

# Painless Injection Systems in Paediatric Dentistry – A Review Article

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**Abstract:-** children as well as adults have a negative perception of needles, which leads to anxiety before the procedure pain encountered while receiving dental injections may affect the coping abilities of the child in subsequent dental visits and creates a negative child-dentist relationship. Thus to overcome this newer delivery devices and techniques which uses pressure and vibration and supplemental anesthesia into the osseous tissue have been introduced to reduce the pain. Thus, the present overview aims to the summarize recent anesthetic delivery devices and several painless local anesthesia techniques in alleviating dental anxiety and pain in paediatric patients as well as provide information to practicing dentists regarding better patient management And pain control.

**Keywords:-** Children, Dental Anxiety, Tens, Jet Injection, Cclad, Vibrotactile Devices, Intraosseous Anaesthesia, Needleless Anesthesia

## I. INTRODUCTION

The aim of any dental procedure is painless treatment with minimal anxiety and apprehension to the patient .pain management is a major concern for most practicing dentists and poses a problem for pediatric patients as well. Inadequate pain management stimulates negative responses and fear in children, which Acts as a for dentists to instill a positive attitude in pediatric patients. Hence, treating pediatric patients with minimal distress and pain has become a predominant objective thus, to overcome these shortcomings exploring new alternative and minimally invasive methods in local anesthetic administration came into the limelight with better pain control, decreased injection pain, and enhanced quality of care for pediatric dentistry different factors like type of anesthetic solution, gauge of needle, temperature of the anesthetic solution, and ph of the site influence the perception of pain [1,2,3] due to the drawbacks of techniques such as psychosomatic, topical gel applications, pre-cooling of soft tissues, music therapy, counter distraction, devices that can inject local anesthetic into the tissues at a set speed. collectively, these "painless anesthetic devices", are termed "computer-controlled local anesthetic delivery" (cclad) devices. thus, there still exists a need to find newer methods of reducing pain of injection [4,5,6,7,8,9,10] alternative to

conventional methods include :computer controlled local anesthetic drug delivery system (cclad's)jet injectors,emla (eutectic mixtures of local anesthesia),topical anesthetic patches ,electronic dental anesthesia ,Iontophoresis.

## II. HISTORY AND BACKGROUND

Although Cook invented the modern dental syringe nearly 150 years ago,[11] it is only recently that anesthetic delivery systems have seen major innovations. One of the biggest barriers to successful delivery of quality dental care to paediatric patients is fear related to injection of local anaesthetic. anaesthetic. Although the conventional aspirating syringe is the most often used way of delivering local anaesthetics,. Newer painless delivery systems improve the quality of care in paediatric dentistry.This article will discuss about computer-controlled local anesthetic delivery (CCLAD) systems, jet injectors vibrotactile devices, safety dental syringes and devices for Intra- Osseous (IO) anesthesia, syringe microvibrator and intra nasal sprays.

## III. DELIVERY SYSTEMS

### A. Computer controlled local anesthesia delivery (cclad) system

Computer-controlled local anaesthesia delivery system enables the control of the rate of flow of the local anaesthetic using computers, minimizing discomfort by administering the anaesthetic slowly and at a constant rate. Before selecting an appropriate system, the operator should consider the system's design, which includes factors such as weight, infection control, speed and mode of drug injection, aspiration potential, and so on. The wand system (launched in 1997) was the first cclad utilised. It is intended for the administration of painless palatine injections.

### ➤ Wand System:

In contrast to conventional syringes, this technique allows the operator to position the needle at the area to be anaesthetized with fingertip accuracy and greater control. The local anaesthetic is delivered at a constant rate through foot-activated control. The handpiece in this system is lightweight and may be handled with a pen-like grip for greater tactile sensations. This is due to the fact that the syringe is contained within the main system, as opposed to other devices (such as

the quicksleeper) that include them in the hand parts. Furthermore, the weight of the cclad is crucial since the operator must hold the device in the anesthetized zone for a long period of time. hence, lighter devices are recommended over heavier ones to minimise needle break injuries and operator muscle fatigue. A computer software manages the anaesthetic flow to produce low-pressure injections that are painless and precise. Into loose connective tissue or firm connective palatal mucous membranethe cartridges used in the wand system are installed in the main unit and the assistant can change the cartridge during anesthesia but 0.3-0.4 ml of solution is lost in this method. Aspiration time in the conventional wand system was initially around 14 seconds which has now been reduced to 5 seconds in the advanced version of the system . regardless of benefits, single tooth anesthesia is costly to use and expensive in maintenance.[15,16].the disadvantage is that Standard needles will not work with the Wand. Luer lock needles are required.

➤ *Computer Comfort Syringe (ccs) System:*

CCS has 3 parts base unit, a syringe and no foot control This system differs from the wand in that there are no foot pedals. The injection and aspiration may be controlled by the syringe itself, and the solution is deposited into the targeted tissues irrespective of resistance. During the injection technique, several computer components may be controlled directly from the syringe. The base feature allows the dentist to programme one of five various injections by pressing a single buttonBlock, infiltration, PDL, intraosseous, and palatal are the five buttons on the base unit.. Each of these injections has a specific corresponding rate of local anaesthetic delivery associated with it.The base device contains digital feedback readings that show the time elapsed, anaesthetic rate, and volume administered. The CCS works with conventional dental needles. When compared to the wand system, ccs is less preferable due to the weight of the device; nevertheless, ccs has a greater advantage over the traditional method of anaesthetic delivery.[17]

There are five pre-programmed injection rates for specific injections.

infiltration	- 0.007ml/sec
regional block	- 0.02ml/sec
palatal	- 0.008ml/sec
intra-ligamentary	- 0.007ml/sec
intraosseous injections	- 0.02ml/sec [18]

➤ *Single Tooth Anesthesia*

An extra-short 30-G needle is inserted into the gingival sulcus parallel to the tooth's long axis. For single-rooted teeth, the number of sites for delivering anaesthetic is one (distal) and two (distal and mesial)/three points, respectively. To provide appropriate anaesthetic, the needle must be inserted into the tissue until it reaches the periodontal ligament. The benefits of single tooth anaesthesia (STA) include the absence of anticipatory anxiety (because to its pen-like shape), the absence of discomfort, and the absence of perioral tissue anaesthetic effects. [33] (lips, tongue, and cheeks), and no permanent tooth crown damage. 41 According to Garret-

Bernardin et al., STA is an useful alternative to traditional procedures since it causes less pain. 42 According to Al-Obaida et al.

Stated that STA increases the patients 'satisfaction and compliance due to its profound anesthetic effect in restorative procedures among adolescence.[19,20]

STA has three rate-modes of injection:

- STA mode: single, slow rate of injection;
- Normal mode: emulates the CompuDent device;
- Turbo mode: faster rate of injection – 0.06 ml/s.

➤ *Sleeper One*

The design is similar to Quicksleeper. It is composed of a pen grip hand piece, a control unit, a foot pedal and permanent analysis of resistance system. It has got a recapping system on the handpiece holder so that accidental injuries can be prevented. The design of needles allows easy penetration into every type of tissue enabling completely painless attached gingiva and palatal anaesthesia. Its intuitive [21]

*B. Jet Injectors*

Jet injection is based on the principle that liquids forced through very small openings, called jets, at very high pressure can penetrate intact skin or mucous membrane 14 this permits a thin column of fluid to be created that will allow the deposition of anesthetic into the subcutaneous tissue without the use of a needle it is mainly of use in children because of less bone density jet injections have an advantage of fast drug delivery and absorption, less tissue damage and lesser pain. these injections.[22,23]

The most commonly used jet injectors in dentistry are

- syrijet mark ii
- med jet h iii
- Madajet xl

➤ *Med Jet h iii:*

In the year 2011, this system was developed. The drug is delivered through a small orifice seven times smaller than the needle with the smallest diameter in this method. Its precision is undeniable, and it delivers anaesthesia at low pressure while maintaining environmental safety, patient comfort, and user compliance. The depth of penetration may be mechanically regulated.it is painless & ideal for nasopalatine and greater palatine injections but inadequate for regional or pulpal block. it is very successful in children.

➤ *Syrijet Mark ii:*

Syrijet has been in use for the last 40 years and has undergone some marked improvement. The device employs 1.8cc syringes, which aid in the delivery of local anaesthetic solutions ranging from 0-0.2cc. It has a nozzle pressure of 2000 pounds per square inch and produces the same impact as a typical needle punctured 1 cm deep into the tissue. Minor surgical procedures such as removal of deciduous anterior teeth and permanent incisors, soft tissue surgeries, removal of bone spicules, application and removal of arch bars and

ligature wires are performed, according to William Greenfield and Joseph Karpinski et al. According to research, the device was well tolerated by patients and could be employed in regions sensitive to needle piercing.[24,25]

### C. Vibrotactile Devices

Vibrotactile modify or interfere with pain signals by closing the neural gate of cerebral cortex. The inhibition occurs without any contribution at the spinal level, the perception of "pain" from the pressure of the liquid entering the tissue is decreased due to distraction.

- **Vibraject®:** Vibraject is a battery-operated device which has an attachment that snaps on to the standard dental syringe. It generates high-frequency vibrations on the needle, which reduces pain feeling during anaesthetic injection..[26]
- **Dentalvibe®:** DentalVibe is a compact cordless injection system with a vibrating U-shaped tip attached to a microprocessor-controlled Vibra-Pulse motor.. It has got an attachment which will help to retract the lip or cheek[26]
- **Accupal :** Accupal is a cordless battery-operated device, that employs both vibration and pressure to Preparation of the oral mucosa. vibrates the injection site 360 degrees proximal to the NEEDLE PENETRATION that shuts the pain gate mechanism which blocks the pain sensation. It is used for inferior alveolar blocks and palatal injections.[26,27]

### D. Supplemental Anesthesia With Intra Osseous Route

Supplemental anesthesia with intra osseous route delivers higher doses of anesthetic closer to the apex, . IO injections provide pulpal anesthesia for duration of less than 60 minutes with vasoconstrictor and approximately 15 to 30 minutes without vasoconstrictor when administered alone.

- **Stabident :** Stabident (Fairfax Dental Inc, Miami, FL, USA) is a device for supplemental anesthesia. A slow-speed hand piece with a latch contra-angle for the perforator and a standard dental anesthetic syringe for the needle it provides effective anesthetic effect in both maxillary as well as mandibular teeth system is composed of:  
Perforator  
Injection needle

The main disadvantage of the device is that the perforation should be made in a properly accessible and visible area in the attached gingiva distal to the tooth to be anaesthetized. If the penetration zone is located in alveolar mucosa that moves once the perforator is removed, it can be

extremely difficult to locate the perforation site with the anesthetic needle.[28]

- **X-tip -x-tip** anesthetic system (Dentsply International Inc, Tulsa, OK, USA) is a type of intra osseous injection. The X-tip unit has a pilot drill which is a hollow tube through which a 27-gauge needle can pass through to express anesthetic solution. The primary differences in using the X-tip device are The penetration need not be performed through the attached gingiva The guide sleeve must be carefully removed with a hemostat after the injection is performed.[29] the x-tip system consists of 2 parts:

a drill (2) a guide-sleeve component

The x-tip drill and guide sleeve is used with a slow-speed hand piece of 15,000 to 20,000 rpm. The advantage of the system is that the guide sleeve remains in place to identify the perforation location for needle placement. X-tip had success rate of 82% as supplemental anesthesia in cases where inferior alveolar nerve failed to provide profound anesthesia. Disadvantages of the x-tip are that the drill and guide sleeve occasionally remain stuck together after perforation, while removing the drill. It is difficult to perforate thick or dense bone in the posterior mandible. Postoperative complication of pain, 1 to 3 days after the procedure is due to increased heat formation during perforation. Dixit and Joshi reported a study to compare the IO anesthetic technique using X-tip with conventional infiltration technique for anesthetizing first permanent molars afflicted by molar incisor hypo mineralization in children. The authors stated that X-tip IO local anesthesia is a safe and effective technique in achieving profound anesthesia for severe hypersensitivity MIH teeth in children with chronic pulpal inflammation.[30]

- **Intraflow :** Intraflow anesthesia system (Pro-Dex Medical Devices, Irvine, CA, USA) is a primary or supplemental technique of delivering anesthesia. It provided 87% successful pulpal anesthesia when compared to inferior alveolar block which had only 60% of success rate.

It has 4 core components:

1. the hand piece with a seat for the anesthetic cartridge and quick disconnect: a rheostat and a coupling
2. the head attachment
3. the perforator: 24-gauge hollow stainless steel needle
4. the transfuser: ABS shell & slider with 20-gauge stainless steel cannula attaches to the head attachment and carries solution from the standard 1.8-ml dental cartridge to the perforator. Remmers et al. stated that The IntraFlow device provided more rapid and safe anaesthesia than the conventional technique.[31]

Alternative methods - advantages and disadvantages

METHOD	ADVANTAGES	DISADVANTAGES
COMPUTER CONTROLLED LOCAL ANAESTHESIA	<ul style="list-style-type: none"> <li>Provides tactile feedback</li> <li>Less intrusive appearance</li> <li>Variety of modes available</li> </ul>	<ul style="list-style-type: none"> <li>Involves a needle</li> <li>Cost of equipment</li> </ul>
JET INJECTORS	<ul style="list-style-type: none"> <li>Fast and easy to use</li> <li>Immediate uptake at the site of administration</li> </ul>	Noise and pressure produced from equipment may negatively affect patients <ul style="list-style-type: none"> <li>Possibly cause haematoma of soft tissues               <ul style="list-style-type: none"> <li>High overhead cost</li> </ul> </li> <li>Can irritate skin and oral mucosa               <ul style="list-style-type: none"> <li>High overhead cost</li> </ul> </li> </ul>
COMOUTER CONTROLLED INTRAOSSEOUS ANAESTHESIA	<ul style="list-style-type: none"> <li>Smaller dosage of LA</li> <li>Reduced soft tissue anaesthesia</li> <li>Rapid onset of profound pulpal anaesthesia</li> <li>Palatal/lingual and buccal anaesthesia with a single needle</li> </ul>	<ul style="list-style-type: none"> <li>It involves a needle</li> <li>Additional application time</li> <li>Shortened duration of anaesthesia</li> </ul>

Table .1 J Dent Anesth Pain Med 2018 April; 18(2): 79-89 [35]

#### IV. RECENT TRENDS

##### A. Syringe Micro Vibrator

It has an off-set rotating micro vibration creator with ultra high frequency and ultra low altitude that can be easily placed on any standard dental syringe and some disposable syringes. Micro vibration of injection needle will alleviate the pain and discomfort during intraoral injections. This device was registered as a dental innovation and was received the Iran National Patent number 63765.[32]

##### B. Intranasal Sprays

Intranasal anesthetic spray containing 3% tetracaine and 0.05% oxymetazoline was approved by the Food and Drug Administration (FDA) in 2016 for anesthesia of the maxillary teeth up to the second premolar[33] and seems to be very effective in performing needle-less anesthesia of all maxillary teeth in child patient weighing more than 88lb.[34] Although it has been approved by the FDA, its clinical field of application of nasal sprays are still narrow. Research activities are needed to evaluate its safety and efficacy in paediatric patients and patients with systemic complications. Nevertheless still it has opened a new horizon in needle-less anesthesia for single tooth restorative procedure in maxillary arch particularly in anterior region.[34]

#### V. CONCLUSION

Many practising dentists prioritise providing painless dentistry. A patient's greatest concern is the needle and syringe, as well as the pain associated with it. The above stated methods can prove to be useful in pain management in certain cases of apprehensive and anxious patients. These techniques help dentists by making children patients' dental appointments more pleasurable, as well as by creating a favourable dental attitude in them for future procedures. Though The trend is changing as education, research and instrumentation reduce the cognitive and emotional barriers

in the dentist's and child's perceptions of the local anesthesia experience. Children's reactions towards injections are among the most profound feelings that dentists confront on a regular basis. Alternative techniques can help the dentist treat patients more efficiently and comfortably. newer advances can be used as per one's requirement, feasibility and availability of equipments. Some of these procedures are time consuming and expensive too. Despite these advances, some dentists prefer employing the conventional techniques, However, innovative approaches will assist in delivering prompt and effective oral health care with more patient satisfaction and less discomfort. Recent advances in PAINLESS INJECTION SYSTEMS AND TECHNIQUES IN PAEDIATRIC DENTISTRY results in more positive outcomes in maintaining a proper child–dentist relationship.

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