nozzle from the can.

Evidence for Topical Pain Reduction

Across multiple controlled studies, topical anesthetics have been shown to reduce needle-insertion pain compared with placebo, although outcomes vary by injection site and product. Palatal studies have demonstrated benefits with both benzocaine and lidocaine relative to placebo.[5,7] Pediatric studies have compared topical gels with alternative delivery formats (eg, oral adhesive preparations and patches) designed to improve contact time and effectiveness.[8,9,13] In other injection contexts (eg, inferior alveolar nerve block regions), findings have been less consistent, suggesting that the effectiveness of topical anesthetics may vary according to the injection site.[10,11]

Future Implications

As dentistry continues to prioritize patient experience, non-pharmacologic adjuncts that reduce the needle event without adding procedural complexity are likely to see increased adoption. Real-world outcome tracking of patient-reported pain, anxiety measures, and chair time impact will be valuable in defining best practices and clarifying where immediate-onset cryogenic approaches provide the greatest clinical advantage.

Conclusion

Injection comfort is both a clinical and behavioral determinant of treatment acceptance. The literature demonstrates that topical anesthetics can reduce needle-penetration pain, but their effectiveness is variable because onset time, depth of anesthesia, and site-specific tissue characteristics, particularly the limited permeability of keratinized palatal mucosa can limit consistent performance.[3,5-11] A drug-free cryogenic desensitization approach that provides immediate topical analgesia without dwell time aligns with contemporary priorities of predictable

patient comfort, streamlined clinical workflow, and cost-conscious practice. When incorporated into sound injection technique and effective patient communication, DentalJect's chairside cooling technology represents a practical adjunct for reducing injection discomfort, with particular benefit during palatal injections and other anxiety-sensitive procedures where improved patient comfort can enhance cooperation and clinical efficiency.[3, 5-11]

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