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RESEARCH ARTICLE

RECENT ADVANCES IN LOCAL ANESTHESIA.

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Abstract

Pain and anxiety are the two main reasons that contribute to the avoidance of dental care. Treating of such patients is stressful for the dentist which might ultimately results in the failure of the treatment, as regardless of practioner's clinical skills, the dental treatment might become compromised without effective pain control system. The ability to provide excellent, high quality pain control in dentistry is required which is based on the practical knowledge of the clinically relevant aspects and updates about the recent advances in the field of topical and local anaesthesia. Knowledge of the local and topical anaesthetic agents and the ability of the clinicians to choose the best delivery methods has become a most important thing in today's dentistry. Therefore, an attempt to compile the literature studies available on recent updates of local anaesthesia in general as well as pediatric dentistry is made for better understanding the procedure and its practical implications.

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Introduction:-

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage¹. Pain and its successful management have been one of the keystone of dentistry worldwide. It is because of the pain that most of the people approaches the dentist. But pain is like a double edged sword to a dentist. The reason which brings the patient to dentist side is the same that takes away from receiving treatment due to fear and anxiety associated with various treatments.

To eradicate the pain during the treatment procedures usually anaesthesia have to be administered. The word Anaesthesia is a compound word from the Greek words an- ("without") and aesthesis ("sensation")². Stanley F Malamed (1980) defined local anaesthesia as a loss of sensation in circumscribed area of the body caused by a

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depression of excitation in nerve endings or inhibition of the conduction process in peripheral nerves³. Conventionally and even today in many areas anaesthesia is administered by injections. This is the reason that children dislike dental treatment due to the fear and anxiety related to needles. This fear related behaviour has been recognised as the most difficult aspect of patient management⁴. It can be a barrier for delivering successful treatment. It has been said that bruises may fade but the pain experienced in the childhood time during dental visit never goes. It remains as a barbaric experience and this will later on develops a negative attitude towards dental treatment.

The challenge facing by the dentist is to find a more comfortable and pleasant means of administering local anaesthetics without much invasion of soft tissues. Even though, painless injection is practically impossible, with the advent of new techniques, needles, anaesthetic gels we can relieve the discomfort caused by the conventional methods to a large extent.

As Thomas Edison says "If there is a way to do it better- find it." Even though a lot of advancements has been done in the field of local anaesthesia still painless injection is a dream. So we have to constantly work on it and have to find newer techniques in our routine practise. Therefore, an attempt to compile the literature studies available on recent updates of topical and local anaesthesia in general as well as pediatric dentistry is made for better understanding the procedure and its practical implication.

Topical Anaesthetics

Topical anaesthesia is that form of anaesthesia obtained by the direct application of the drug to abraded skin or to the mucous membrane (Monheims 7th edition)⁵. It is used to anesthetize small wounds and intact mucous membrane for simple procedures. These anaesthetic agents are available in different kinds such as : gels, lotions, patches, cream, solutions, aerosol forms. Even though, this form of anaesthesia is effective only on tissue surfaces it has got a definite place in dental practise particularly in dealing with pediatric patients.

Mechanism of action

Topical anaesthetics reversibly block nerve conduction near the site of administration. They act on the free nerve endings in the dermis or mucosa producing temporary loss of sensation in a limited area. Nerve impulse conduction is blocked by decreasing nerve cell membrane permeability to sodium ions. This change in permeability decrease depolarisation and increases excitability threshold until the ability to generate an action potential is lost⁶.

Types of topical anaesthetics⁵

According to the vehicle that used to make them amenable to surface application, topical anaesthetics are classified as:

- A) Non aqueous or water insoluble
- B) Aqueous or water soluble

A. Non aqueous or water insoluble

These anaesthetics are insoluble in water but they are soluble in vehicles such as alcohol, polyethylene glycol, propylene glycol or carboxymethylcellulose. By adding these less viscous solutions mentioned above, topical anaesthetics remain in contact with the area for a longer period thereby increasing the duration of action. The topical anaesthetics belonging to this group are Benzocaine and Lidocaine base.

1)Benzocaine is an ester of amino-benzoic acid that lacks a cationic amino terminus which makes benzocaine poorly soluble in water and a poor candidate for parenteral use. It is available in the forms of Spray, gel, gel-patch, ointment or solution as 6-20% and in different flavours also.

Brand names available : Orajel, Hurracaine (Beutich LP Pharmaceuticals, USA) (Fig 1-2)



Fig 1:-Orajel



Fig 2:-Hurricane

Combinations of benzocaine :

Orabase- combination of benzocaine, gelatin, pectin & sodium carboxymethylcellulose (fig3).

Cetacine: It contains 14% benzocaine, 2% butamen, 2% tetracaine HCl⁷(Fig 4).



Fig 3:-Orabase



Fig 4:-Cetacaine

Recent advances

Hurripak (fig 5) which contains 20% benzocaine is anaesthetic liquid which is one of the recent development topical anaesthetics for periodontal procedures. It is available as a needle-free periodontal anaesthetic kit. It consists of 3ml plastic syringe and disposable plastic tips which are inserted deep within the gingival sulcus. The onset of action is 30 seconds and the duration of action is 15 minutes⁷. Sometimes it won't provide adequate anaesthesia for a routine dental visit on adult patients, so multiple administration is recommended



Fig 5:-Hurripak

2)Lidocaine base is used in 5% concentration and indicated for production of anaesthesia of accessible mucous membrane of oropharynx, temporary relief of pain associated with minor burns, abrasions of skin. It contains lidocaine and polyethylene glycol as the major ingredients. It is available in the form of flavoured gels and ointments.

Brand names: Lidocream 5

Water soluble topical anaesthetics.

These anaesthetics are soluble in water. It will rapidly get absorbed into the blood stream and thus reported to have more toxic properties like allergic reaction, methamoglobinemia etc. So it is not recommended to be sprayed on mucous membrane. While spraying, it will distribute over a wide area and might get absorbed. To get best anaesthetic effects for this group, mucosa should be dried with a cotton swab before application. The anaesthetics belong to this group are:

1. Benzyl alcohol
2. Tetracaine hydrochloride
3. Lidocaine hydrochloride

Benzyl alcohol is an aromatic alcohol with anaesthetic properties which is available in liquids and sprays in 4-10%.

Tetracaine hydrochloride is an ester type local anaesthetics which is available as 2% - 4% for topical application. Its application time is recommended as 30 minute. As it is a water soluble anaesthetic it can rapidly be absorbed into circulation. When it is applied to dry mucosa, onset of action is slow but duration is long lasting. So in order to get a rapid onset, they are usually used in combinations with other.

Combinations of tetracaine hydrochloride:

Tetracaine, adrenaline (epinephrine), and cocaine (TAC)

It was the first topical anaesthetic mixture found to be effective for non-mucosal skin lacerations to the face and scalp⁶. It is a dermal anaesthetic used for open wounds, such as lacerations and abrasions. The ingredients are tetracaine, cocaine, and epinephrine. Tetracaine acts on neuronal membranes, interacts with sodium channels and prevents the generation and conduction of nerve impulses in axons of the peripheral nervous system, cocaine along with its vasoconstrictive property also blocks the conduction of impulses in sensory nerves whereas epinephrine prolongs the duration of action by retarding drug removal and limiting systemic absorptions.

Lidocaine, epinephrine, and tetracaine (LET)

It is a more safer and cost-effective alternative to tetracaine, adrenaline, cocaine (TAC) because in this cocaine is replaced by lidocaine. Lidocaine, epinephrine and tetracaine (LET) is used on non-mucosal skin lacerations by placing a few drops directly into the wound (Fig 6)



Fig 6:-Lidocaine, adrenaline & tetracaine gel

c) S-caine patch™ and local anesthetic peel the patch

It is manufactured by ZARS, Inc., Salt Lake City, UT, US. It is a controlled heat aided drug delivery patch (CHADD) with a heat generating medium, a drug reservoir for lidocaine and tetracaine and a medical tape cover. The application of warm technology will help in accelerating transcutaneous delivery and analgesic effect of anaesthetics⁸. When applied to the skin, heat passes from the patch to the area thus increasing the skin temperature. This heat is generated by the mixture of iron powder, activated carbon, sodium chloride, wood flour, and water which is placed in a pouch made of filter paper (Fig 7). This paper is again sealed between two polymer films. One of the films has holes of pre-calculated size and the other membrane with tiny holes covers the heat generating chemical components. Air flows through the holes present in the cover membrane at a controlled rate into the heating mixture and initiates a chemical reaction that generates heat when this package is exposed to atmosphere. This heating element can produce a temperature of 39°C to 41°C for 2 hours⁸.

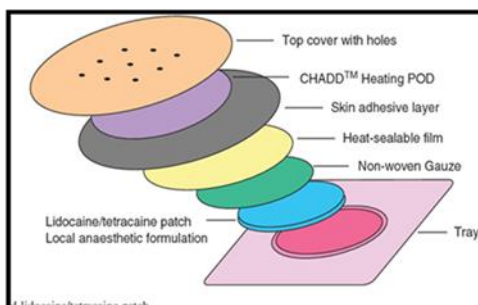


Fig 7:-Cross sectional view of S-caine patch

3) **Lidocaine hydrochloride** is the only amide based topical anaesthetics that can also be used as injectable anaesthetics. It is available in 2% or 4%. Since it belongs to water soluble category, the penetration to tissues is better when compared to lidocaine base. It is available in the brand names as Lidoderm patch (fig 8) which is comprised of an adhesive material containing 5% lignocaine. Dentipatch (fig 9) (Noven Pharmaceuticals Inc, USP IV in 1996) first bioadhesive patch used for delivering local anaesthesia to oral mucosa⁸, Topicaïne which is 4% lignocaine in a hydro-ethanolic gel microemulsion drug delivery system.



Fig 8:-Lidoderm patch



Fig 9:-Dentipatch

Combinations of lidocaine hydrochloride:

Eutectic mixture of local anaesthetics (EMLA) is an oil-in-water emulsion mixture. It is composed of lignocaine 2.5% and prilocaine 2.5% in an emulsion in which oil phase is a eutectic mixture of lignocaine and prilocaine in a ratio of 1:1 by weight⁹ (Fig 10). Even though its first usage was in dermatology field, a lot of uses like pain relief during scaling, rubber dam clamp placement, palatal injections is also been credited under its name. It has got low viscosity so it is difficult to handle and apply at the site of needle injection. So to overcome that it is applied under occlusive dressings like Tegaderm™, Saran-wrap™, or Band-aid™, which aids diffusion into the skin. Depth of anaesthesia depends on the contact time with EMLA. Anaesthetic effect has been shown to reach a maximal depth of 3 mm after a 60-min application, and 5 mm after a under occlusive dressing and persist for 1-2 h after removal of the cream 120-min application.



Fig 10:-EMLA

Betacaine-LA contains lignocaine, prilocaine and phenylephrine. As it is a proprietary anaesthetic, exact ingredient of Betacaine LA is not yet revealed. The product reports concentrations of lignocaine and prilocaine to be 4 times that of EMLA and so, it should not be applied to an area larger than 300 cm² in adults and is not advocated for use in children¹⁰.

c)**Oraqix** It has been developed by Dentsply, Pennsylvania, USA in 2004². It has been approved by FDA for dental use (fig 11). It contains 2.5% of lidocaine and 2.5% of prilocaine. It is non-injectable gel anaesthetic deposited into periodontal pockets during root planning and scaling using tips. Some studies have been reported of its efficacy of pain relief during orthodontic bands¹¹.



Fig 11:-Oraqix

Recent Advances In Topical Anaesthesia

1)Precooling (Cryo Anaesthesia)

It is the application of cold to a localised part of body in order to block the local nerve conduction of painful impulses¹². The local application of ice before and sometimes after painful procedures has been practiced for thousands of years and was one of the first source of local anaesthesia and analgesia. Topical cold application stimulates myelinated A fibers, activating inhibitory pain pathways which in turn raises pain threshold. **Iqra et al 2015** in her article concluded that, cooling will slow down or eliminate transmission of pain signals¹³. It is available in ice (crushed ice or cubed ice), refrigerant spray forms. The trade names of refrigerant spray are Gebauer's pain ease, Pharma ethyl

a)Gebauer's Pain Ease®

Gebauer's Pain Ease® (fig 12) is a topical anaesthetic skin refrigerant (vapocoolant) introduced and approved by US Food and Drug administration in the year 2004¹². It is a proprietary blend of 1,1,1,3,3-pentafluoropropane and 1,1,1,2-tetrafluoroethane and is non-flammable. Its onset of action is 4-10 seconds.

b)Pharmaethyl®

It is introduced by Septodont¹⁴ (fig 13). It is used in the production of topical cryoanesthesia in the oral cavity and to test pulpal vitality. It is a proprietary blend of 1,1,1,2-tetrafluoroethane and dimethyl ether with natural mint flavour.



Fig 12:-Gebauer's Pain Ease



Fig 13:-Pharmaethyl

Advantages of precooling:

1. It produces immediate anaesthesia as it suppresses both pain and pressure
2. It is an easy, reliable, and effective technique.
3. It is comfortable, safe and physiologically active.
4. Cost effective.

Disadvantages of precooling:

Short acting

Application time:

2-5 min (Aminabadi et al 2009)¹⁵

2) Iontophoresis

Iontophoresis is a method of enhancing the transport of topically applied drugs using a mild electric current to increase the permeability of charged drugs through the skin.

Mechanism of action: The drug which can exist in positively charged state like lignocaine and adrenaline can be encouraged to penetrate the tissue under the influence of electrical charge. The apparatus consists of two electrodes and a circuit. The electrode has to be placed over the tooth to be treated and the other one is applied to the skin over the surface of the wrist, with the help of iontophoretic apparatus and a low voltage direct current (0-3ma) is applied, which travels through the skin reaches underlying connective tissue goes back the same path and is collected by a return electrode¹⁶(fig 14). The ions of the drug traverse through the same path as the current. This procedure will enhance the penetration of the drug by 20–60-fold when compared with topical application



Fig 14:-Iontophoresis

Advantages

1. Patient acceptance is very high.
2. Provide rapid and effective anaesthesia compared to topical anaesthesia alone.

Disadvantages

1. At higher current densities or upon longer application, it can cause skin irritation.
2. Sometimes mild electrical sensation can be uncomfortable for some patients.
3. Equipment is expensive and bulky
4. Cannot be used over large surface areas of the body.

Injectable Local Anaesthetics

Injectable local anaesthetics are tertiary amines. All local anaesthetics are amphiphatic that is they possess a lipophilic and hydrophilic part. It is this hydrophilic part that makes them suitable for parenteral use. The typical local anaesthetic molecule consists of lipophilic part, intermediate chain and a hydrophilic part. The intermediate chain can be either ester or amide linkage. Based upon this linkage, local anaesthetics are classified as ester local anaesthetics and amide local anaesthetics.

Ester local anaesthetics includes cocaine hydrochloride, procaine, propoxycaine, chlorprocaine, tetracaine.

Amide local anaesthetics includes lidocaine, mepivacaine, prilocaine, articaine, bupivacaine, etidocaine.

Centbuclidine is a quinolone local anaesthetic which is synthesised at Centre for Drug Research Of India at Lucknow in 1983¹⁷ Topical application of Centbuclidine is also reported but mostly in ophthalmic surgeries¹⁸. 0.5% concentration of centbuclidine can be used for infiltration, nerve blocks and spinal anaesthesia. It is 4-5 times more potent than 2% lignocaine and has longer duration of action and analgesic properties. It has got intrinsic vasoconstrictive and anti-histaminic properties. Centbuclidine can be used in the place where amides are contraindicated due to systemic problem. Pioneer study of centbuclidine in dentistry was conducted by Vacharajani

et al in which he compared the efficacy of 0.5% centbucridine with that of 2% lidocaine for dental extractions in 120 patients. It was concluded that degree of analgesia attained by centbucridine is comparable with that of lidocaine with no significant changes in cardiovascular parameters and serious side effects¹⁹

Recent advances in local anaesthetic solution

a) Phentolamine mesylate

Prolonged local anaesthesia is an unwanted consequence of intraoral local anaesthesia. Most of the patients who had less invasive procedures reported that prolonged soft tissue anaesthesia interferes the normal function like eating, drinking, talking as their tongue and lip being numbed. One of the recent innovation in the field of anaesthesia is the introduction of Phentolamine Mesylate, a drug used to reverse the local anaesthetic effect. It is an alpha adrenergic antagonist. It reverses the effect of vasoconstrictor.

Mechanism of action :

Phentolamine mesylate is a vasodilator. It produces faster diffusion of anaesthetic solution into the vascular system and away from the injection site²⁰.

Advantages:

It can avoid one of the fairly common complication of local anaesthesia that is, soft tissue injury which is commonly seen in pediatric, physically disabled or mentally disabled patients after dental treatment with the use of local anaesthesia. It can be used as an option to decrease prolonged anaesthesia for the patient who may need to return to work or may have a speaking engagement.

Disadvantages:

It should be given with caution in patients with cardiovascular disease and stroke as this is an alpha adrenergic blocking agent. Sometimes it may cause tachycardia and arrhythmias.

Available forms:

It is available as a cartridge with a concentration of 0.4mg/1.7ml

Recommended dose:

It is based on the number of cartridges of local anaesthetic with vasoconstrictor administered. One cartridge of reversal agent is required for every cartridge of local anaesthetic given.

Recovery time:

According to Tavares et al 2008, the median recovery time to normal lip sensation was 60minutes whereas in the non treated group it was found to be 135 minute²¹.

Method of application:

It is administered following the dental procedure It should be injected at the same location and by the same technique (infiltration/ block injection) employed for the administration of local anaesthetic solution. After administration the patient is counselled not to eat /drink until normal sensation returns.

Trade name :

Oraverse (fig 15).It was introduced into the market by Novalar Pharmaceuticals Inc, San Diego, CA,USA. It was approved by FDA in the year 2009²⁰. According to Tavares et al 2008, Oraverse was found to be safely tolerated in children between 4-11 years²¹.



Fig 15:-OraVerse

b)Sodium bicarbonate

As we know, local anaesthetics are weak bases. They are combined with an acid to form hydrochloride salt, to render them water soluble, creating a stable injectable anaesthetic solution. Therefore all local anaesthetic solutions are acidic before injection which may cause stinging or burning sensation during administration and post- injection tissue injury. So in order to avoid these, recent technical advances made it practical to alkalinize dental anaesthetic cartridges at chair side immediately prior to injection. The concept of alkanization in local anaesthetic literature was reported for more than 100 years. It was widely used in the field of ophthalmology, dermatology, ear, nose and throat. For to achieve buffered solution, the physician has to add a volume of sodium bicarbonate to the solution. In dentistry, due to the prefilled, manufactured local anaesthetic cartridge, it was difficult for the practitioner to buffer anaesthetics prior to injection.

Indications:

It is indicated to hasten the onset of analgesia and to reduce injection pain.

Trade names:

Onset® (Onpharma)

Onpharma's Sodium Bicarbonate Injection, 8.4%, USP Neutralizing Additive Solution is a sterile, nonpyrogenic, solution of sodium bicarbonate (NaHCO_3) in water for injection. It is added to Lidocaine with epinephrine as a neutralizing agent immediately prior to injection. This was introduced into the market in February 2011²².

Components :

The company provides mixing pen and a cartridge connector.

The Mixing Pen (fig 16) is a precision compounding and dispensing device used to mix two solutions together. Once assembled, the Pen enables the precise transfer of fluid from a standard 3 mL size cartridge into a second container, such as a 1.8 mL cartridge, allowing the two solutions to be mixed.

The Cartridge Connector (fig 17) is used for the transfer of sterile solutions from one sealed container into a second sealed container and provides a reservoir for collecting excess solution displaced from the second sealed container during the transfer process. The Onset Cartridge Connector is used with the Onset Mixing Pen.(Fig18)

Working pattern :

The Pen is reassembled and a second fluid container, such as a 1.8 mL cartridge, is attached to the end of the Pen . In order to facilitate the attachment of a second fluid container to the end of the Pen, a cartridge connector may be used. The Pen's volume dispensing dial is then turned so that the desired amount of solution can be transferred from the 3 mL size cartridge into the second fluid container. Each number on the Mixing Pen corresponds with approximately 0.01 mL's of fluid. For instance, to dispense 0.18 mL of fluid, the dial would be turned to "18". Upon depressing the dispensing button, fluid is transferred from the 3 mL size cartridge into the second fluid container allowing the two solutions to be mixed.²³

Advantages:

1. Rapid onset, we can start procedure faster and thus reduces treatment time.
2. Provides less painful injections
3. Produce profound, consistent anaesthesia .
4. Easy to use
5. It can be used in the cases of abscess to get anaesthetic action.



Fig 16:-Mixing pen



Fig 17:-Cartridges

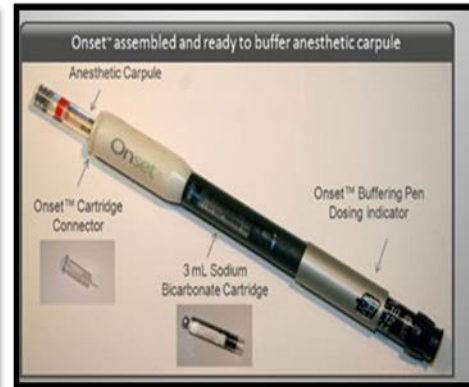


Fig18:-Onset assembled with pen & cartridge

Disadvantages:

1. It is not cost effective
2. Instability of the solution may leads to wastage.
3. It provides an extra step at the chair side as it cannot be prepared prior to the appointment .
4. Patients report more post operative soreness at injection site.

Delivery Systems In Local Anaesthesia

Effective delivery of local anaesthesia is one of the major factor which determines the success of modern dental practise. Most of the people hesitate to receive treatment due to the fear of injections. Newer technologies has provided enhanced pain relief with minimal pain from injection and fewer side effects.

The advancement in the field of local anaesthetic delivery systems are described below.

Transcutaneous electric nerve stimulation (TENS)/ electronic dental anaesthesia

It is a non- pharmacological method which is widely used for the management of acute and chronic pain in a variety of conditions. Transcutaneous electrical nerve stimulation (TENS) is the use of electric current produced by a device to stimulate the nerves for therapeutic purposes.

It was in 19 th century, a physician named Francis first described the use of electricity for the relief of dental pain²⁴. According to articles, use of transcutaneous nerve stimulation to control chronic pain was introduced by Shealy in 19678. In 1972, food and drug administration also has proved transcutaneous electric nerve stimulation as a method of pain alleviation²⁵.

Indications:

1. It can be used successfully in pediatric patient. Since the equipment contains no syringes, it will impart a positive behaviour in children and reduces their fear.
2. It can be equally useful in adult patients to produce analgesia during rubber dam placement, cavity preparation, pulp capping, endodontic procedures, prosthetic tooth preparations, oral prophylaxis, extractions, and to reduce the discomfort from injection of local anaesthesia.

3. It is used to alleviate chronic pain of temporomandibular joint syndrome, trigeminal neuralgia and post herpetic neuralgia.
4. It can be used in patients with xerostomia by increasing the salivary flow rate. In this case, TENS is applied over the skin overlying the parotid glands

Contraindications:

1. It is contraindicated in apprehensive patients as this technique requires patient co-operation. So it cannot be used in handicapped and mentally disabled people.
2. It cannot be used in patients with cardiac pacemakers. TENS currents can interfere with the function of pacemaker.
3. It cannot be used in patients with a history of aneurysm, stroke and transient ischemia as it stimulates peripheral blood flow which can be fatal.
4. Transcutaneous electric nerve stimulation (TENS)pulses have the potential to trigger a seizure, so it cannot be used in epileptic patients.
5. It cannot be used in pregnant patients even if there is no specific side effects. Because till now FDA has not approved its usage in pregnant patients.

Mechanism of action:

Analgesic effect of transcutaneous nerve stimulation is based upon two main theories

Gate control theory: This was proposed by Melzack and Wall in 1965²⁵. They suggested that dull, slow, diffuse burning pain is carried by small unmyelinated (C fibres) while the sensation of light, touch is carried by large myelinated (A fibres). The sensory output carried by two groups are modulated in substantia gelatinosa of spinal cord. This substantia gelatinosa present in the dorsal horn of spinal cord functions as a gate control. Thus by transcutaneous electric nerve stimulation large myelinated fibres are stimulated and inhibits transmission of small unmyelinated fibres. So in short, pain control can be achieved by increasing large fiber input and decreasing small fiber input and thus closing the gate.

The endogenous opioid theory: It was in 1969, Reynolds showed that electrical stimulation of periaqueductal gray region of the midbrain produces analgesia equivalent to that induced by morphine. Thus, alternative explanation is that, electric stimulation will result in the release of endogenous opioids which functions as an inhibitory synaptic transmitters and thus stops the pain.

Classification²⁵ :

Depending upon the frequency of stimulation, it is classified into two categories:

1. High frequency transcutaneous electric nerve stimulation (TENS) uses a frequency of greater than 50 Hz.
2. Low frequency transcutaneous electric nerve stimulation (TENS) uses a frequency of less than 10 Hz. Low frequency transcutaneous electric nerve stimulation (TENS) claimed to have more systemic and long term response.

Components :

The main parts of transcutaneous electric nerve stimulation (TENS) are Fig 19

1. TENS unit- It is an electric pulse generator. It has got two variations. First one is a clinical model, which is used by dentist in the clinic and it is connected to the buildings electrical outlet to generate power. Second one is patient model, which is small and portable type. It contains battery as a power source.
2. Lead wires
3. Electrodes –electrodes can be placed extraorally or intraorally.

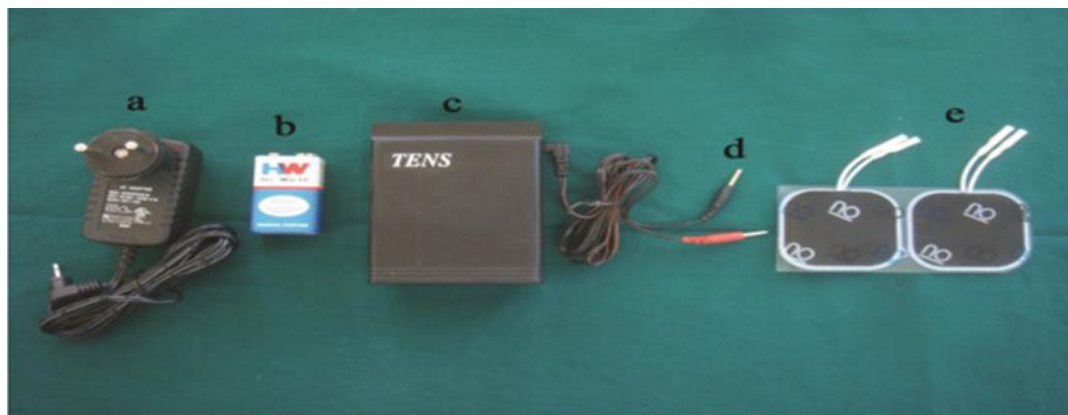


Fig. 1. a) AC adapter; b) 9V battery; c) TENS unit; d) Lead wires; e) Electrodes

Fig 19:-TENS device

Precautions to be taken.

1. Practitioner should assess the nature of pain and its onset.
2. In case of chronic pain, it is necessary to determine whether the pain is altered by movement.
3. Correct localisation of pain by the patient determines the success of TENS therapy.

Procedure :

1. Place the electrode wherever we want to anaesthetise.
2. In case of treating mandibular teeth, the electrodes were placed over each mental foramen, and for mandibular permanent molars, they have to be placed over the apices of the last molar and over the mental foramen ipsilaterally, with at least 0.5 inch in between.
3. In case of treating maxillary teeth, electrodes are placed over the apices of primary molars just below each zygoma and for permanent molars, it is placed over the apices of last molar and just below the ipsilateral zygoma with at least 0.5 inch in between.
4. Initiate the unit with a maximum frequency (140 Hz) and pulse width (250 micro second) as recommended by the manufacturer. Slowly turns up and adjust the dials to find the stimulation pattern near the electrodes and do the procedure.

Advantages:

1. It is non invasive and safe.
2. It can be used to achieve anaesthesia in tryphanophobic patients in small procedures like minor extractions, restorations and pulp therapy.
3. There is no lingering post operative anaesthesia compared to local anaesthesia because its anaesthetic effect will go when the unit is turned off.
4. Patient can administer TENS treatment by himself and can titrate dosages according to his/her pain threshold. As a result of this, patient acceptance is more for this technique.

Disadvantages:

1. It cannot replace local anaesthesia in most of the cases.
2. It can also be used as an adjunct to control the pain during various dental procedures.

Munshi et al in 2000 used TENS for the management of pain during treatment procedures such as minor extractions, restorations and pulp therapy in children between the age of 5-12 years and found significantly favoured results²⁶. **Dhindsa et al 2011** compared efficacy of TENS with 2% lignocaine in reducing pain during extraction, cavity preparation, pulpotomy and pulpectomy of deciduous teeth and concluded that TENS can be a useful adjunct in pediatric patients in achieving anaesthesia²⁷.

2)Jet injection

Jet injection technology has been around in medical fields for many years. It was introduced by John. F. Roberts in the year 1933. The first dental study using needless jet injector was reported by Margetis et al in the year 1958²⁸ Its clinical usage is limited compared to other technology. But still this needle free technology has reported to reduce anxiety and fear while using in pediatric patients.

Indications:

1. It is commonly used in pediatric patients and it is reported with high success rate.
2. Increased anaesthetic effect in children as they have less bone density.
3. It is used for vasoconstriction or post-operative analgesia after oral surgical procedures.
4. It is indicated for nasopalatine and greater palatine block.
5. It is used for mass vaccination.
6. It is indicated in cases where we need surface and pulpal anaesthesia.

Contraindications :

1. It is relatively contraindicated in epileptic patients as it creates sudden noise and pressure during the delivery of anaesthesia.
2. It is contraindicated in quadrants where want to replace local anaesthesia with jet injection.

Mechanism of action:

The basic principle of this injection is “if a high enough pressure can be generated by a fluid in intimate contact with the skin, then the liquid will punch a hole in to the skin and be delivered in to the tissues in and under the skin”²⁹. The mechanism is as shown in the (Fig 20).It uses mechanical energy source to create sufficient pressure which when released push a dose of liquid medication through a small orifice. When the knob of the device is pressed, it releases air pressure which produces a fine jet solution which penetrates the mucosa through a small puncture to produce surface anaesthesia.

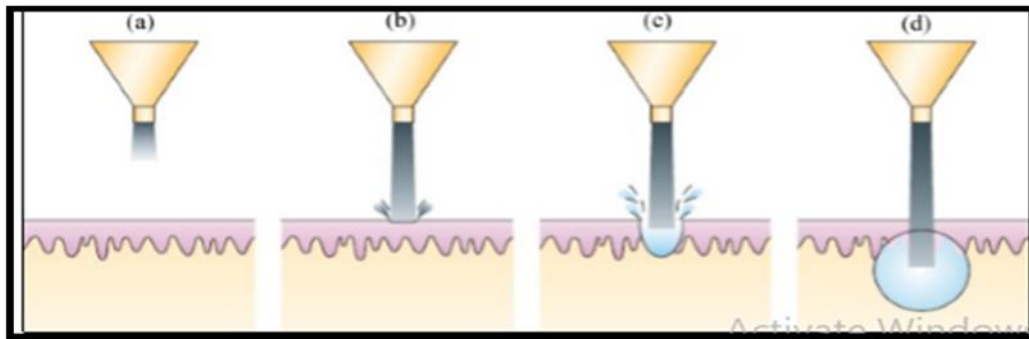


Fig 20:-Mechanism of Jet injectors.

Advantages:

1. •It is easy to use
2. •No needle stick injury
3. •Patient acceptance is more because it is needless
4. •It causes less tissue damage.
5. •Less chances of infection at the site.
6. •Faster drug absorption
7. •Autoclavable
8. •Self-administration is feasible with needle free injections

Disadvantages

1. •Initial cost of equipment
2. •Little bleeding at the site of injection
3. •Popping sound during injection may make the patient uncomfortable.
4. •Difficulty in positioning the device and the need for close tissue contact during deposition of solution in the posterior region especially in the case of injex device

Trade names:

Syrijet, Med-Jet H III

a) Syrijet:

It was introduced by Keystone industries Cherry Hill, NJ USA (Fig21). Even though it has been on the market for nearly 40 years, some minor improvements have been made in the recent years²⁰. It is the most widely used jet injector in dentistry and it is especially used by pedodontist.

It has a nozzle pressure of 2000 pounds per square inch which when turned on provides penetration of anaesthetic solution and can penetrate to a depth of 1 cm with a quantity upto 0.2ml/ injection. It uses the standard 1.8 ml cartridges of local anaesthetic solution. It ensures sterility of solution and is completely autoclavable.

b)MED-JET III

It was launched in 2011 by medical international technologies, Montreal, QC, Canada(Fig22). This is a latest development in jet injection technology. This device can direct the anaesthetic solution through a small orifice 7 times smaller than the smallest available needle in the world. Head of device is placed firmly against the mucosa and when the trigger is released, solution passes through the mucosa to produce anaesthesia. With the help of this device, intradermal, subcutaneous, intramuscular with a volume of 0.01 to 1 cc at 2000 psi can be given. It can render painless anaesthesia and is ideal for nasopalatine and greater palatine injection. Moreover, depth of penetration can be adjusted mechanically. This system is unique in its ability to render anaesthesia without compromising accuracy and ensures patient comfort, environmental safety and user affordability



Fig 21:-Syrijet



Fig 22:-Med Jet III

To date, the effectiveness of jet injection technology in dentistry has been reported to be limited. Controlled studies evaluating the efficacy are lacking and reports are primarily anecdotal. Nikolaos et al in 2010 compared the acceptance, preference and efficacy between jet injection and local infiltration anaesthesia in 6-11 year old patients and found that traditional infiltration was more effective, acceptable and preferred compared to the jet injection³⁰.

3)Computer controlled local anaesthetic delivery system (C-CLAD)**Indications:**

1. It can be used in pediatric patients as it renders painless anaesthesia by administering small amount of anaesthetic solution at slow speed.
2. It can be equally indicated in adult patients to produce anaesthetic effects during pulp capping, endodontic procedures, extractions.
3. It is indicated for delivery painless palatine injections.

Contraindications:

1. It is relatively contraindicated in highly apprehensive patients as they might get anxiety on seeing the bulky set up.
2. Contraindicated in intellectually disabled children as its methods are highly technique sensitive.

Mechanism of action:

The core technology is an automatic delivery of local anaesthetic solution at a fixed pressure:volume ratio regardless of variation in tissue resistance. This results in a controlled, highly effective and comfortable injection even in resilient tissue such as palate. (Ram et al 2002)³¹

Trade names:

CompuDent, Comfort control syringe, Single tooth anaesthesia, Quick sleeper, Sleeper one.

a) CompuDent/Wand

Computer controlled local anaesthetic system or simply C-CLAD was introduced by Milestone Scientific in United states in 1997³². It was originally known as Wand. Later on, subsequent versions were introduced in the market as Wand Plus and then CompuDent the current designation. (Fig 23). It consists of a base unit, hand piece and foot pedal. The hand piece is an ultra light –pen like handle in which a conventional anaesthetic cartridge is fixed. It has got a base unit which contains microprocessor which controls a piston that expresses local anaesthetic by pushing the local anaesthetic plunger up into the cartridge. The solution is forced through the micropore tubing of the handpiece which is controlled by computer control unit. Upon activation of foot pedal, rate of injection can be controlled. There are three modes of flow rate available namely slow, fast and turbo speed.

Advantages:-

1. Good alternative to administer small quantities of anaesthetic solution continuously during needle insertion, which anaesthetize the tissue immediately ahead of the advancing needle.
2. Precise control of flow rate of anaesthetic solution.
3. Increased tactile “feel” and ergonomics from the light weight handpiece.
4. Non threatening to patient.
5. Automatic aspiration enabled in the needle prevents inadvertent intravascular injection.



Fig 23:-CompuDent

6. Reduced force is required for needle insertion and this makes the patient more comfortable.
7. Ability to rotate handpiece back and forth during needle insertion to avoid needle deflections
8. Ability to perform newer techniques such as anterior middle superior nerve block, periodontal ligament infiltration, palatal approach to anterior superior alveolar block.
9. Better tolerated by pediatric patients and less disruptive behavior is observed while doing pulp therapies and extractions.

Disadvantages:

1. High cost

b) Comfort Control Syringe

It was introduced by Dentsply International, York, PA, USA in 2001³³. It is believed to be an alternative to Wand. It is an electronic, pre-programmed anaesthetic delivery device with two stage delivery system. It differed from Wand by absence of foot pedal. (Fig 24)



Fig 24:-Comfort control syringe

It has got two components – a base unit and a syringe. The unit uses a two stage delivery rate for every injection. Initially, anaesthetic rate will be slow and after ten seconds, the rate slowly increases to the pre-programmed value for the selected injection. According to desired injection techniques like block, infiltration, PDL, intraosseous and palatal, the pre-programmed speeds can be selected by the push of a button. Injection and aspiration can be controlled directly from syringe.

Advantages:

1. Easy to see exactly how much local anaesthetic solution has been dispensed just like in a manual syringe.
2. Familiar syringe type of delivery system.
3. Easily accessible means of anaesthetic solution delivery system which can be customised according to our need.
4. Inexpensive disposables.
5. Less costly than other C-CLADs

Disadvantages:

1. Syringe is bulky
2. Technique sensitive

c) Single Tooth Anaesthesia System (STA)

It is the newest dental computer controlled local anaesthetic delivery system. It was introduced by Milestone Scientific Inc, Livingston, NJ, USA in 2007³². In addition to the computer controlled, it uses vibration technology to decrease the pain. This device also incorporates dynamic pressure –sensing technology that provides a constant monitoring of the exit pressure of the local anaesthetic solution. It is a computerised unit consists of foot control, cartridge holder, tube. Cartridge contains the anaesthetic, foot control drives a plunger rod into the local anaesthetic cartridge at slow speed and the tube connects the unit to a hand piece with a very tiny needle. (Fig 25) Upon activation of foot control, anaesthetic solution will slowly released through the needle. The rate of injection can be selected from the computerised unit.

Advantages:-

1. This system can be utilised for all traditional intraoral injection techniques.
2. Dynamic pressure sensing technology system incorporated provides constant monitoring of the exit pressure of local anaesthetic solution during all phases of drug administration.
3. Dynamic Pressure Sensing technology system provides confirmation that the needle tip is in the desired location and has not moved outside the working area during drug administration by audible tones, visual displays and spoken alerts³³.
4. A greater volume of anaesthetic solution can be administered with increased comfort and less tissue damage.
5. The cartridge holder, tube and “Wand” handpiece are all single use disposables and this ensures good sterilisation and prevents cross infection



Fig 25:-STA

Disadvantages

1. Expensive both in maintenance and purchasing
2. Larger volume of hazardous waste is seen since cartridge holder, tube, handpiece are disposables.
3. It takes longer than standard injection.
4. Bulky instrument.

d)Quick Sleeper

It was introduced by Dental Hi Tec, Cholet, France in 2011³⁴. It was introduced as an alternative for Wand. After the acceptance of Quick Sleeper, newest model Quick Sleeper S4 which is 40% lighter and 19% reduced in diameter compared to previous models is also introduced in the market³⁵.(fig 26)

It consists of hand piece with a grip, a control unit, a foot pedal and a permanent analysis of resistance system.



Fig 26:-Quick Sleeper

First of all, unscrew the cap which is incorporated on the hand piece. It has a double foot pedal which separately activates the slow injection of anaesthesia solution and rotation of needle touching the bone. Three step of anaesthesia can be performed by this device namely anaesthesia of mucosa, computerized rotation of needle distal to tooth in question enables easy penetration to the cancellous bone and computerized injection of anaesthetic solution³⁶. Quantities of anaesthetic solution injected can be directly viewed all over the hand piece.

Advantages:

1. It can be used for all dental procedures.
2. It provides less painful anaesthesia
3. It enables us to anaesthetize a single tooth or several teeth with small amounts of anaesthetic solution.
4. Numbness of lips, tongue or cheek does not occur, only the tooth in question becomes completely sensation free.
5. Onset of anaesthesia is immediate.
6. The permanent analysis of resistance system ensures the operator to work smoothly despite of the density of the infiltrated tissue and without exerting much muscular effort³⁵.
7. There is a provision of palatal, lingual as well as buccal anaesthesia with a single needle penetration.
8. All of its accessories are autoclavable.

Disadvantages:

1. Additional application time compared to conventional anaesthetic methods.
2. Shortened duration of anaesthesia

3. Ideal in short lasting , non surgical procedure
4. Inadequate for extraction of lower third molars. This may be due to variability of bone density and duration of operation.

Sleeper One

It was introduced by Dental Hi Tec, Cholet, France³⁴. The design of this device is similar to Quicksleeper. (fig 27)



Fig 27:- Sleeper one

This anaesthetic system composed of a pen grip hand piece, a control unit, a foot pedal and permanent analysis of resistance system. A recapping system is incorporated on the handpiece holder to prevent accidental prick. Upon the activation of foot pedal, the anaesthetic solution slowly releases through the needle. The use of DHT Needles* with their bevel cut like a scalpel blade enable you to penetrate into every type of tissue easily, without effort, without twisting and without pain³⁴. This device does not feature a rotating needle and therefore it excludes transcortical and osteocentral use.

Advantages:

1. Highly efficient for periodontal injections, intraseptal, infiltration, nerve block and palatal infiltration anaesthesia.
2. Lightest handpiece makes the operator to hold comfortably and the pen like appearance is helpful to use in front of pediatric patients.
3. All of its accessories are autoclavable

Krochak and Friedman in 1998 noted decreased anxiety in subjects given Wand injections compared to traditional methods³⁷. Versloot et al 2005 reported that C-CLAD devices lost their benefits in highly anxious children because of their fear of treatment overwhelmed by technique sensitive methods³⁸. Varun salgotra et al in 2014 reported that even though there are contraindicatory studies about C-CLAD system, it appeared to be painless in comparison to conventional injection³⁹

4. Vibrotactile devices

Pain relief by vibratory stimulation is a potential method for the relief of pain. It is one of the several non-pharmacological technique used to reduce pain. The technique of pinching and shaking the cheek has been followed to distract the brain from the discomfort of the anaesthetic shot has been used. The same concept has been used in the case of vibrotactile devices by producing vibration in the tissue adjacent to injection site.

Indications:

1. It is indicated in pediatric patients as distraction and pain reduction created by vibrating massages can be helpful in reducing sensation of needle administration.
2. Indicated in cases where topical anaesthesia is undesirable (due to taste or allergy) or simply insufficient for relieving pain.

Contraindications:

1. Contraindicated in epileptic patients.
2. In severe neurological disorder patient
3. In the areas we need profound anaesthesia as it can be used as an adjunct with anaesthetic method.

Mechanism of action:

Analgesic effect of vibrotactile devices can be explained on the basis of :

Gate control theory: The gate control theory proposed by Melzack and Wall in 1965 suggested that pain experience can be reduced by activation of nerve fibres that conduct non-noxious stimuli²⁵. This theory stated that

stimulation of large diameter A beta fibres can close a neural gate to nociceptive signals and consequently reduce the perception of pain. This proposal has been conceptualised in vibrotactile devices by producing vibration in tissue adjacent to injection site.

Aminabadi et al (2008) indicated that counter stimulation reduces pain perception. They concluded that when vibration is applied as a counter stimulation to an anaesthetic injection it will reach the brain before the pain sensation does and the brain can perceive only one sensation at a time. Therefore, the sensation that arrives at the brain first is the one that will be felt⁴⁰.

Advantages:

1. Decreases the fear and anxiety of needle administration especially in pediatric patients.
2. It is easy to use.

Disadvantages:

1. Expensive
2. Sometimes vibration make the patient uncomfortable.

Devices which work on this concept:

Currently, there are four vibrotactile devices available in market. They are VibraJect, DentalVibe, Accupal and Single tooth anaesthesia. Among this, single tooth anaesthesia uses both computer controlled and vibrational technology whereas rest are purely relying on vibrations. A fifth device, syringe micro vibrator is ready to be introduced.

a) Vibraject:

It was introduced in 2002 by Miltex Inc, York, PA²⁰ It reduces pain from dreaded dental injection by vibration. It is a miniature vibrator that snaps onto a dental syringe. (Fig 28) It is a small battery operated attachment that snaps on to the standard dental syringe. The VibraJect clips directly onto any conventional syringe and it can be positioned at any point of the syringe. The battery cap has to be twisted to start the vibration. It delivers a slight vibration to the needle that is strong enough for the patient to feel when the knob is turn clockwise. Once it is on, we can proceed with the normal injection techniques.

Advantages:

1. It is a quick and effective non-drug topical dental anaesthesia device .
2. It does not require any additional training.
3. It reduces the pain and anxiety that occur during needle administration.
4. It produces less painful palatal injection because it delivers small amounts of anaesthetic solution over a period of time.
5. Clip that attaches to the syringe part is autoclavable.



Fig 28:-Vibraject

Disadvantages :

1. It is not a substitute for dental local anaesthesia.
2. Expensive
3. Needle is visible, so it will not reduce the anxiety especially in pediatric patients.

Dental Vibe

It is a recently introduced cordless vibrotactile device. The inventor, Dr. Steven Goldberg designed this device in 2008. The BING Innovations LLC, crystal Lake IL, USA is marketing the device now (www.dentalvibe.com)^{41,42}. It is a cordless, rechargeable, hand held injection system, having an U-shaped vibrating tip attached to a microprocessor-controlled Vibra Pulse motor. (fig 29)



Fig 29:-Dental vibe

The device delivers a pulsed, percussive vibration with enhanced amplitude which gently taps the mucosa in a synchronised but changing pattern when it is switched on. It has got illuminated tip for improved visibility in oral cavity. It has an attachment to retract lip and cheek. To get vibration, the anaesthetic tip is applied first to the injection site and then dental syringe with anaesthetic solution is administered in the vibrated zone.

Advantages:

1. It provides effective pain reduction during the administration of anaesthesia.
2. Dental Vibe looks like a mirror and as the needle is not integrated to the device, it is easy to use in pediatric patients.
3. It can be used with any anaesthetic syringe to deliver comfortable injections in all areas of the mouth.
4. As it produces microvibration, it is found to be more effective than VibraJect.
5. It is effective for pediatric patients and those who have a phobia of intraoral injection as an audible proprioceptive distraction (70-75 db) is provided here. (Shilpapiya et al 2015)⁴²
6. This apparatus makes the tissue to be vibrated first before the needle penetration.
7. The comfort tip provides gentle massaging of the injection site through Vibra-pulse Technology and prevents a swelling of the bolus of the anaesthetic solutions as it is injected.

Disadvantages:

1. Expensive
2. As this is available as a separate unit and not attached to the syringe, both hands have to be engaged with this technique.
3. It cannot be autoclaved, only the tips are disposable.

Accupal

Accupal is a recently introduced vibrotactile device by Accupal, Hot springs, AR, USA²⁰. The master brain behind this device is Michael Zweifler. It is a cordless device that uses both pressure and vibration to precondition the oral mucosa. The device has a hole headed slot which is attached to motor (fig 30). The needle is placed through a hole in the head of the disposable tip. When applied to the required area, the head vibrates and illuminates. Through the needle which is placed through a hole in the head, anaesthetic solution can be given. The company has recently expanded its product with I/A model designed for inferior alveolar nerve blocks. In the new variant, specialised tip is designed for mandibular injections.



Fig 30:-Accupal

Advantages:

1. The ultrasonic tissue stimulation vibrates the tissue injection site and reduces the needle's pain-producing effects.

2. It ensures the clinician to insert the needle bevel at its narrowest point, which provides the most minimally invasive path possible and reduced tissue damage to deliver a comfortable palatal injection every time.(www.accupal.com)⁴³
3. Specially designed to reduce the pain during palatal injection.

Disadvantages:

1. High cost.
2. As it is available as a separate unit, both hands have to be engaged with this technique

d) Syringe Micro Vibrator

It is a new design being introduced in the field of dentistry. It is registered as an invention in the field of dentistry and received Iran National Patent number of 63765. (Bonjar 2011)¹. Its structural part consists of stainless steel bearing four flexible attachment arms, eccentrically weighted plate and motor and two button batteries. For to get vibration, the motor is turned on by turning in clockwise direction. Its parallel mounting on the dental syringe, as shown in the fig 31, allows the clinician to rotate the syringe while in the mouth if necessary. After that, the normal injection techniques can be done.

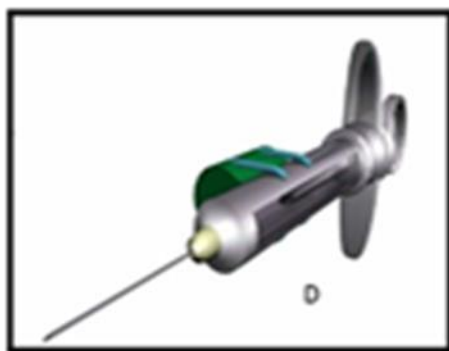


Fig 31:-Syringe microvibrator on syringe

Advantages over VibraJect

1. Firm grasping
2. Efficient vibration conveyance
3. Applicable to all standard conventional syringes.
4. Least clinician vision masking.
5. Yield of uniform micro vibration, more precise localisation of injection point
6. Efficiently enhance patient pain reduction and accuracy during injection.

Research regarding the effectiveness of VibraJect is mixed. **Yoshikwa et al 2003** and **Saijo et al 2005** reported no significant pain reduction compared to the conventional dental syringe^{44,45}. **Naintos et al 2009** compared the injection technique with & without vibration in adult patients and concluded that vibration can be used to decrease pain during injection⁴⁶.

Intraosseous anaesthetic system

The intraosseous technique has been used in clinical dentistry for over a century. The original technique was too invasive. It requires elevation of gingival flap in order to gain access to buccal cortical bone for perforation with a small round bur. Even though, its importance declined after the introduction of lidocaine in 1940's, **Lilienthal** in 1975 described a technique in which he used a handpiece- driven root canal reamer to perforate the cortical plate³². This was considered to be the first modern technique of intraosseous anaesthesia and laid the foundation upon which all current methods are based.

Indications:

1. Indicated in procedures where we need enhanced deep pulpal anaesthesia
2. Excellent for patients with the classic "hot tooth"(irreversible pulpitis cases)⁷

Contraindications:

Intraosseous injection of solutions containing epinephrine or levonordefrin should be limited or avoided in patients with significant cardiac disease

Advantages :

1. Intraosseous injection is reported to be efficient, effective and preferred by most patients for conservative treatment to provide pulpal anaesthesia in patients with irreversible pulpitis or hypersensitive teeth.
2. It provides fast, comfortable onset of anaesthesia.
3. Avoids numbness of soft tissue anaesthesia.
4. It significantly enhances pulpal anaesthesia after inferior alveolar nerve block in endodontic pain patients by delivering high doses closer to apex.
5. Additional palatal injections are not needed if intraosseous anaesthesia is given anaesthetises .
6. It can be used as a supplemental anaesthesia for to control the pain during various dental procedures especially to treat irreversible pulpitis cases
7. In pediatric dentistry, this technique is well accepted and works adequately as the intercrestal bone is thinner in children and the cancellous bone is more sparse. Moreover, injection can be given with minimal pressure.
8. Computer controlled local anaesthetic delivery system when delivered intraosseous injection shows higher success rate, easy administration, fast onset, significant patient comfort and duration long enough for endodontic treatment.

Disadvantages:

While carrying out the procedures in mandible, intraosseous anaesthesia has reported with some adverse reactions like increase in heart rate, injection pressure discomfort and post operative tenderness. But according to Malamed, these complications can be avoided with correct positioning of needle and avoidance of excessive injection pressure³.

Available devices are :

Stabident, X-Tip, Intra Flow

Stabident :

The Stabident system, first arrived in market in United Kingdom in February 1991. It was introduced by Fairfax Dental Inc, Miami, FL, USA²⁰.

Stabident system composed of perforator and a solid stainless steel injection needle (fig32) with a bevelled end that when activated, drills a small hole through the cortical plate. The anaesthetic solution is delivered to cancellous bone through the needle. A protective cap is enclosed over the needle of the perforator. In case of repeated injection, ultra short needle is used to facilitate the re-insertion of needle into opening made by perforator. Typical insertion point is on attached gingiva 2 mm below gingival margin and midway between the tooth of interest and an immediately adjacent, preferably distal to tooth.

The steps for intraosseous technique is depicted in the following figures 33

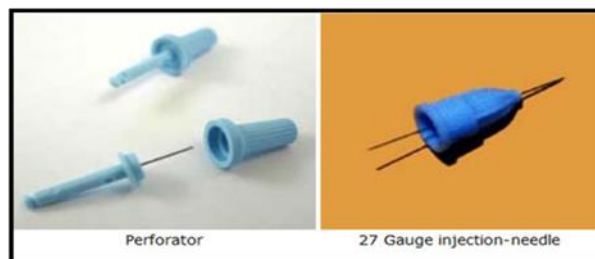


Fig 32:-Parts of Stabident

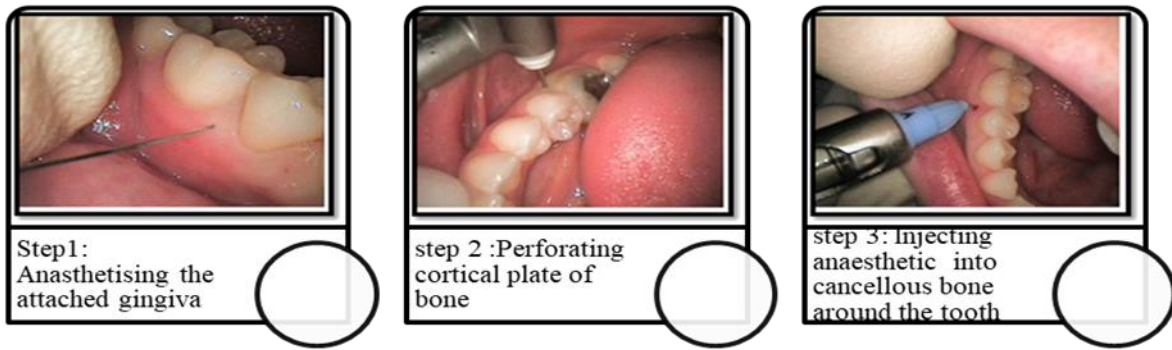


Fig 33:-Steps in Stabident administration

Advantages:

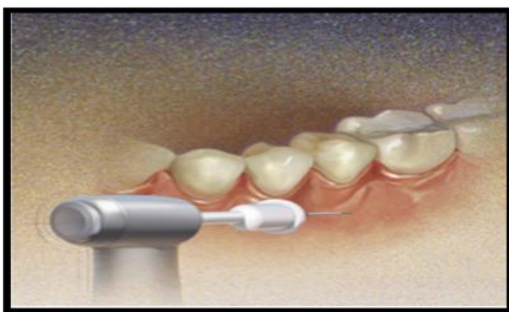
- It is inexpensive .
- It can be used with equipment already existing in a dental office, that is a slow speed hand piece with a latch contra angle for the perforator and a standard dental anaesthetic syringe for the needle.
- This is an easy technique which give quick result.
- Avoids numbness of soft tissue.

Disadvantages:

- It can be used only in visible and readily accessible area.
- The difficult part of this injection is to find the hole left in the bone from the perforator.
- Multiple step procedure.

b)X-Tip :

The X-Tip anaesthetic system was designed by Dentsply International Inc, Tulsa, OK, USA by Michael Feldman in September 2010. It was introduced in order to eliminate the weakness of Stabident²⁰The X-Tip system consists of three parts : the drill (perforator), a 25-gauge guide sleeve that fits over the 27-gauge drill and an ultra short needle of same diameter. The drill leads the guide sleeve through the cortical plate into cancellous bone. The drill portion can then be removed, leaving the guide sleeve in place. This guide sleeve can direct the needle into cancellous bone to deposit the anaesthetic solution. The steps are depicted in fig 34. The penetration need not to be performed through the attached gingiva. The guide sleeve after the administration of anaesthetic solution, must be removed carefully with a hemostat



Step 1 :Drill and hand piece in place



Step2: separation of drill & guide sleeve



Step 3 :Administration of anaesthetic through guide sleeve

Fig 34:-Steps in X-Tip anaesthetic system

Advantages :

- The guide sleeve remains in place to identify the perforation location for needle placement which is not possible in Stabident system.
- X-Tip does not require additional specialized equipment
- Compared to Stabident, it provides profound anaesthesia.

Disadvantages:

- Sometimes, drill and guide sleeve remain stuck together after perforation and while removing the drill, guide sleeve also comes out of the sleeve.
- X-Tip finds to be more difficult to perforate thick or dense bone in the posterior mandible.
- Multiple step procedure.
- Due to the X-Tip's wider diameter of drill and guide sleeve, it may contribute increased heat formation and post operative pain (Guglielmo et al 1999)⁴⁷.

c)Intraflow

The IntraFlow Anaesthetic system is designed by Pro –Dex Medical devices, Irvine, CA, USA^{15,48}. It is one of the latest technology in intraosseous system. The IntraFlow system combines the two procedures like perforation and injection via a sophisticated handpiece design. The IntraFlow device (Fig35) composed of four components. The handpiece with a seat for the anaesthetic carpule and quick disconnect: a rheostat and a coupling. The head attachment, perforator which is 24 gauge hollow stainless steel needle and a transfuser which consists of ABS shell and slider with 20-gauge stainless steel cannula attaches to the head attachment and carries solution from the standard 1.8ml dental cartridge to the perforator.

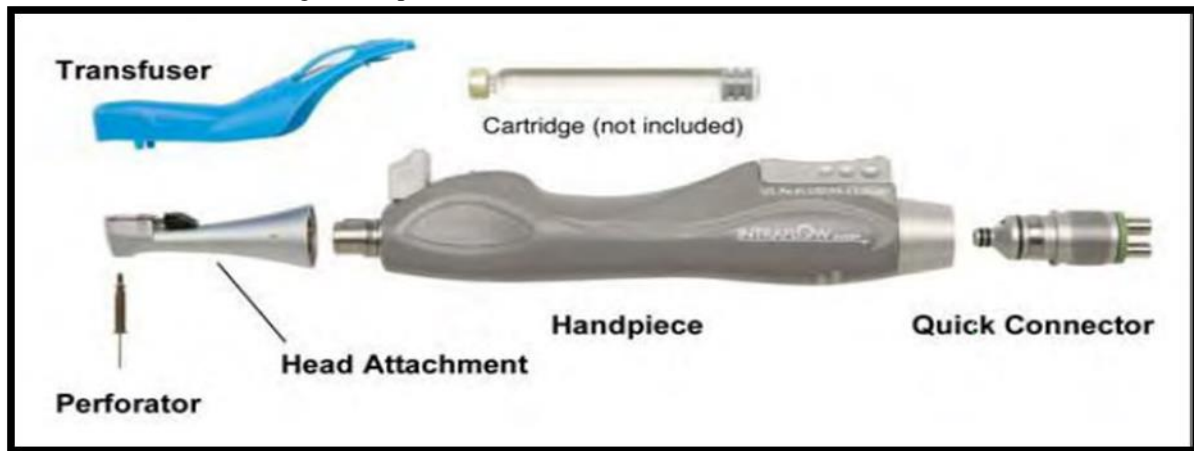


Fig 35:-Components of Intraflow system

After assembling the device, the rheostat is depressed at full speed and the perforator is pushed through the gingiva, cortex and cancellous spaces⁴⁸. To carry out the injection, the rheostat is depressed again lightly. All these procedures are done in one step only.

Advantages:

- It is simple, one-step technique .
- The single step procedure is helpful in penetrating the zones that are difficult to access which other intraosseous system cannot do.
- It provides immediate pain relief and profound pulpal anesthesia in about one minute.
- No lingering numbness to the cheek, lips or tongue
- Dentist can work in multiple quadrants during a single visit and it is time saving.

Disadvantages:

- It is not cost effective. Start up and maintenance costs are really high.
- If the device is not assembled properly, it may leads to leakage of anaesthetic solution.
- Studies are presently in progress to review the efficacy of this device.

Nussteinet et al in 2003 concluded that X-Tip supplemental intraosseous injection in patients with irreversible pulpitis provides profound pulpal anaesthesia when compared to conventional inferior alveolar nerve block alone⁴⁹. **Gallatin et al in 2003** reported that primary injection with Stabident intraosseous injection system and primary X-Tip intraosseous injection system were similar regarding the anaesthetic success in mandibular posterior teeth but find higher incidence of post operative swelling⁵⁰. **Reemers et al in 2008** reported that Intraflow system is a primary technique which provide reliable anaesthesia of posterior mandible teeth compared to injectable inferior alveolar nerve block⁵¹.

Conclusion:-

To raise new questions, new possibilities and to deal old problems from new angle requires creative imagination and real advance in science. In recent years, we have seen technology advancing at lighting speed, allowing us to accomplish lifesaving feats never imagined before. The same advancements is reflecting in each segments in dentistry. Painless treatment is always an integral element of quality pediatric dental care. Dentistry is fortunate in possessing an abundance of excellent agents, techniques for the relief of perioperative and post operative pain. As someone said "Opportunities dances with those already on the dance floor". So the modern day dentist has the responsibility of knowing the variety of anaesthetic devices and techniques. When the goal of painless anaesthesia is achieved, dentist obtains satisfaction and the patient will be happier with the improved quality of care. The availability and cost factors are not the excuses to adapt newer proven methods when the benefits outweigh the shortcomings. This review widens up the scope of recent advances in local anaesthetic solutions, topical anaesthesia and the various delivery techniques which can be applied to pediatric as well as in adult patients.

References:-

1. Shahidi Bonjar. Syringe micro vibrator (SMV) a new device being introduced in dentistry to alleviate pain and anxiety of intraoral injections, and a comparative study with a similar device. *Annals of Surgical Innovation and Research* 2011;5(1):1-5
2. Lee. Recent advances in topical anaesthesia. *Journal of Dental anaesthesia Pain medicine* 2016 Dec; 16 (4): 237-244
3. Stanley F Malamed; *Handbook of Local Anaesthesia* by Malamed.6th edition St.Louis (MO): Elsevier;2013.
4. Dubey A, Singh BD, Pagaria S, Avinash A. The Wand: A mini review of an advanced technique for local anaesthesia delivery in dentistry. *American Journal of Advanced Drug delivery*. 2014; 001-006
5. C.Richard Benett. *Monheim's Local anaesthesia and pain control in dental practice* 7th edition .
6. Mritunjay Kumar, Rajiv Chawla, Manish Goyal. Topical anesthesia. *Journal of Anaesthesiology Clinical Pharmacology*;2015 October-December;31(4):450-456
7. Boyce R, Kripalani T, Mohan N. Updates of topical and local anaesthesia gaents. *Dent Clin N Am* 2016 April 1; 60(2) : 445-471
8. Sujatha Tadicherla, Brian Berman. Percutaneous dermal drug delivery for local pain control. *Therapeutics and Clinical Risk Management* 2006;2(1): 99–113.
9. Alireza Daneshkazemi, Seyyed Mohammed, Pedram Daneshkazemi. Efficacy of eutectic mixture of local anaesthesia as a topical anaesthetic agent used for dental procedure:A brief review.*Anesth essays Res* 2016 Sep-Dec; 10(3): 383-387.

10. Friedman PM, Mafong EA, Friedman ES, Geronemus RG. Topical anesthetics update: EMLA and beyond. *Dermatol Surg* 2001Dec; 27(12):1019-1026.
11. Kwong TS, Kusnoto B, Viana G, Evans CA, Watanabe K. The effectiveness of Oraqix versus TAC(a) for placement of orthodontic temporary anchorage devices. *Angle Orthod* 2011May 12; 81(5): 754-759.
12. Garima Lathwal, Inder Kumar Pandit, Neeraj Gugnani, Monika Gupta. Efficacy of Different Precooling Agents and Topical Anesthetics on the Pain Perception during Intraoral Injection: A Comparative Clinical Study *International Journal of Clinical Pediatric Dentistry*, May-August 2015;8(2):119-122
13. Iqra Mohiuddin, Jyothsna V. Setty , Ila Srinivasan, Junaid Ahmed Desai. Topical application of local anaesthetic gel vs ice in pediatric patients for infiltration anaesthesia. *J of evolution of Med & Dent Sci* 2015 Sep;4(74):12934-12940
14. Nithasha N Hameed, Sharan S Sargod, Sham S Bhat, Sundeep K Hegde, Muhsin Mohammed Bava. Effectiveness of precooling the injection site using tetrafluoroethane on pain perception in children. *Journal of Indian Society of Pedodontics and Preventive Dentistry*2018 July-September; 36(3): 296-300
15. Naser Asl Aminabadi. The Effect of Pre-cooling the Injection Site on Pediatric Pain Perception during the Administration of Local Anesthesia *The Journal of Contemporary Dental Practice* 2009 May;10(3):043-050
16. Priyatham S, Nuvvula S. Intraoral Topical anaesthesia in pediatric dentistry;Review. *Int J Pharm Bio Sci* 2016 Oct; 7(4):346-353
17. Dr Sharma S, Dr Sharma A, Dr Saravanan C, Dr Satyabhama. Newer local anaesthetic drugs and delivery systems in dentistry-An update. *Journal of Dental and Medical Sciences*. 2012 Sep-Oct; 1(4):10-16
18. Ghose S, Biswas NR, Das GK, Sethi A, Verma B, Jhingan S, Pandey RM – A prospective Randomised double masked controlled clinical trial to determine the efficacy of multiple drop Centbucridine as an ocular surface anaesthetic. *Indian J Physiol Pharmacol* 2004 Oct;48(4):466-470
19. Vacharajani GN, Parikh N, Paul T, Satoskar RS – A comparative study of Centbucridine and lidocaine in Dental Extraction. *Int J ClinPharmacol Res* 1983;3(4):251-255
20. Ogle O, Mahjoubi G. Advances in local anesthesia in dentistry. *Dent Clin N Am* 2011July 1; 55(3):481-499
21. Tavares M, Max Goodson J, Studen Pavlovich D. Reversal of soft tissue local anaesthesia with phentolamine mesylate in pediatric patients. *J Am Dent Assoc* 2008; 139(8):1095- 1104
22. Logithetis D. Anaesthetic Buffering: New Advances for use in dentistry *RDH* 2013 Jan;62-66
23. <http://www.onpharma.com>. Accessed on 2018
24. Quarnstorm F. Electronic Dental Anaesthesia. *Anesth Prog* 1992 39(4-5): 162-177
25. Kasat V, Gupta A, Ruchi L, Kathariya M, Saluja H, Farooqi A. *J Clin Exp Dent*.2014; 6(15):562-568
26. Munshi AK, Hegde AM, Girdhar D. Clinical evaluation of electronic dental anesthesia for various procedures in pediatric dentistry. *J Clin Pediatr Dent*. 2000; 24(3):199-204
27. Dhindsa A, Pandit IK, Srivastav N, Gugnani N. Comparative evaluation of the effectiveness of electronic dental anaesthesia with 2% lignocaine in various minor pediatric dental procedures: a clinical study. *Contemp Clin Dent*. 2011Jan;2(1):27-30.
28. Makade C, Shenoi P, Gunwal M. Comparison of acceptance, preference and efficacy between pressure pressure anaesthesia and classical needle infiltration anaesthesia for dental restorative procedures in adult patients. *Journal of Conservative dentistry*. 2014Mar-April;17(2):169-174
29. Kale TR, Momin M. Needle free injection technology-An overview. *Innovations in pharmacy*. 2014 Jan 1;5(1).
30. Arapostathis K, Dabarakis N, Coolidge T, Tsirlis A, Kotsanos N. Comparison of acceptance, preference and efficacy between jet injection INJEX and local infiltration anesthesia in 6-11 year old dental patients. *American Dental Society of Aneesthesiology* 2010 March;57(1):3-12
31. Ram D, Peretz B. Administering local anaesthesia to pediatric dental patients- current status and prospectus for the future. *International Journal of Pediatric Dentistry* 2002 March; 12(2):80-89
32. Clark T, Yagiela J. Advanced techniques and armamentarium for dental local anesthesia. *Dent Clin N Am* 2010 Oct; 54(4): 757-768
33. Kumar S. Newer delivery systems for local anaesthesia in dentistry. *J. Pharm.Sci & Res*.2015; 7(5):252-255
34. <http://www.dentalhitec.com>. Dental Hitec .User manual and clinical guideline. Cholet. France. Accessed on 2018
35. Tom K, Aps J. Intraosseous anaesthesia as a primary technique for local anaesthesia in dentistry. *Clin Res Infect Dis* 2015; 2(1):1012-1019
36. Sixon JL, Marie Cousin. Pain assessment y children and adolescent during intraosseous anaesthesia using computerized system (Quick sleeper). *Int. J. Pediatric Dent* 2009 Sep; 19(5):360-366
37. Krochak M, Friedman N. Using a precision metered injection system to minimize dental injection anxiety. *Compendium* 1998 Feb; 19(2):137-148

38. Versloot J, Veerkamp JS, Hougstraton J. Computerised anaesthesia delivery system versus traditional syringe: comparing pain and pain related behavior in children. *Eur J Oral Sci.* 2005; 113(6): 488-493
39. Salgotra V, Agrawal R, Mandal S, Kohli S. New gadgets in local anaesthesia: A review. *Journal of Dental and Medical sciences.* 2014 Mar;13(3):62-66
40. Aminabadi NA, Farahani RM, Balayi Gajan E. The efficacy of distraction and counterstimulation in the reduction of pain reaction to intraoral injection by pediatric patients. *Journal of Contemporary Dental Practice.* 2008;9(6):33-40
41. <http://www.dentalvibe.com>. Accessed on 2018
42. Mangalampally Shilpapiya, Mungara Jayanthi, Venumbaka Nilaya Reddy, Rajendra Sakthivel. Effectiveness of new vibration delivery system on pain associated with injection of local anaesthesia in children. *Jrnl of Indian Society of Pedodontics and Preventive dentistry* 2015; 33(3):173-76
43. <http://www.accupaldental.com>. Accessed on 2018
44. Yoshikawa F, Ushito D, Ohe D. Vibrating dental local anaesthesia attachment to reduce injection pain. *J. Jpn Dent Soc Anesthesiol* 2003; 31:194-95
45. Saijo M, Ito E, Ichinohe J . lack of pain reduction by a vibrating localanaesthetic attachment: A pilot study. *Anesth Prog* 2005; 52(2):62-64
46. Naintsos E, Vartuli A, Forte A. The effect of vibration on pain during local anaesthesia injection. *Aust Dent J* 2009; 54(2): 94-100
47. Guglielmo A, Reader A, Nist R et al. Anaesthetic efficacy and heart rate effects of the supplemental intraosseous injection of 2% mepivacaine with 1:20,000 levonordefrin. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1999;87(3):284-293
48. http://www.pro-dex.com./media/IntraFlow_manual_English.pdf .Accessed on 2018
49. John Nusstein, Shawn Kennedy, Mike Beck, Joelweaver. Anaesthetic efficacy of supplemental X-tip intraosseous injection in patients with irreversible pulpitis. *Journal of Endodontics.*2003Nov;29(11):724-728
50. Juliana Gallatin, Mika Beck. A comparison of two intraosseous techniques in mandibular posterior teeth. *Journal of American Dental Association* 2003 Nov; 34 (11):1476-1484
51. Todd Remmers, Gerald Glickman, Robert Spears, Jianing He. The efficacy of IntraFlow Intraosseous injection as a primary anaesthetic technique. *Journal of Endodontics.*2008 March; 34(3):280-283.