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ORIGINAL ARTICLE

Infiltrative local anesthesia with articaine is equally as effective as inferior alveolar nerve block with lidocaine for the removal of erupted molars

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Abstract
Aim The aim of this study is to assess the efficacy of 4% articaine with 1:100,000 adrenaline given as buccal and lingual infiltration in adult patients undergoing erupted mandibular first and second molar teeth extraction versus inferior alveolar nerve block technique using 2% lignocaine with 1:80,000 adrenaline.
Materials and methods A total of 100 patients undergoing extraction of mandibular posterior teeth were divided into two equally matched groups for the study, out of which 50 patients were given 4% articaine with 1:100,000 adrenaline as buccal and lingual infiltration and 50 patients were given 2% lignocaine with 1:80,000 adrenaline using classic direct inferior alveolar nerve block with lingual and buccal nerve block. Efficacy of anesthesia was determined using a numeric analog scale (NAS) ranging from 0 indicating no pain to 10 indicating the worst pain imaginable. The NAS was taken by a different operator to avoid bias.
Results The pain scores in both groups were analyzed using the Mann–Whitney U test, and a p value of 0.338 was obtained which is not statistically significant. Hence, no significant difference in the pain score was established between both groups. The adverse effects of both the local anesthetics if any were noted.
Conclusion From this study, we concluded that the use of 4% articaine with 1:100,000 adrenaline is as effective as inferior alveolar nerve block with lignocaine but without the risk of attendant adverse effects of inferior alveolar nerve block technique.

Keywords Articaine · Buccal and lingual infiltrations · Inferior alveolar block technique

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Introduction

Local anesthesia plays the most important role for pain control in dentistry. The first substance used for pain control in dentistry was cocaine, as far back as in 1884. In April 2000, the U.S. Food and Drug Administration granted approval for the sale of 4% articaine with 1:100,000 adrenaline in the USA under the name of Septocaine (Septodont) [1]. 4% articaine with 1:100,000 adrenaline is a safe local anesthetic for use in clinical dentistry in adults and children [2–4]. Approximately 5 to 10% of articaine is excreted unchanged [5, 6].

Inferior alveolar nerve block is the most commonly used anesthetic technique for various dental procedures in the mandibular teeth. This is a difficult technique for beginners and has the highest failure rates, owing to several factors including difficulty in identification of landmarks, and may involve complications such as trismus, hematoma formation, and facial nerve palsy [7]. Rosenberg and colleagues [8] showed articaine and lignocaine to have a similar efficacy for pain reduction when given as a supplemental buccal infiltration for inadequate pulpal anesthesia during endodontic procedures. Additionally, the combination of buccal and lingual infiltration of lignocaine has been shown to be more effective than buccal alone in obtaining pulpal anesthesia of the lower anterior teeth [6].

However, only buccal and buccal plus lingual infiltrations of articaine with epinephrine did not differ in their efficacy in obtaining pulpal anesthesia for the mandibular permanent first molars [9].

The recent work done by Robertson and colleagues [10] showed that buccal infiltration of 4% articaine with 1:100,000 adrenaline is more effective than a similar injection of 2% lidocaine with 1:100,000 adrenaline in obtaining pulp anesthesia in the mandibular molars of healthy volunteers .The success of mandibular infiltration with 4% articaine and adrenaline for first molar anesthesia is comparable to that of an inferior alveolar nerve block with 2% lignocaine and epinephrine when similar outcome measures are used. A recent blinded crossover study by Il–Young Jung [11] indirectly compared the two techniques, with statistically comparable success of around 50% for articaine infiltration and lignocaine inferior alveolar nerve blocks for mandibular first molar anesthesia.

The mandible is made of thick cortical bone. Due to the increased thickness of the alveolar buccal bone when compared to the maxillary bone which is thin, porous, and cancellous, local infiltration of 2% lignocaine with 1:80,000 adrenaline cannot penetrate the mandibular buccal bone efficiently to produce pulpal anesthesia when local infiltration injection is given [7]. Even for a single molar tooth extraction, inferior alveolar nerve block technique supplemented with buccal nerve infiltration has been the choice to anesthetize the tooth before extraction. Studies have shown that 4% articaine with 1:100,000 has excellent buccal bone-penetrating property and can anesthetize the pulp satisfactorily [9, 11].

This study has been designed to evaluate and compare the anesthetic efficiency of 4% articaine with 1:100,000 adrenaline using local buccal and lingual infiltration injection technique versus 2% lignocaine with 1:80,000 adrenaline using the conventional inferior alveolar nerve block technique in adult patients undergoing erupted mandibular first and second molar extraction.

Materials and method

This randomized control study was carried out in Ragas Dental College & Hospital, Uthandi, Chennai during the academic year 2015–2016 and approved by the ethical committee of our institution. A total of 100 patients between age group of 20 to 40 years, undergoing extraction of mandibular posterior teeth, were included in the study. They were divided into two equally matched groups of 50 patients each (in which 30 patients in each group were carious related and 20 patients were periodontal-related extractions). One group of patients was given 4% articaine with 1:100,000 adrenaline with buccal and lingual infiltration, and the patients of the other group were given 2% lignocaine with 1:80,000 adrenaline using classic direct inferior alveolar nerve with lingual and buccal nerve block and waited for 3 to 5 min after injecting the local anesthesia and before starting the procedure. All extractions (in which 22 teeth were mandibular first molar of either quadrant in each group and 28 teeth were mandibular second molar of either quadrant in each group) were performed by the same operator to avoid bias.

Inclusion criteria

1. Completely erupted mandibular first or second molar teeth either carious or periodontally weak teeth.
2. Patients without allergy to local anesthetic drugs.

Exclusion criteria

1. Periapical abscess in relation to the tooth to be extracted.
2. Patients with space infection.
3. Local infection in relation to the tooth to be extracted.
4. Hypertensive patients.
5. Diabetic patients.
6. Patients with thyroid disorders.
7. Patients with liver diseases.
8. Patients with renal diseases.
9. Patients with bleeding and clotting disorders.
10. Patients under antidepressant medication.
11. Patients with bone diseases and disorders.
12. Patients with altered physiological responses which affects pain perception mechanisms.
13. Any condition which interacts with the mechanism of action of local anesthesia.

Evaluation of pain during the procedure

Efficacy of the block was determined using a numeric analog scale (NAS) ranging from 0 indicating no pain to 10 indicating the worst pain imaginable. The NAS was taken by a different operator to avoid influencing the patients during scoring.

Statistical analysis

Data were entered and analyzed using SPSS (10.05). The Mann–Whitney *U* test was employed to assess the difference between the two groups.

Results

$p < 0.05$ was considered to be statistically significant but we found no statistical difference between the two treatment groups with respect to pain using the NAS scoring system.

Mean age of the group for 2% lignocaine with 1:80,000 adrenaline was 31.4 ± 7.9 years, out of which 27 individuals were females and 23 were males. Mean age of the group for the 4% articaine 1:100,000 adrenaline group was 30.2 ± 6.4 years, out of which 21 individuals were females and 19 were males. As much drug within the permissible limit was administered to achieve adequate anesthesia in all the subjects. The mean drug volume was 3.3 ± 1.1 ml, ranging from 2.5–5 ml for 2% lignocaine with 1:80,000 adrenaline group and 3.08 ± 4.3 ml, ranging from 1.8 to 5.4 ml for 4% articaine with 1:100,000 adrenaline group.

See pain ratings (Fig. 1) (Table 1).

The mean pain score for 2% lignocaine with 1:80,000 adrenaline group was 1.16 ± 1.8 and for 4% articaine with 1:100,000 adrenaline was 2.0 ± 3.0 with a mode of 0 for both groups. We found NAS scores between 0 and 10 showed no significant difference in pain experience with 4% articaine or 2% lignocaine. In the articaine group, 51.1% of patients reported no pain, 26.6% mild pain, 4.4% moderate pain, 13.3% severe pain, and 4.4% worst pain. In the lignocaine group, 58% of patients reported no pain, 30% mild pain, 8% moderate pain, and 4% severe pain. The average pain score for 4% articaine group was 2.0 ± 3.0 and for the lignocaine group was 1.16 ± 1.8. The pain scores between both the groups were analyzed using the Mann–Whitney U test with an obtained p value of 0.338. Hence, no significant difference in pain scores was established between both groups.

Only four of our patients, two in each group, need supplementary local anesthesia to complete the extraction, which may be due to improper technique or patients' fear/poor pain threshold.

Discussion

Using local anesthetics to control a patient's pain is one of the most important factors for successful treatment. Articaine was

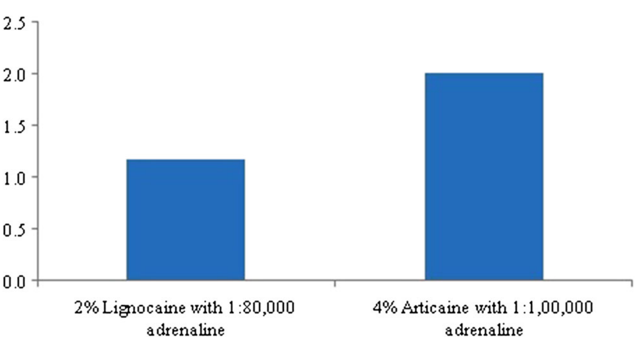

Fig. 1 Mean pain score chart

Table 1 Comparison of pain scores between 2% lignocaine with 1:80,000 adrenaline and 4% articaine with 1:1,00,000 adrenaline

Group	Number	Mean ± S.D.	Mode	p value
2% lignocaine with 1:80,000 adrenaline	50	1.16 ± 1.8	0	0.338
4% articaine with 1:100,000 adrenaline	50	2.0 ± 3.0	0	
Total	100			

identified in older German literature as articaine or carticaine. Articaine is unique among available amide local anesthetics because it has a thiophene moiety rather than the typical benzene group. Articaine unlike other amide local anesthetics undergoes biotransformation in both the liver and plasma thus is cleared more quickly from the body [5, 6]. Articaine has a reputation of providing an improved local anesthetic effect. The available literature indicates that articaine is equally effective when statistically compared to other local anesthetic [6, 12–16]. Here, the results of a randomized clinical trial are discussed, 4% articaine with 1:100,000 adrenaline being compared with 2% lignocaine with 1:80,000 adrenaline for the purpose of evaluating the efficacy of articaine. 2% lignocaine with 1:80,000 adrenaline is chosen as a reference substance as its effects are well documented [5]. Since the study used identical protocols, the results obtained were comparable and the combined analysis of the trial was valid.

Articaine is manufactured as a 4% local anesthetic solution. This is in contrast to lignocaine which is a 2% solution .Equal analgesic efficacy along with lower systemic toxicity allows the use of articaine in a higher concentration than other amide-type local anesthesia [17].This is advantageous with respect to the required bone penetration, and hence, it is possible to inject smaller volumes thereby minimizing injection-induced pain.

4% articaine is combined with either 1:100,000 adrenaline or 1:200,000 adrenaline. Numerous studies have evaluated the anesthetic activity of articaine in these two distinct concentrations of epinephrine [18–21]. In one such study conducted by Elliot V. Hersh [1], various hemodynamic parameters were evaluated between 4% articaine with 1:100,000 and 1:200,000 adrenaline, such as systolic pressure, diastolic pressure, mean pressure, and oxygen saturation, and found that the pharmacokinetic profile between A100 and A200 was similar. However, they cautioned on the use of A100 in patients with cardiovascular diseases. In our study, the inclusion criteria was specific not to include such patients; hence, we continued the use of 4% articaine with 1:100,000 adrenaline.

Various studies have compared the anesthetic efficacy of 2% lignocaine with 1:80,000 adrenaline versus 4% articaine with 1:100,000 adrenaline given as a supplementary buccal infiltration after a classical inferior alveolar nerve block technique in cases of inadequate lower mandibular molar anesthesia for various dental procedures, and concluded that 4% articaine with 1:100,000 adrenaline infiltration was higher or similar in efficiency to that of lignocaine [8, 10, 20]. Il–Young Jung et al. [11] indirectly compared the anesthetic efficacy of 4% articaine with 1:100,000 adrenaline buccal infiltration to 2% lignocaine with 1:80,000 adrenaline inferior alveolar nerve block. He concluded that 4% articaine with 1:100,000 adrenaline buccal and lingual infiltrations for mandibular first molar can be used as an alternative for 2% lignocaine 1:80,000 adrenaline. Inferior alveolar nerve block as articaine infiltration has a faster onset and similar success rate. However, he suggested that further studies are needed to compare the effectiveness of both methods directly.

The advantages of 4% articaine with 1:100,000 adrenaline infiltration over 2% lignocaine with 1:80,000 adrenaline classical inferior alveolar nerve block are that 4% articaine infiltration is a simpler technique than the classic 2% lignocaine inferior alveolar nerve block, articaine infiltration anesthetizes less soft tissue [24], has a shorter duration of anesthesia as it is metabolized both in the liver and plasma [5, 12, 17], and avoids trismus and non-surgical paresthesia as a result of damage from the needle to inferior alveolar and lingual nerves [12, 22, 23]. It reduces concentration-related neurotoxicity [22, 23]. Articaine infiltration can be advantageous in hemophilic patients in order to reduce the chances of dangerous hemorrhage [24].

The results of the present study show increased efficacy of infiltration anesthesia in the mandibular molar region with 4% articaine with 1:100,000 adrenaline in approximately 51.1% of adults. Therefore, the study provides evidence to support the view that mandibular buccal and lingual infiltration with 4% articaine with 1:100,000 adrenaline can be as effective as a classic inferior alveolar nerve block with 2% lignocaine with 1:80,000 adrenaline in adult patients undergoing erupted mandibular first and second molar teeth extraction.

Buccal infiltration with 4% articaine with 1:100,000 adrenaline has been shown to achieve higher success rates in mandibular molar anesthesia than that reported with a buccal infiltration of 2% lignocaine with 1:100,000 adrenaline. This increase in efficacy may be a result of a concentration effect or greater diffusion of articaine because of the thiophene ring which helps the anesthetic agent to readily diffuse through the buccal bone [9].

Factors influencing the latency of anesthesia are intrinsic properties of the drug and anesthetic technique, and it is directly influenced by the corresponding pK_a value—smaller pK_a values being associated with a shorter latency. The pK_a of 4% articaine solution is 7.8 [7]. In our study of 100 patients, there were no adverse effects or complications observed although there are few studies reporting increased incidence of nerve alterations, paresthesia, and hyperesthesia with inferior alveolar nerve block with 4% articaine [22, 23]. Keeping the efficacy in mind, articaine is a safer local anesthetic agent similar to other group of local anesthetics [12].

Conclusion

Pain measurement is difficult to establish, because its perception and intensity are multifactorial, encompassing sensorial and affective factors. Multiple variable factors exist like technique variability, anatomic variations, complexity of procedure, and reporting error. Pain itself is multifactorial; perception and pain reaction vary greatly among individuals. Although VAS may show deficiencies regarding understanding and perception, it provides a validated and meaningful measure of anesthetic efficiency and has been used for this purpose by many authors.

No study has compared the efficacy of 4% articaine with 1:100,000 adrenaline buccal and lingual local infiltrations versus 2% lignocaine with 1:80,000 adrenaline inferior alveolar nerve blocks for the extraction of erupted mandibular first and second molars in adults.

A classic inferior alveolar nerve block technique is technique sensitive with high failure rates [19] and complications when compared to a buccal and lingual infiltration (field block technique) [20, 21]. Due to the thick cortical buccal plate, 2% lignocaine with 1:80,000 adrenaline cannot penetrate the bone and anesthetize the region of the adult mandibular molar teeth. Hence, for a single mandibular molar tooth extraction, inferior alveolar nerve block is inevitable. But, 4% articaine with 1:100,000 adrenaline has been shown to be as effective as an inferior alveolar nerve block that allows completion of the tooth extraction procedure successfully and also avoids the possible complications of inferior alveolar nerve block. However, further studies are needed to estimate the onset, duration of anesthesia, and their use in cases of irreversible pulpitis in erupted mandibular teeth extraction in adults.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Elliot V, Hersh H, Giannakopoulos L, Levin M, Stacey S, Paul A, Moore CP, Matthew H, Mohammed B, Ari M, Raymond RT (2006) The pharmacokinetics and cardiovascular effects of high-dose articaine with 1:100,000 and 1:200,000 epinephrine. J Am Dent Assc Vol 137:1562–1571
2. Dudkiewicz A, Schwartz S, Laliberte R (1987) Effectiveness of mandibular infiltration in children using the local anesthetic Ultracaine (articaine hydrochloride). J Can Dent Assn 1:29–31
3. Ram D, Amir E (2006) Comparison of articaine 4% and lidocaine 2% in pediatric dental patients. Int J Paediatr Dent 16(4):252–256

4. Malamed SF, Gagnon S, Leblanc D (2001) Articaine hydrochloride: a study of safety of a new amide local anesthetic. J Am Dent Assc 132:177–185
5. Malamed SF, Gagnon S, Leblanc D (2000) Efficacy of articaine: a new amide local anesthetic. J Am Dent Assoc 131(5):635–642
6. Nuzum FM, Drum M, Nusstein J, Reader A, Beck M (2010) Anesthetic efficacy of articaine for combination labial plus lingual infiltrations versus labial infiltration in the mandibular lateral incisor. J Endod 36(6):952–956
7. Malamed SF Handbook of local anesthesia. Fifth edition Mosby Publishers page no.227 and page no.71
8. Rosenberg AP, Ketan GA, Yigal Z, Louis ML (2007) Comparison of 4% articaine with 1:100,000 epinephrine and 2% lidocaine with 1:100,000 epinephrine when used as a supplemental anesthetic. J Endod 33(4):403–405
9. Corbett IP, Kanaa MD, John MW, John GM (2008) Articaine infiltration for anesthesia of mandibular first molars. J Endod 34:514–518
10. Douglas R, John N, Reader A, Beck M, Melissa MC (2007) The anesthetic efficacy of articaine in buccal infiltration of mandibular posterior teeth. J Am Dent Assoc 138(8):1104–1112
11. Il-Jung Y, Kim JH, Kim E-S, Lee CL, Lee SJ (2008) An evaluation of buccal infiltrations and inferior alveolar nerve blocks in pulpal anesthesia for mandibular first molars. J Endod 34:11–13
12. Yapp KE, Hopcraft MS, Parashos P (2011) Articaine: a review of literature. Br Dent J 210(7):323–329
13. Vahatalo K, Antila H, Lehtinen R (1993) Articiane and lidocaine for maxillary infiltration anesthesia. Anesth Prog 40(4):114–116
14. Nusstein J, Berlin J, Reader A, Beck M, Weaver JM (2004) Comparison of injection pain, heart rate increase, and postinjection pain of articaine and lidocaine in a primary intraligamentary injection administered with a computer-controlled local anesthetic delivery system. Anesth Prog 51(4):126–133
15. Nusstein J, Reader A, Beck M, Weaver JM (2005) A comparison of articaine and lidocaine for inferior alveolar nerve blocks. J Endod 31(4):265–270
16. Oliveira PC, Volpato MC, Ramacciato JC, Ranali J (2004) Articaine and lignocaine efficiency in infiltration anaesthesia: a pilot study. Br Dent J 197(1):45–46
17. Oertel R, Rahn R, Kirch W (1997) Clinical pharmacokinetics of articaine. Clin Pharmacokinet 33:417–425
18. Carlos FS, CSM K, PMGiglio F, Vivien TS, Adriana MC (2007) Epinephrine concentration (1:100,000 or 1:200,000) does not affect the clinical efficacy of 4% articaine for lower third molar removal: a double-blind, randomized, crossover study. J Oral Maxillofac Surg 65(12):2445–2452
19. Giovanarado M, Juliana CR, Patricia CO, Maria CV (2003) Comparison of effectiveness of 4% articaine associated with 1: 100,000 or 1:2,00,000 epinephrine in inferior alveolar nerve block. Anesth Prog 50:164–168
20. Mayes ME, John N, Melissa D, Al R (2011) Anesthetic efficacy of 4% articaine with 1:100,000 epinephrine versus 4% articaine with 1:2,00,000 epinephrine as a primary buccal infiltration in the mandibular first molar. J Endod 37(4):588–592
21. Simon MA, Gielen MJ, Alberink N, Vree TB, van Egmond J (1997) Intravenous regional anesthesia with 0.5% articaine, 0.5% lidocaine, or 0.5% prilocaine. A double blind randomized clinical study. Reg Anesth Pain Med 22(1):29–34
22. Haas DA, Lennon D (1995) A 21 year retrospective study of reports of paresthesia following local anesthetic administration. J Can Dent Assoc 61:319–330
23. Hillerup S, Jensen R (2006) Nerve injury caused by mandibular block analgesia. Int J Oral Maxillofac Surg 35(5):437–443
24. Meechan JG (2002) Supplementary routes to local anaesthesia. Int Endod J 35:885–896