Comparison of Efficacy of 4% Articaine and 0.5% Bupivacaine and 2% Lignocaine Anaesthetic agents in Orthodontic Extractions-A Prospective Randomised Controlled Study

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ABSTRACT

Aim: Articaine, bupivacaine, lignocaine are amide type of local anesthetic agents, which are of almost equal potency. However, lidocaine is considered the gold standard and is the most widely used anesthetic agent because of its potency, safety, and efficiency. Articaine is fast acting and bupivacaine is long lasting local anaesthesia. The aim of this clinical study was to evaluate and compare the clinical anesthetic efficacy of 4% articaine and 0.5% bupivacaine and 2% lignocaine in therapeutic orthodontic extractions.

Materials and Methods: A 150 healthy patients, requiring Maxillary premolars extraction for orthodontic reasons were included. Patients were categorized into three groups (4% articaine and 0.5% bupivacaine, 2% lignocaine) in a crossover manner. Subjective and objective observations recorded that include age, gender, and pain score using visual analog scale. At the first appointment, both upper premolars were extracted on one or two sides of the jaws. Each patient was evaluated using a visual analogue scale.

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Results: The results showed that 0.5% Bupivacaine had significantly faster onset of action and lower visual analogue scores when compared with articaine and lignocaine. However, the duration of analgesia and need of first rescue analgesic medication was longer in the bupivacaine group.

Conclusion: Within the limitations of study we found that Bupivacaine has the best anaesthetic effect with low pain scores followed by Articain and followed by Lignocaine. Bupivacaine is an alternative local anaesthetic drug for performing therapeutic orthodontic extractions.

Keywords: Articaine; bupivacaine; lignocaine; visual analogue scale.

1. INTRODUCTION

Local anesthesia and pain management are the most important tenets in any oral surgical procedure. Patient compliance and effective surgical procedure mandates complete pain control in order to gain patient cooperation and manage patient anxiety. Pain perception depends upon the patient's pain threshold and quality of local anesthetics used. It has been estimated that more than 300 million cartridges of local anaesthesia are administered annually by dentists in the United States [1]. Local anaesthetics are believed to be the most frequently used drugs in clinical dentistry. Local anaesthetics agents are chemicals that block nerve conduction in a specific, temporary, and reversible manner, without affecting the patient's consciousness. The molecule consists of a hydrophilic amino group, and a lipophilic aromatic ring. According to the type of intermediate alkyl linkage between them, they are classified under ester-type anesthetics, with an amino-ester bond and whose prototype is procaine, and the amide-type with amino-amide bond and whose prototype is lidocaine [2]. Until the beginning of the twentieth century, cocaine was the drug of choice for surgical and dental pain control despite its significant limitations such as its low therapeutic index, the risk of addiction and potentially lethal arrhythmias. After its synthesis in 1904 by Alfred Einhorn procaine became the main local anesthetic in medicine and dentistry. Because of the long latency period of procaine and allergies to ester anesthetics, lidocaine, the first amide anesthetic, quickly became the gold standard after its synthesis in 1943 by Nils Lofgren. Other amide anesthetics have subsequently been introduced [3]. It has been suggested that long acting local anesthetics such as bupivacaine, could provide additional analgesia time known as “residual analgesia” and minimize the duration of postoperative pain, facilitating postoperative care and maintenance of proper oral hygiene. Its main indications are lengthy procedures and postoperative pain management [4].

2. MATERIALS AND METHODS

2.1 Study setting and Data Collection

150 healthy patients, requiring Maxillary premolar extraction for orthodontic reasons were included in this study. Patients were categorized into three groups randomly: one group 0.5% bupivacaine, and second group 4% articaine third group 2% lignocaine in a crossover manner. Subjective and objective observations recorded that includes age, gender, pain score using visual analog scale.

Patients were reported to Saveetha Dental College for orthodontic treatments. The Patients were reported to the Department of Oral and Maxillofacial Surgery for therapeutic orthodontic extraction.

Parameters assessed: Time of anesthetic onset, duration of postoperative analgesia, and visual analog scale.

Inclusion Criteria- Patients of all age groups and gender who underwent therapeutic orthodontic extraction were included.

Exclusion Criteria- Patients underwent any treatment other than therapeutic orthodontic extraction, and common dental problems were excluded from the study.

Datas were reviewed by an external reviewer. Total sample size is, n=150. Demographic data such as the patient's age, gender were recorded.

2.2 Data Analysis

The data obtained were tabulated in Microsoft Excel 2016 (Microsoft office 10) and later exported to SPSS (Statistical Package for Social Sciences) for Windows version 20.0, SPSS Inc, Chicago IU, USA) and subjected to statistical analysis. One way anova test was employed with a level of significance set at p<0.05.
3. RESULTS

The results showed that 0.5% bupivacaine had significantly faster onset of action and lower VAS scores when compared with articaine and lignocaine. However, the duration of analgesia and time to first rescue analgesic medication were also longer in the bupivacaine group. The visual analogue scale indicated numbers from 0 to 10 (no pain to worst pain). The score 0-10 was given as chosen by the patient. Gender distribution shows 45.33% males and 54.67% females (Fig. 1) age group distribution shows 12-16 years 38%, 17-20 years 42.67%, 21-24 years 19.33% (Fig. 2), and Fig. 3, 4 shows bupivacaine gender and age group distribution, Fig. 5, 6 shows articaine gender and age group distribution, Fig. 7, 8 shows lignocaine gender and age group distribution.

Bupivacaine has mean value of 4.08 and standard deviation of 1.209 (Table 1), Articaine has mean value of 4.86 and standard deviation of 1.129 (Table 1), Lignocaine has mean value of 4.90 and standard deviation of 1.161 (Table 1), Anova Statistical test seen in Table 2, 3.
Fig. 3. Bupivacaine group gender distribution. This graph shows distribution of gender under the Bupivacaine group. X axis represents gender group and Y axis represents number of patients. From the graph, it is observed that the prevalence of females is more compared to males.

Fig. 4. Bupivacaine group age distribution. This graph shows distribution of age group under Bupivacaine group. X axis represents age group and Y axis represents number of patients. From the graph, it is observed that prevalence of patients in age group of 17-20 years was more when compared to other groups.

Fig. 5. Bar diagram showing Articaine group gender distribution. This graph shows distribution of age group under Articaine group. X axis represents gender group and Y axis represents number of patients. From the graph, it is observed that the prevalence of females is more compared to males.
Fig. 6. Bar diagram showing Articaine group age distribution. This graph shows distribution of age group under articaine group. X axis represents age group and Y axis represents number of patients. From the graph, it is observed that prevalence of patients in age group of 17-20 years was more when compared to other groups.

Fig. 7. Bar diagram showing lignocaine group gender distribution. This graph shows distribution of age group under lignocaine group. X axis represents gender group and Y axis represents number of patients. From the graph, it is observed that the prevalence of females is more compared to males.

Fig. 8. Bar diagram showing lignocaine group age distribution. This graph shows distribution of age group under lignocaine group. X axis represents age group and Y axis represents number of patients. From the graph, it is observed that prevalence of patients in age group of 12-20 years was more when compared to other groups.
Table 1. Descriptives VAS

|        | N   | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | Lower Bound | Upper Bound | Min | Max |
|--------|-----|------|----------------|------------|---------------------------------|-------------|-------------|-----|-----|
|        |     |      |                |            |                                 |             |             |     |     |
| Bupivacaine | 50  | 4.08 | 1.209          | .171       |                                 | 3.74        | 4.42        | 2   | 7   |
| Articaine  | 50  | 4.86 | 1.129          | .160       |                                 | 4.58        | 5.22        | 2   | 7   |
| Lignocaine | 50  | 4.90 | 1.161          | .164       |                                 | 4.53        | 5.19        | 2   | 7   |
| Total    | 150 | 4.61 | 1.219          | .100       |                                 | 4.42        | 4.81        | 2   | 7   |

Table 2. ANOVA VAS

| Sum of Squares df Mean Square F Sig. |
|-------------------------------------|---------------------------------|----------------|----------------|---|
| Between Groups         | 21.373  | 2 | 10.687  | 7.847 | .001 |
| Within Groups          | 200.200 | 147 | 1.362  | -    | -    |
| Total                  | 221.573 | 149 | -       | -    | -    |

3.1 Multiple Comparisons

Table 3. Dependent Variable: VAS

| Bonferroni |
|------------|
| (I) Group | (J) Group | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval |
|-----------|-----------|-----------------------|------------|------|-------------------------|
|           |           |                       |            |      | Lower Bound Upper Bound |
| Bupivacaine | Articaine | -.820                 | .233       | .002 | -1.39 - .25              |
|           | Lignocaine| -.780*                | .233       | .003 | -1.35 - .21              |
| Articaine | Bupivacaine| .820*                | .233       | .002 | .25 1.39                |
|           | Lignocaine| .040                  | .233       | 1.000| -.53 .61                |
| Lignocaine | Bupivacaine| .780*                | .233       | .003 | .21 1.35                |
|           | Articaine | -.040                 | .233       | 1.000| -.61 .53                |

* The mean difference is significant at the 0.05 level.

4. DISCUSSION

It is essential to standardize the procedure for comparing the efficacy of three anesthetic drugs. In this study, we compared the efficacy of 4% articaine hydrochloride with 0.5% bupivacaine hydrochloride and 2% lignocaine during the extraction of bilateral maxillary premolars for orthodontic treatment. The study followed a bilateral crossover design, which has the advantage that each patient acts as his/her own control. Thus, the individual characteristics of each patient and their subjective assessment of pain do not influence the results of the study.

VAS scores was the parameter discussed in the study. Time of onset was calculated as the interval between injection and the time when anesthesia was achieved. It represents a key factor when choosing different anesthetic solutions. Lidocaine is the most commonly used local anesthetic agent in dentistry and is considered to be the referral base to check for the efficiency of other local anesthetic agents. It provides pulpal anesthesia for about 1 h and soft tissue anesthesia for about 3–5 h [5]. Lidocaine is also used as a topical anesthetic gel and transdermal patch. Various preparation methods have been proposed so far [6]. When several
other local anesthetic agents failed to compete for the standard of lidocaine, articaine was found to be equally efficient and sometimes more efficient than lidocaine since its introduction in 1969 [7]. Articaine is a commonly used local anesthetic agent in dentistry. It provides pulpal anesthesia for about 1 h and soft tissue anesthesia for about 2.25 h. Articaine is unique among the other amide local anesthetics because it contains a thiophene group instead of the benzene ring [8]. Articaine is one of the safest local anesthetics due to its faster metabolic rate. Subsequently, it decreases the risk of systemic toxicity and overdose. Evidence was claimed that articaine had its faster metabolic rate and no toxic reactions when injected among 50 patients [9].

Bupivacaine's longer duration of action is in part because of protein binding [10]. There is little advantage to having lip numbness for extended periods of time. Difficulty in eating, speaking, and possibility of soft tissue trauma are viewed as nuisances by the patient [11]. Anesthesia duration of 411 minutes [2.5-6 hours] after the buccal infiltration, which is a longer period than that observed in our study. Oertel et al., who reported that the concentration of articaine in the alveolus of a tooth after extraction was about 100 times higher than in systemic circulation [12]. Articaine has a very short systemic half life. The long duration of postoperative analgesia evoked by articaine may be explained by its ability to readily diffuse through tissues due to the presence of a thiophene group in the molecule, which increases its liposolubility [13].

Articaine, unlike other amide local anaesthesia undergoes biotransformation in both the liver and plasma and is thus cleared quickly from the body [14]. It is rapidly eliminated from the body, but the elimination of bupivacaine takes longer. Hence, the duration of postoperative analgesia offered was significantly longer with bupivacaine than articaine. This finding was in accordance with previous studies. Because of the longer duration of postoperative analgesia offered by bupivacaine, the time to rescue analgesic medication was also longer.

Several authors have advocated for the analgesic effect of bupivacaine, with consequent lower perception of pain and less analgesic intake by the patient, compared with other anesthetics such as lidocaine.

About 4% articaine group offered a better palatal anesthesia than 2% lidocaine group with only buccal infiltration [15]. 4% articaine's efficiency in providing palatal anesthesia only with buccal infiltration. Pain perception in the lidocaine group is higher during extraction when compared to the other groups. Lidocaine infiltration given both buccally and palatally and articaine infiltration given buccally provide an excellent anesthetic effect. Lidocaine when given only buccally has no effect on palatal tissues. In spite of the application of topical local anesthetics before the injections, palatal injections remain to be the least painful in bupivacaine followed by articaine and painful in lignocaine used patients.

For the safety assessment of the anesthetic, we considered the values and changes in blood pressure, pulse and oxygen saturation, bleeding during surgery and postoperative complications. Although it has been argued that bupivacaine exerts a dose dependent decrease in systolic blood pressure and articaine exerts an increase in systolic blood pressure [16], no significant differences in blood pressure or pulse were found [17–27].

5. CONCLUSION

Within the limitations of study we found that Bupivacaine has the best anaesthetic effect with low pain scores followed by articaine and followed by Lignocaine. Bupivacaine is an alternative local anaesthetic drug for performing therapeutic extractions for orthodontic treatment.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

Ethical committee approval for this study was obtained from the Institutional Ethics Committee with the following ethical approval number. SDC/SIHEC/2020/DIASDATA/0619-0320.

LIMITATIONS OF THE STUDY AND FUTURE SCOPE

This study is of shorter duration with limited population. So to ascertain the findings of our study we have to do further studies in the future with large sample size and longer duration. This can be of helpful to find the clinical anesthetic efficacy of 4% articaine and 0.5% bupivacaine and 2% lignocaine in patients undergoing therapeutic orthodontic extractions.
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