

Jet Injector A Needle Free Drug Delivery System In Pediatric Dentistry: A Narrative Review

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Abstract: Needle-stick injuries are frequent occurrences in healthcare settings which can lead to serious complications. we should remember and apply many precautions to prevent the broad spectrum of sharps and splash injuries that could occur during the delivery of dental care. A new generation of needle-free vaccine delivery devices (jet injectors) has been developed in an effort to decrease the risks of needle stick injuries to healthcare personnel and to prevent improper reuse of syringes and needles. Jet injection is a needle-free drug delivery method in which a high-speed stream of fluid impacts the skin and delivers drugs. Needle-free technology offers the very obvious benefit of reducing patient concern about the use of needle. These newer techniques, when used exclusively or in conjunction with the traditional method of anesthesia, prove to be quite helpful in meeting the objective of pain control during dental procedures. So pertaining literature focus on use of jet injections in pediatric dentistry to provide painless dental care amongst children. We in brief explained how it can be a superior method over conventional once in the literature

Keywords: Pediatric Dentistry, Dental Anxiety, Pain, Jet Injectors

INTRODUCTION: In dentistry, the administration of local anesthesia (LA) is an essential prerequisite for performing most procedures. However, many individuals—especially children—harbor a fear of needle pricks. While the pain from the procedure may subside quickly, the discomfort during administration of anesthesia can be quite significant [1].

Conventional syringe-based local anesthetic delivery, although widely used, is often perceived as painful and anxiety-inducing. One of the most distressing factors in dental treatment is the anxiety and fear associated with dental injections, particularly in pediatric patients. This fear, commonly referred to as needle phobia or belonephobia, can lead to considerable psychological distress [2,3].

Needle-related pain (NRP) is not merely a physical or chemical sensation—it is also a psychological challenge, especially for children. In pediatric patients, NRP can elicit negative emotional and cognitive responses, leading to long-term aversion toward dental procedures [4].

The traditional method of administering LA using syringes and needles often contributes to increased apprehension and fear. Parents and children may delay or avoid treatment altogether, show poor cooperation, or develop full-fledged needle phobia. In many cases, it is the sight of the needle, rather than the procedure itself, that provokes fear [5].

Achieving effective pain control is, therefore, a crucial factor for both successful treatment and behavior management in pediatric dentistry. In an effort to minimize NRP, needle-free jet injectors have been introduced. These systems deliver local anesthesia without needles and aim to reduce pain and fear associated with injection [6].

By eliminating pain and anxiety, these systems help establish a positive, trust-based relationship between the pediatric dentist and the child. Ultimately, this fosters a healthier attitude toward future dental care and improves long-term compliance [7].

What exactly is the New Needle-free injection system ?

Traditional injection methods rely on the use of a needle. In recent years, new needle-free injection systems have become more popular, as they offer many advantages with the aim of eliminating problems related to the use of needles.

Jet injector systems are needle-free systems that work with the principle of applying anesthetic solution with pressure to penetrate the tissues with spring-loaded devices, in a manner reinforced with pressurized air or gas.[6].

Thus yield a higher level of comfort, because it involves no puncture or injection phase(recognized as the more painful stages of traditional anesthesia administration) This system works on the principle of pressure dynamics. Pressure injector systems can be applied as an alternative to conventional dental needle method which is safe and generally well accepted by the patients. It promises to be a viable mode of pain control during various procedures in clinical pedodontics.

Objectives of Needle-free Injection System

Needle-free jet injection aims to administer local anesthesia effectively while minimizing patient discomfort and anxiety associated with traditional needles. This method promotes a more positive dental experience. [8]. Compared to conventional techniques, it offers several advantages:

- a) Rapid Action
- b) Easy to Use
- c) Minimal or No pain
- d) Decreases risk of needle stick injuries
- e) Reduces excessive time for waste disposal created by needles and syringes
- f) Enhances Infection control by Eliminating cross contamination
- g) Aids in behaviour management by reducing dental anxiety in children
- h) Helps in gaining co-operation

These benefits position needle-free systems as a safer and more efficient alternative in modern dental and medical practices.

Mechanism: The jet injector functions by a finely coordinated process that combines many critical components to provide anesthesia without the use of a needle.

The jet injector system is usually made up of Piston, Energy source, Drug plunger, Container to load the anesthesia.

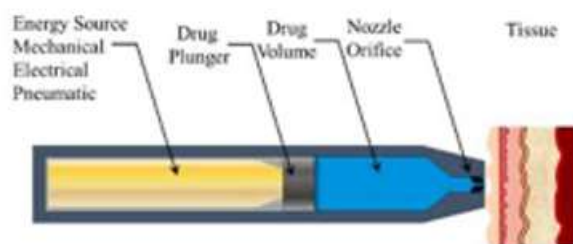


Figure 1: Parts of Jet injector system [9]

A jet injector is a needle-free device that uses mechanical energy to deliver anesthetic solution through a small orifice in the form of a high-pressure fluid stream. When activated, the piston releases pressure from the energy source, propelling the drug plunger forward. This generates a narrow, high-velocity jet (100–350 m/s) that creates a micro-puncture in the mucosa, allowing the anesthetic to penetrate the skin and reach subcutaneous tissues without using a needle. The key components of the device include a piston, energy source, drug plunger, and an anesthesia container [9,10].



Figure 2: Mechanism of Jet injector system [9]

DISCUSSION: There is Dental anxiety and fear amongst children about needles and related pain. Where, Behaviour management by reducing fear and anxiety of children is key to successful treatment. Another concern related to use of needles is Needle stick injuries and cross infections. WHO estimates million's of these needle stick injuries and blood-borne infections associated risks [11]. So, to overcome this Significant concern regarding needle related pain a alternative method for delivering anesthesia have emerged i.e; Needle free injections.

These Jet injectors works with mechanical energy by expelling drug or anesthetic solution through tiny orifice smaller than that of conventional needle enabling effective administration. These are fast on onsets, shows rapid action with minimal or no pain, lesser tissue trauma and reduced fear amongst children. This system have some limitations such as its cost effectiveness, technical skill's, Limited depth control, noise and bulkiness [12].

Although various studies have states usefulness of these needle free injections in pediatric dentistry. Makade et al. reported less pain and fear during the surgery with needleless anesthetic. The jet injection approach may be especially useful in pediatric dentistry, where it could lessen fear and contribute to limited dose administration [13].

Recent randomized clinical trial (2024) reported high levels of discomfort and the need for additional anesthesia in 44–88% of pediatric procedures, highlighting its limitations in effectiveness for deeper or more invasive treatments. Despite these concerns, other studies have shown promising results. Ocak et al. (2020) demonstrated the feasibility of using jet injectors for maxillary tooth extractions in children, suggesting that with proper case selection, these devices can be clinically effective [14]. While Theocharidou et al. (2022) explored an electric motor-driven jet in adults, they reported a 75% success rate and a clear preference among patients for the jet method, which may indicate potential for future pediatric adaptation [15]. Recent findings by Jaju et al. (2024) further support the use of jet injectors in managing pulpal pain in adults, with outcomes comparable to conventional methods, which may provide insight for pediatric application as technology and technique evolve [16].

All studies suggests that Jet injectors provide a needle-free innovative painless alternative that is perfect for anxious pediatric patients and routine dental care. They contribute to reducing occupational sharps injuries and simplifying compliance with sharps safety measures. Patient acceptance can be improved by proper training and counseling about device loudness or sensation.

Future Directions: Mechanical advancements aim to improve dosage accuracy and prevent splash-back, while computer-controlled injection systems like Jet injectors can reduce discomfort and enhance user experience. Controlled clinical trials are needed to compare jet-injection to traditional anesthetics, and widespread use could reduce needle-related injuries and sharps waste.

CONCLUSION: Jet-injector devices offer a needle-free, pain-reducing alternative for pediatric dental anesthesia, despite limitations like cost and noise. Despite limitations, they offer safety and patient comfort, making them a promising option for modern pediatric dentistry.

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