Review Article **Allied sciences**

International Journal of Pharma and Bio Sciences

ISSN 0975-6299

INTRAORAL TOPICAL ANAESTHESIA IN PEDIATRIC DENTISTRY: REVIEW

SUNNY PRIYATHAM*[1] AND SIVAKUMAR NUVVULA[1]

[1]Department of pedodontics, Narayana dental college, Nellore, Andhra pradesh, India.

ABSTRACT

Topical or surface anaesthesia is an important prerequisite for many pediatric dental procedures. Pediatric dentist/dentist should give serious thought to the type of topical and local anaesthesia administered before, during, and after the procedure. Depending on invasiveness of the dental procedure, it is imperative that the clinician choose the best anaesthesia for the job at hand. Clinician should be well versed with type, duration, quantity of topical anaesthesia to be administered in achieving maximum efficiency, without the risk of toxicity. The aim of this review is to provide an insight about topical anaesthetics and their application in various intraoral operative procedures with a special focus on applications in pediatric dentistry, including specific clinical recommendations.

KEYWORDS: **Children, Intraoral, Pediatric Dentistry, Topical Anaesthetics, Topical local anaesthetics.**

SUNNY PRIYATHAM
Department of pedodontics, Narayana dental college, Nellore, Andhra pradesh, India
dr.priyatham@gmail.com

***Corresponding Author**

INTRODUCTION

Topical anaesthetics, also termed as Topical local anaesthetics (TLA) are frequently used in dental practice to reduce acute and chronic pain as well as facilitate atraumatic dental treatment. TLA induces temporary loss of sensation on the applied surface up to a depth of 2-3mm.[1] TLA is an important prerequisite for many pediatric dental procedures such as needle penetration, scaling and root planing, mucosal punch biopsies, application of orthodontic appliances and rubber dam clamps, postsurgical pain, recurrent or chronic pain conditions associated with ulcers and atypical odontalgia.[2] Topical anaesthetics can be employed effectively wherever skin is no longer intact due to injury, also on the mucous membranes. Topical anaesthesia can be achieved by various methods and techniques.[1] Reviews on intraoral topical anesthetics in pediatric dentistry are lacking so this review was undertaken with the aim to provide an insight about topical anaesthetics and their application in various intraoral operative procedures with a special focus on applications in pediatric dentistry and their specific clinical recommendations.An advanced search using search terms “topical anaesthetics” and “dentistry” was carried out in PubMed database, based on which this review is composed.

TOPICAL ANAESTHESIA

Topical or surface anaesthesia is effective only on the surface tissues upto a depth of 2-3 mm and its efficiency depends upon many factors such as, chemical composition, solubility, percentage concentration, form in which it is given, delivery method, site of application, duration of application.(1)Various agents are available to produce topical anaesthesia at acceptable clinical concentrations, such as, lignocaine, benzocaine, dyclonine hydrochloride, which are available in various forms (Gel, spray, patch, liquid, ointment, cream). Compounded topical preparations (mixture of two or more agents) such Eutectic mixture of local anaesthesia (EMLA), Precaine (8% Lidocaine + 0.8% Dibucaine), TAC (tetracaine + adrenaline + cocaine), TAC alternate, XAP (xylo-adrenaline- phenylepinephrine), Cetacaine (benzocaine+ butyl aminobenzoate +tetracaine + benzalkonium chloride), phen-eph-let are also used in dentistry. Topical anaesthesia is effective when they are in contact with the applied site for a minimum duration of 2 minutes,[1]and lower duration of application might not produce desired clinical effect. This duration of application is different for different topical anaesthetics. Gill and Orr 1979 have demonstrated that, when topical anaesthetics are applied (approximately 10 to 15 seconds), their effectiveness is no greater than that of a placebo, especially for palatal injections.[3] Stern and Giddon 1975 showed that, application of a topical anaesthetic to mucous membrane for 2 to 3 minutes leads to profound soft tissue analgesia.[4] No direct proportional relationship is found between duration of application of topical anaesthesia and increased clinical effectiveness.[5] Based on their study they reported that, there is a reduction in the palatal injection prick pain on application of 5% lignocaine when applied for 2, 5 or 10 minutes application and there is no significant difference between 2, 5 or 10 minutes group. There is no direct proportional relationship between duration of topical anaesthetic application on its clinical efficiency.

ALTERNATIVES TO TOPICAL LOCAL ANAESTHESIA

Electronic dental anaesthesia (EDA), precooling, vibration, iontophoresis, and sonophoresis are some alternative techniques that can be used for producing topical/surface anaesthesia.

ELECTRONIC DENTAL ANAESTHESIA (EDA)

Electronic dental anaesthesia (EDA), previously known as transcutaneous electrical nerve stimulation (TENS) involves the application of high frequency electrical impulses around the tissues, where anaesthetic effect is required.[6] The EDA device is a modified TENS unit for intraoral dental use which delivers lower currents at higher frequencies.[7] EDA uses the Gate Control Theory of transcutaneous electrical nerve stimulation. Advantage of EDA is, it delivers electric currents to non-invasively block the dental pain transmission.[8] Bansal *et al.,* 2014 reported EDA by transcutaneous electrical nerve stimulation was better than conventional local anaesthesia in children in reduction of needle prick pain and hence, it can be used as an adjuvant in providing local anaesthesia to children.[9] EDA was also reported to reduce discomfort due to restorative procedures in children and was preferred by children over local anaesthetic injection.[7,10]

PRECOOLING (CRYO-ANAESTHESIA)

Cryo-anaesthesia is the application of cold to a localized part of the body in order to block the local nerve conduction of painful impulses. Cryo-anaesthesia may be induced either by the use of refrigerant sprays or with the use of ice. The main advantage of cryo-anaesthesia is it acts upon all the cells unlike topical anaesthesia, which acts only on nerve cells , hence, cryo-anaesthesia is reported to be much efficient than conventional topical anaesthesia.In children, cooling the injection site produced better results than topical anaesthetics (benzocaine) in relieving intraoral needle prick pain (infiltration and nerve blocks).[11-13] (Table-1).

TABLE 1
STUDIES ON PRE-COOLING/CRYO-ANAESTHESIA IN CHILDREN

SNO	AUTHOR-YEAR	INTERVENTION	RESULTS
1.	Lathwal *et al .,* 2015[12]	Children age 5-8 years. One minute ice cone vs 5 seconds refrigerant spray vs benzocaine for IANB and Greater palatine block.	Ice cone had shown significantly higher efficacy as compared to benzocaine and refrigerant.
2.	Ghaderi *et al .,* 2013[11]	Children age 8-10 years buccal infiltration (Benzocaine) on one side (control) for 1 min and topical anaesthetic agent plus one minute of ice pack on the other side	Cooling the injection site before infiltration of local anaesthetics in the buccal mucosa for 1 min, reduced pain perceived by pediatric patients.
3.	Aminabadi *et al.,* 2009[13]	Children aged 5-6 years of age. Benzocaine for 1 min followed by a 2-min application of ice before injection of local anaesthetics.	Pre-cooling of the soft tissues of an injection site prior to the administration of a local anaesthetic can minimize the discomfort and anxiety associated with the injection procedure

VIBRATION

Vibratory stimulus is a counter-stimulation, that relieves the pain experience or perception due to anaesthetic injection, it will reach the brain before the pain sensation does.[9] Mechanism of pain relief is attributed to gate control theory by Melzack and Wall. An important component of the theory is that, stimulation of the larger diameter A beta fibres (e.g., using appropriate pressure or vibration) can close a neural ‘‘gate’’ to nociceptive signals and consequently reduce the perception of pain. Vibration can cause pain relief by simultaneous activation of nerve fibres that conduct non-noxious stimuli. Shilpapriya et al., 2015 conducted a study on 6-12 years old children, to evaluate the efficacy of vibratory stimulus, using an instrument called Dental vibe in reducing pain and anxiety during local anaesthesia administration. Local anaesthetic administration with vibration resulted in significantly less pain, compared to the injections with the application of topical anaesthesia.[14]

LIPOSOMAL ENCAPSULATION

Incorporation of local anaesthetics into liposomes has been used as a means of increasing uptake. Liposomes are artificial membranes composed of lipid and aqueous layers similar in composition to biological membranes. The number of layers and the size of the liposome can be controlled depending upon the desired function. A unilamellar structure is ideal for delivery of a hydrophobic drug, whereas, a multilamellar structure with more aqueous phases is better for incorporation of hydrophilic drugs. Liposomes offer the following advantages compared to conventional topical delivery. Better tissue penetration, non-allergenic delivery vehicle, act as a depot for controlled release of drug, protection from metabolism, therefore, a longer lasting effect. Paphangkorakit *et al.,* 2012 reported that Liposome-encapsulated 2% lignocaine improved the efficacy of local anaesthetic. It was prepared by sonicating 2% lignocaine hydrochloride dental injection (with 1:100,000 adrenaline) with a lipid mixture using a dental ultrasonic scaler for 1 min.[15]

IONTOPHORESIS

Iontophoresis is a means of delivering local anaesthetics to the deeper tissue after topical application. Positively charged drugs such as, lignocaine and adrenaline can be encouraged to penetrate the tissue under the influence of electrical charge. Gangarosa 1974 described the successful use of iontophoresis with lignocaine and adrenaline as a means of extracting deciduous teeth.[16] The mouth electrode was constructed to fit over the tooth to be extracted and to surround the soft tissue around the tooth. The indifferent electrode is applied to the skin over the volar surface of the wrist, with the help of iontophoretic apparatus, a low-voltage direct current (0 and 3 ma). Extraction of loose deciduous teeth after iontophoretic application of local anaesthetics is a satisfactory procedure, if the tooth has minimal bony attachment and the deep mucosal anaesthesia obtained is adequate to eliminate discomfort. Patient acceptance of the procedure was high. No anxiety was evident at return appointments for further extractions by this method. Most of the teeth were extracted after the electrical current had been applied for ten minutes. It was found that epinephrine in ratios of 1:20,000 to 1:50,000 was satisfactory for prolonging the deep surface anaesthesia obtained by iontophoresis. Tharian *et al.,* 1994 reported successful extraction of deciduous teeth only by iontophoresis.[17] Patient satisfaction was observed when higher drug concentration was applied for a longer duration of time.

SPECIFIC CLINICAL RECOMONDATION OF TOPICAL ANAESTHESIA IN PEDIATRIC DENTISTRY

Diagnostic radiology

Zhang *et al.,* 2008 have reported that use of local anaesthetics (1% dyclonine and local cryo-anaesthesia) improves the accuracy, quality, and success rate in taking dental X-ray films.[18]

Teething pain

Traditionally topical anaesthetic preparations (benzocaine and lignocaine) were used extensively to alleviate discomfort due to teething in babies. In 2011, FDA warned that, using OTC benzocaine gels for

teething or mouth pain can cause a rare but serious condition called methemoglobinemia.[19, 20] This condition results in a large decrease in the amount of oxygen carried through the blood which is life-threatening and can result in death. Hence, FDA recommended benzocaine products should not be used on children less than two years of age, except under the advice and supervision of a healthcare professional.Later in 2014, FDA warned that, prescription of oral viscous lidocaine 2 % solution should not be used to treat infants and children with teething pain. When too much viscous lidocaine is given to infants and young children or they accidentally swallow too much, it can result in seizures, severe brain injury, and cardiac disturbances.Cryo-anaesthesia, using teething ring chilled in refrigerator is considered as effective and safe option for treating teething pain in children.[21]

Painful mouth ulcers

TLA are recommended for painful oral mucosal conditions such as, aphthous ulcers[22-23] and infectious ulcerative mouth conditions such as, gingivostomatitis, ulcerative pharyngitis, or hand, foot, and mouth disease. It was believed previously that, topical anaesthetics improve the oral fluid intake in such conditions, but based on a study by Hopper *et al.,*2014 topical anaesthetics might reduce the pain due to ulceration but they did not significantly improve oral fluid intake in children in children with painful infectious mouth ulcers when compared to placebo.[24]

PEDIATRIC RESTORATIVE DENTISTRY

Rubber dam clamp placement

Rubber dam clamp placement is perceived as a painful procedure by children. The discomfort associated with rubber dam clamp placement can be reduced by using topical anaesthetics such as, lignocaine 2%, lignocaine 20 %, and benzocaine 20%, EMLA gel. Topical anaesthetics were better than placebo in reducing discomfort due to rubber dam clamp placement in children.[23,25] 20 % benzocaine is better than other topical anaesthetics to reduce discomfort associated with rubber dam clamp placement.[26-27] (Table-2).

TABLE 2
STUDIES ON TLA USE IN RUBBERDAM CLAMP PLACEMENT

SNO	AUTHOR-YEAR	INTERVENTION	RESULT
1	Couder*et al.,*2014[23]	Children. Topical 2 % lignocaine vs placebo-clamp placement pain in children	2% lignocaine was better.
2	Yoon *et al.,*2009[26]	Children. EMLA gel and 20 % benzocaine for rubber dam clamp	Benzocaine 20% was better than EMLA in children.
3	Lim *et al.,*2004[25]	Children EMLA vs placebo Rubber dam clamp placement 6-12 Year old children.	EMLA was better than placebo.
4	Stecker *et al.,*2002[27]	Children. 20% lignocaine patch for 5 minutes vs 20% benzocaine for 1 min for gingiva tissue for rubber dam clamp placement.	Both had comparable result 20 % benzocaine was slightly better.
5	Haasio et *al.,*1990[28]	EMLA and 10 % lignocaine for achieving gingival anaesthesia	No statistically significant difference between both.

DENTINAL ANAESTHESIA FOR RESTORATIVE PURPOSES

Dentinal sensitivity during restorative procedures can be reduced by application of EMLA to buccal sulcus of deciduous teeth.[29] EDA by TENS is also as effective as local anaesthesia in reducing dentinal sensitivity during restorative procedures in children. Children preferred TENS over local anaesthesia.[10, 30]

PEDIATRIC ENDODONTICS

Vickers *et al.,* 1993 reported that when EMLA was applied to buccal sulcus region topically longer than 30 minutes, can produce a certain degree of pulpal anaesthesia.[31] DeNunzio *et al.,* 1998 reported that, direct topical application of 20% benzocaine to the exposed dental pulp produced pulpal anaesthesia during pulpectomy.[32]

PEDIATRIC ORAL SURGERY

Compounded topical preparations such as LAT (lidocaine+adrenaline+tetracaine) provides adequate analgesia for suturing facial lacerations in children and reduces the need for hospital admission and general anaesthesia.[33] Compounded preparation such as LPT (lignocaine+phenylepinephrine+tetracaine) are as effective as lignocaine infiltration for repair of oral mucosal lacerations in children.[34] Compounded preparations are also helpful for intraoral soft-tissue biopsy.

TO REDUCE LOCAL ANAESTHESIA NEEDLE PRICK PAIN

Injection prick is perceived as painful procedure and most children are fearful about the needle prick rather than the dental procedure itself. Various topical anaesthetics are efficient in reducing pain due to needle insertion in children. For buccal infiltrations, benzocaine 20% is reported to be slightly better than 10% lignocaine spray and EMLA cream.[35] Benzocaine 20% has rapid onset of action which is of great advantage in pediatric patients.[36] EMLA 5% cream was found to be superior than benzocaine 20% and lignocaine 10% in reducing pain perception due to buccal infiltration in the study by Nayak *et al.,* 2006.[36] Needle insertion in palatal sites is perceived as one of the most traumatic procedure by children. For reducing needle prick pain in palatal sites lignocaine 20% patch (Dentipatch) is more efficient than

benzocaine 20%.[32] Benzocaine 20% and 5% EMLA have comparable efficacy.(37) EMLA is better than TENS for reducing needle prick pain in palatal sites.[38] For palatal sites based on the available studies we can assume that, Lignocaine 20% patch is efficacious than benzocaine 20% and 5% EMLA followed by TENS. (Table-3).

TABLE 3
STUDIES ON TLA USE IN REDUCTION OF NEEDLE PRICK PAIN

SNO	AUTHOR-DATE	INTERVENTION	RESULTS
1	Shehab *et al.,* 2015[39]	Lignocaine 20 % patch vs lignocaine 5% gel. Needle prick pain in children.	Lignocaine 20% is better
2	Atabek *et al.,* 2015[40]	Wand vs 10 % lignocaine pump spray	Same efficacy in reducing injection pain
3	Sharma *et al.,* 2014[41]	15% lignocaine spray and 8% lignocaine gel Buccal infiltration anaesthesia Children 7 and 12 years.	No significant difference
4	Deepika *et al.,*2012[42]	8% Lidocaine + 0.8% dibucaine vs 20% benzocaine. Ia injection pain in children	Both are equipotent.
5	Bagesund and Tabrizi 2008[43]	Lignocaine 20% patch vs lignocaine 5% gel. Buccal infiltration in children.	Both has comparable clinical efficacy.
6	Nayak *et al.,* 2006[36]	EMLA 5% cream, Benzocaine 18% gel or lignocaine 5% ointment.Buccal infiltration Children	Benzocaine gel had the most rapid onset of action. EMLA 5% cream proved to be superior in pain reduction compared to benzocaine and lignocaine. Taste acceptance was better with benzocaine gel.
7	Paschos *et al.,* 2006[44]	Four topical anaesthetics (Gingicain Spray, Gingicaine Topical Anaesthetic, Legecain-Solution, EMLA Creme). Buccal injections in children.	Gingicain spray was better.
8	Wu *et al.,* 2003[45]	Benzocaine gel and lignocaine patch	Patch was preferred by children.
9	Primosch *et al.,* 2001[37]	Benzocaine 20% oral adhesive vs benzocaine 20% gel vs EMLA 5% oral adhesive (EMLA 5% cream in Orabase Plain). Palatal sites. Children 7-15 years.	All had equivalent effect in pain reduction.
10	Kreider *et al.,* 2001[46]	20% benzocaine VS 20% lignocaine patch. Greater palatine injection.	Dentipatch was better
11	Tulga *et al.,* 1999[35]	EMLA 5% Cream (lidocaine 2.5 percent, prilocaine 2.5 percent), Vision-Gel (benzocaine 20 percent), Anaesthetic Tabs (tetracaine hydrochloride 0.68 mg, cincocain hydrochloride 0.02 mg), Xylocaine 10% aerosol (lidocaine 10 percent). Intra-oral injection pain.	Benzocaine 20 percent observed to be the most effective.
12	Roghani *et al.,*1999[47]	5% EMLA cream, 10% cocaine, 10% lidocaine, 10% benzocaine, 1% dyclonine, and a placebo. The topical anaesthetics were left on the gingiva for 3 min and off for another 3 min.	5% EMLA cream was superior in performance to all other topical anaesthetics.
13	Meechan *et al.,* 1996[38]	Emla vs Electronic dental anaesthesia Palatal injections Children.	EMLA was better than electrical nerve stimulation
14	Meechan *et al.,* 1994[29]	Emla vs 5% lignocaine ointment. Maxillary buccal infiltration injections	No significant difference between both.

TOPICAL ANAESTHETICS FOR PEDIATRIC EXODONTIA

Successful reports of only topical anaesthesia without the use of local anaesthesia was used for extraction of primary teeth in children. Munshi *et al.,* 2001 reported successful use of (EMLA) alone for extraction of the mobile primary teeth and root stumps.[48] Taware *et al.,* 1997 used a bioadhesive patches of 20 mg lignocaine, to the buccal and palatal/ lingual gingiva in the apical region of the tooth to be extracted as the sole means of anaesthesia for dental extractions in both adults and children and reported positive results.[49]

POST-EXTRACTION (UNDER GENERAL ANAESTHESIA) PAIN RELIEF

In the past, it was assumed that topical bupivacaine 0.25% with adrenaline 1:200,000 swabs, when placed in dental extraction socket, could reduce pain due to extraction after post general anaesthesia recovery in children.[50] Recent studies reveal that there is no significant difference between topical bupivacaine 0.25% with adrenaline 1:200,000 swabs, compared to saline soaked swabs in reducing pain.[51,52]

ORTHODONTICS

Topical anaesthetics are efficient in reducing pain due to orthodontic mini-implant placement.[53]Compounded preparations are better in reducing pain due to orthodontic mini-implant placement.[54,55] Kwong *et al.,* 2011 have compared the use of Oraquix vs TAC alternate (a compounded mixture of 20% lidocaine, 4% tetracaine, and 2% phenylephrine) for placing temporary anchorage devices (TADs). TAC alternate was better than Oraqix in placing temporary anchorage devices.[55]Orthodontic brackets can cause pain and mucosal irritation as a result of increased friction between mucosal tissue and the surface of the brackets. Kluemper *et al.,* 2002 have reported use of wax incorporated with benzocaine 20% is effective in

reducing pain associated with mucosal irritation caused due to orthodontic brackets.[56]

PHARMACOKINETICS, TOXICITY, AND ALLERGIC REACTIONS

Many local anaesthetics used effectively via injection prove ineffective when applied topically (e.g., articaine, mepivacaine, prilocaine, procaine), because, the concentrations necessary to produce anaesthesia via topical application are high, with significantly increased overdose and local tissue toxicity. Higher concentration also increases the risk of toxicity, locally and systemically if the drug is efficiently absorbed. Allergic reactions are more common with ester type when compared to amide type. The risk of overdose with amide topical anaesthetics is greater than that with the esters and increases with the area of application of the topical anaesthetic. Because topical anaesthetic formulations do not contain vasoconstrictors and local anaesthetics have vasodilatory properties, vascular absorption of some topical formulations is rapid, and blood levels may quickly reach those achieved by direct IV administration. Preservatives, such as methylparaben, and other ingredients may also cause allergic reactions. Toxic reactions to local anaesthetics are more common after topical than via any other route of administration. It is the amount of drug administered that is important with regard to toxicity and topical agents are usually available in concentrations much greater than are found in injected formulations.

DOSAGE CONSIDERATIONS IN CHILDREN

For both children and adults, the dosages should broadly be related to the body size and note taken of the total dose which accrues from topical use of other formulations of lignocaine, such as, pastes or creams or sprays. The doses injected should be the minimum that allows the treatment to proceed. If necessary, the doses are better given at a series of appointments rather than as a large volume on one single occasion.[57]

DOSAGE TO BE ADMINISTERED = DOSE OF TLA ADMINISTERED + DOSE OF LOCAL ANAESTHESIA ADMINISTERED

The lignocaine and monoethyl glycinexylidide absorbed from the DentiPatch did not reach toxic plasma levels in children. However, plasma concentrations were much higher than in adults and were high enough to require inclusion in the calculation of total lignocaine administered to a pediatric patient.[58]

ADVERSE EFFECTS

Various adverse effects are reported due to TLA administration. Overdoage, Allergic reactions, ulcerations[46], idiopathic swelling of soft tissues[59], anaphylaxis[60], toxic reactions to topically applied local anaesthetics are known to occur. Methaemoglobinaemia is reported to occur due to various topical preparations such as EMLA[61]and Benzocaine.[62,63] Compounded topical anaesthetic preparations are more toxic; seizures and even death are reported to occur.[64-66]

CONCLUSION

Topical anaesthetics are most important armamentarium for pediatric dentists to make dental procedures atraumatic for the children. Knowledge about selection, dosage and toxicity should be kept in mind while administering specific topical anaesthetic for children.

CONFLICT OF INTEREST

Conflict of interest declared none.

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