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COMPARISON OF EFFICACY OF THREE LOCAL ANAESTHETIC SOLUTIONS ON PULP THERAPY OF PRIMARY MOLAR - AN ORIGINAL STUDY.

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ABSTRACT

Aim: The aim of this study was to compare the local anaesthetic efficacy of Articaine, Lignocaine and Bupivacaine during pulp therapy after their administration by either mandibular nerve block or maxillary infiltration.

Materials And Methods: The study comprised 60 children who required a pulp therapy on their primary molars. Pain-related behaviours were used to assess the severity of pain during the injection of Articaine, Lignocaine or Bupivacaine following maxillary infiltration compared to mandibular nerve block. Behaviour during the injection and treatment procedures was assessed using Wong-Baker Facial Pain Rating Scale (WBFPRS), Visual Analogue Scale (VAS), and Frankl Behaviour Rating Scale (FBRS) and physiological measures like Blood Pressure [BP] and Heart rate [HR]. The recorded values were subjected to statistical analysis using Kruskal Wallis test and Mann – Whitney U test.

Results: Anesthetic efficacy scores for different local anesthetic solutions show that scores were significantly higher in the Bupivacaine group than the Lignocaine and Articaine. Better overall experience of the patients was with articaine-based on Mean values obtained for WBFPRS scores and VAS scores for respective local anesthetic solutions.

Conclusion: The study depicted that ARTICAINE was most effective in achieving pulpal anesthesia in primary molars. Even though a gold standard in dental procedures, Lignocaine showed much lesser scores than articaine. The least efficacious of the three was Bupivacaine which had the lowest scores on both scales."

KEYWORDS : Lignocaine, Articaine, Bupivacaine, pulp therapy, children.

INTRODUCTION:

During dental treatment, pain is one of the inevitable factors. It is one of the significant reasons a patient may fear dental treatments, especially paediatric dental patients. Therefore, effective pain control during dental procedures is essential for paediatric dentistry.[1]

The use of local anesthesia is increasingly common in paediatric practice. Paediatric regional anesthesia has attained wide use internationally because of its efficacy and safety. Erstwhile, the technique of local anesthetic administration is an essential consideration in paediatric patient behavior guidance.

The choice of the LA agent(s) and the injection technique(s) depend on each patient's age, fitness, medical status, anatomy, and physiology. Numerous local anesthetic agents are available to facilitate pain management in dental patients. Local anesthetics are broadly divided into two types based on chemical formulations: (1) esters (e.g., procaine, tetracaine, benzocaine); and (2) amides (e.g., lidocaine, articaine, mepivacaine, prilocaine,).[3]

Since 1948, lidocaine became the first gold standard local anesthetic and is the most commonly used local anesthetic in dentistry.[4] however due to a few drawbacks newer agents were sought for. Articaine is a widely-used local anesthetic that differs from other members of this class of local anesthetic agents. Its improved penetrating ability into tissues makes Articaine a very effective local anesthetic agent. A long-acting local anesthetic, Bupivacaine has Protein binding characteristics and high lipid-solubility. These properties contribute to Bupivacaine's greater potency and anesthetic duration than other local anesthetics used in dentistry. Literature is scant on the usage of Bupivacaine in children. There are many comparative reports on the local anaesthetic efficacy of Articaine and Bupivacaine on permanent teeth. This contrasts with the small number of comparative reports on the local anesthetic efficacy of articaine and Bupivacaine on primary teeth.[5]

Measuring more than one dimension of the pain experience is important to assess children's pain effectively. Because pain is a highly individual and multidimensional phenomenon, self-reporting is usually the best way of assessment.[6]

Although a composite measure, which includes self-report, observational or behavioural, and physiological assessments are desirable, this is not always easily accomplished in children. Due to poor communication, pain perception and its reporting can be variable and unreliable in children.[7] The VAS and FPRS are two different scales of measurement (continuous and ordinal, respectively).[8]

Since anxiety levels could influence pain perception, it becomes imperative to differentiate between subjects with high and low anxiety levels by measuring BP and heart rate.[9]

The present study aims to compare the local anaesthetic efficacy of 4% Articaine with epinephrine and 0.5% Bupivacaine without epinephrine and 2% Lignocaine with epinephrine during pulp therapy procedures in children.

In addition, the study also does the metric and psychometric analysis of the adverse events such as pain and anxiety during or after the procedure through pain rating scales and vitals, respectively.

MATERIALS AND METHODOLOGY:

Sixty child patients between the ages of 4-9 years were selected from the outpatients of the Department of Paediatric and Preventive Dentistry. Selection criteria for the patients included:

1. A child belonging to Frankl's behavior rating III and IV
2. Indication of pulp therapy in any primary molars
3. Absence of soft tissue lesion at the site of injection
4. No known history of allergy to local anesthetic solutions.

Exclusion Criteria:

1. Medically and mentally compromised children
2. History of significant behavior management problems
3. Children who do not understand local language.

Written information explaining the purpose and the procedure of the

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study was explained and obtained from the parents of the children. Approval was obtained from the Institutional ethical committee.

Local Anaesthesia:

Initially, a preoperative radiograph was taken. Then, patients were randomly assigned to receive IANB for mandibular teeth or infiltration in maxilla with lignocaine hydrochloride with 1:80,000 adrenaline solution (Lignospan Special, Septodont) [Figure 1A] or with articaine hydrochloride with 1:100,000 epinephrine (Septanest, Septodont) [Figure 1B] or bupivacaine without adrenaline (Anawin™) [Figure 1C].

A single researcher injected the local anesthetic for all the patients. A Septodont syringe with a 27-gauge needle was used to deliver the injections after loading with the corresponding cartridge of lignocaine or articaine local anesthetic agent. In addition, 2ml disposable syringes with a 27-gauge needle were used to deliver the injections after loading with the corresponding amount of bupivacaine local anesthetic agent [Anawin™] and the pulp therapy was performed.

Figure 1: Materials Used

Recording Scores:

The same researcher recorded the blood pressure and heart rate before [Figure 3A], during [Figure 3C], and after [Figure 3F] the procedure [Figure 3B]. After completing the procedure, the patients self-assessed their experience by recording Wong baker's facial pain rating Scale (WBFPRS) [Figure 2B] score [Figure 3D] and Visual Analogue Scale (VAS) [Figure 2A] Score [Figure 3E]. Blinding could not be done for this study as the injection techniques and three solutions were different and identifiable. Instead, the data were compiled and subjected to statistical analysis using Kruskal Wallis test and Mann – Whitney U test.

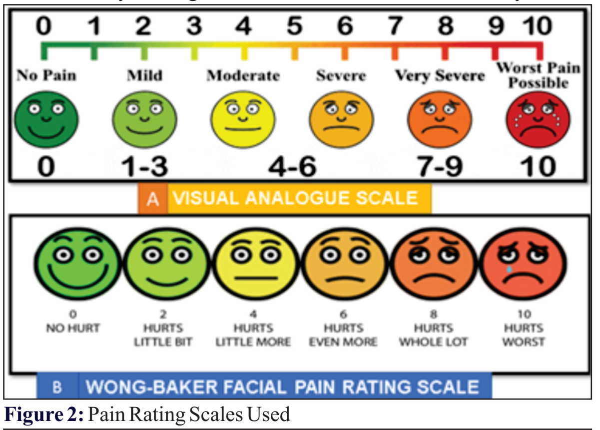

Figure 2: Pain Rating Scales Used

Figure 3: Methodology Adapted To Assess Efficacy Of Local Anaesthetic Agent

RESULTS:

The following inference has been obtained from the present study.

Frankels Behavior Rating Scale:

Kruskal Wallis test was used to obtain the association between Bupivacaine, Articaine, and Lignocaine with Frankel's Behavior Rating Scale.

Table 1A depicts scores for the three local anesthetics employed in the study obtained through Frankel's behavior rating scale(P=0.455). Even though the results were not statistically significant Lignocaine showed a lower mean in efficacy.

Wong-Bakers Facial Pain Rating Scale:

Kruskal Wallis test was used to obtain the association between Bupivacaine, Articaine, and Lignocaine with Wong-baker Facial Pain Rating Scale.

Table 1B depicts scores for different local anesthetics which were highly significant with Wong-Bakers Facial Pain Rating Scale(P=0.000). The results showed that Articaine's anesthetic efficacy was superior to Lignocaine, followed by Bupivacaine.

Visual Analogue Scale:

Kruskal Wallis test was used to obtain the association between Bupivacaine, Articaine, and Lignocaine with Visual Analogue Scale.

Table 1C depicts scores for different local anesthetics which were significant with the Visual Analog Scale(P=0.000). The results showed that the anesthetic efficacy of Articaine was superior to Lignocaine, followed by Bupivacaine.

Table -1: The Association Between Three Local Anaesthetic Solutions Using Three Different Rating Scales.

A. The association between bupivacaine, articaine, and Lignocaine with Frankel's Behavior Rating Scale.

Anaesthetic Agent	Sample Size	Mean	Std. Deviation	P-value
Bupivacaine	20	3.3	0.47016	0.455*
Articaine	20	3.3	0.47016	
Lignocaine	20	3.15	0.36635	
Total	60	3.25	0.43667	

B. The association between Bupivacaine, Articaine, and Lignocaine with Wong-baker Facial Pain Rating Scale.

Anaesthetic Agent	Sample Size	Mean	Std. Deviation	P -value
Bupivacaine	20	7.4	0.94032	0.000**
Articaine	20	5.5	1.5728	
Lignocaine	20	6.9	1.20961	
Total	60	6.6	1.48666	

C. The association between Bupivacaine, Articaine, and Lignocaine with Visual Analogue Scale.

Anesthetic Agent	Sample Size	Mean	Std. Deviation	P-value
Bupivacaine	20	7.6000	0.75394	0.000**
Articaine	20	4.5000	1.31789	
Lignocaine	20	6.4000	1.27321	
Total	60	6.1667	1.70907	

*P-value>0.05- non-significant, **P-value<0.001- Highly significant

Physiological Measures:
The physiological measures of blood pressure and heart were considered before and post-anaesthesia. The values recorded did show changes but the values recorded were within the normal physiological limits and thus rendered non-significant.

Anaesthetic Efficacy:
Anesthetic efficacy scores for different local anesthetic solutions results show that scores were significantly higher in the Bupivacaine group than the Lignocaine and Articaine, suggesting the better overall experience of the patients with articaine based on Mean values obtained for WBFPRS scores and VAS scores respective local anesthetic solutions.

DISCUSSION:
Pain management in dentistry is essential for reducing the fear and anxiety associated with dental procedures. Local anaesthesia is the procedure employed for pain control in dentistry, and there has been substantial research interest in finding safer and more effective local anaesthetics. Furthermore, since paediatric dentistry has a crucial role in achieving a positive experience during the child's first dental visit, building trust and achieving cooperation, pain control becomes vital.[10] Administering a painless block for a pre-schooler s one of the most challenging dental tasks. In addition, the administration of multiple injections can compromise the behaviour of young children. Empirically, the profundity of anaesthesia has been related to the child's age and injection site. [11]

Lidocaine hydrochloride (HCl) 2% with 1:100,000 epinephrine is preferred in routine dental practice because of its low allergenic characteristics and greater potency at lower concentrations. However, few studies have discussed the ineffectiveness of Lidocaine in more invasive procedures or when a better distribution into the tissue is necessary, especially in the bone tissue. In addition, Lidocaine does not always provide adequate profound pulpal analgesia when clinicians carry out the invasive procedure in children, and multiple injections may be required. Considering these factors, there have been continuous attempts to look for a more efficacious anesthetic agent.[12]

Articaine has gained popularity with its unique chemical structure and increased potency. Its comparative efficacy with Lignocaine encourages further research using articaine to improve its effectiveness. In 2000, FDA accepted the sale of 4% articaine with 1:100000 epinephrine as Septocaine (Septodont). [13] It has been used in several European countries for almost 30 years, and its safety has been well documented by many studies.[14]

The other newly available local anaesthetic in India is 0.5% bupivacaine without adrenaline. Bupivacaine HCL is a long-acting amide local anesthetic. First manufactured in 1957 by Ekernstam at A. B. Bafors Laboratories in Molndel, Sweden, this drug has undergone trials with varying degrees of acceptance.[15]

The present study selected the 4–9-year age group because younger children might encounter difficulty recalling and prescribing their pain experience. The age of four years was standardized in our study due to conflicting conclusions of the two studies. A systematic review done by Meechan J et al. [2011][16] concluded that usage of articaine below Four years of age is not recommended while Elhneey AA et al. [2020][17] supported effective and secure use of articaine to treat children below four years of age thus we kept the lower limit value as 4 years.

Criteria for selecting children also included a behavioural rating of "positive" or "definitely positive" according to Frankl's scale (1962). Observing a child's physiological condition during dental treatment is helpful in pain evaluation. To accurately assess pain perception during pulp therapy, physiological measures like Blood Pressure and Heart Rate were taken before, during and after the procedure for objective assessment of pain in this study to avoid age related uncooperative responses that may be misinterpreted as pain.[18] Previous studies stated that physiological measures such as Heart rate, Blood pressure act as superior predictors of pain making them an essential pain measuring criterion.[19]

In the present study, maxillary infiltration technique and mandibular nerve block were employed as recommended by Mc Donald.

The VAS and WBFPRS scales for pain measurement provide the subject with multiple options to improve individual pain determination. Apart from them being conceptually simple, they are easily accessible for users. This was in accordance with the studies done by Amit Katri et al. [2012].[20]

Previous studies by Malamed SF et al. [2006][18] suggest that the VAS is generally a good, reliable tool for pain measurement in children. The visual analogue scale has been used for the assessment of pain in children in previous studies done by Roger BS et al. [2014] [19], Jorgenson et al. [2019][20].

Hockenberry et al. 2005[21] stated that WBFRS is a valuable tool for assessing pain in children. Facial expression in this scale makes the interpretation of pain in children easier, according to Ram D et al. [2006][22]. WBFPRS was used to assess pain in previous studies done by Meenu M et al. [2015][23], Nilesh V Rathi et al. [2019][24].

The present study is a premier study to compare the efficacy of 4% articaine with epinephrine, 2% lidocaine with epinephrine, 0.5% bupivacaine without epinephrine in achieving pulpal anaesthesia of primary molars by assessing the pain perception using three subjective measures – Frankel Behaviour Rating Scale, Visual Analogue Scale and Wong-Baker Facial Pain Rating Scale and two Physiological objective measures – Blood Pressure, Heart Rate.

Mean scores for the values of Frankel's behaviour rating scale before and after the administration of Local anaesthesia with the three local anaesthetic solutions showed no significant difference(P=0.455) [Table 1A]. This was also in accordance with the study done by Elhenney AA et al. [2020][17].

Within the physiologic limits, Blood pressure and heart rate increased during the procedure compared to the value recorded before the treatment depicting that dental injection made the child anxious. After the completion of the procedure was relatively low when compared with the pre-treatment and intraoperative values representing the decrease in the child's anxiety after completion of the procedure. Even though a significant difference was not noted and values were will within physiological limits, children who experienced more pain had higher values of blood pressure; heart rates are in the physiological limits of the child's age. This signifies those physiological measures are good adjunctive pain measurement to the available pain rating scales. This was also confirmed by the previous study done by Subramanian et al. [2018].[19]

This study included 60 children, of which 31 were males and 29 were females. A significant difference was observed between both the genders with WBFPRS and VAS, and the scores of WBRPRS and VAS were higher for females than males. This might be due to unequal distribution of samples in both genders [Females=31, males=29].

The VAS and WBFPRS values for maxillary infiltration technique and mandibular nerve block were higher when Bupivacaine was used. In addition, intermediate values were obtained with Lignocaine while scores were low both for infiltration and nerve block with articaine. This was previously confirmed in a study done by Minu MO et al. [2021][25].

The scores of VAS were higher after administration of Bupivacaine [Mean 7.6]. Intermediate values [mean – 6.4] were obtained with Lignocaine depicting that Lignocaine is efficacious than Bupivacaine, and the comparison was statistically significant [P =0.000] [Table 1C]. This was in accordance with some previous studies done by Renie gross et al. [2007][26], which also stated that Bupivacaine has lower efficacy than Lignocaine. However, our results were contradictory when compared to studies done by Masoud et al. [2015][27], which concluded that Bupivacaine and Lignocaine were equally efficacious to treat mandibular molars and Rizwan et al. [2020][28], which stated that Bupivacaine is higher anaesthetic efficacy than Lignocaine during pulp therapy.

The VAS scores were lower with articaine [mean 4.5] with the statistically significant difference when compared to Lignocaine [P=0.000] and Bupivacaine [Table 1C]. This result was also confirmed in several previous studies done by Malamed SF et al. [2000][18], Meenu M et al. [2015][23] who concluded that articaine is more efficacious than Lignocaine, while a study done by Ashwin et al. [2014][24] concluded that articaine is more efficacious than Bupivacaine.

The mean scores of WBFPRS were higher after administration of

Bupivacaine [Mean 7.4]. when compared to Lignocaine (mean -6.9) indicating lignocaine is efficacious than Bupivacaine [Table 1B]. However, the obtained finding was not statistically significant. The mean WBFPRS scores were even lower for articaine [mean 5.5] when compared to Lignocaine [Table 1C] and Bupivacaine [P =0.000] [table 1C]. The difference obtained was statistically significant. Our findings were in accordance with previous studies done by Ram D et al. [2000][25], Jorgenson et al. [2019][20], Nilesh V Rathi et al. [2019][24].

Based on the result of the VAS and WBFPRS scores in this study, it can be inferred that VAS is a more sensitive scale in depicting the anaesthetic efficacy when compared to WBFPRS. This might be due to the better ordinal arrangement on VAS. While the scoring on vas is delineated into ten equal markings, the same is not valid in the case of WBFPRS, where the range of measurement is limited to 5 divisions. Therefore, the number of markings contributes to the sensitivity and specificity of the Visual Analogue Scale. This was previously confirmed in the previous study done by Garra G [2010][26], which stated that The VAS has been found to have an excellent correlation in children and had a uniformly increasing relationship with WBFPRS.

In this study, the local anaesthetics 4% articaine with epinephrine, 2% lidocaine with epinephrine, 0.5% bupivacaine without epinephrine had a statistically significant difference in their efficacy in children who underwent pulp therapy for primary molars. Both physiological and subjective measures suggest that articaine had higher efficiency than Lignocaine and Bupivacaine, thereby indicating that Bupivacaine is the least efficacious anaesthetic agent of the three compared to local anaesthetic solutions.

"It can be inferred that Local anaesthesia with 4% articaine has better acceptance than 2% lignocaine and 0.5% bupivacaine in children."

In our study, no side effects were observed with articaine except for the prolonged soft tissue anaesthesia, which lasted for 2-3 hours. However, the incidence of soft tissue injuries was seen with Bupivacaine due to its prolonged duration of action.

Limitations:

1. The sample size was small i.e., 60 children. A higher sample might be required to validate our findings.
2. The age and gender distribution [29 males and 31 females] was not equitable.
3. 0.5% Bupivacaine without epinephrine was administered with a sterile 2ml syringe with 27-gauge needle due to non-availability of this drug in cartridge and lack of formulation with epinephrine in the demographic area. However, the gauge of the needle used was the same.

CONCLUSION:

With the increasing use of new delivery systems such as aspirating syringes with cartridge systems, local anaesthesia with articaine provides an effective alternative, with minimal discomfort in children. Additional studies with a larger population are required as child safety is the prime consideration. Behavioural precautions and the possibility of soft tissue trauma should be advised to the patients and caregivers post-operatively to diminish the clinical complications.

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