

Articaine and Lidocaine Mandibular Buccal Infiltration Anesthesia: A Prospective Randomized Double-Blind Cross-Over Study

Mohammad Dib Kanaa, MPhil, DDS, John Martin Whitworth, PhD, BChD, Ian Porter Corbett, PhD, BDS, and John Gerard Meechan, PhD, BDS

Abstract

This randomized crossover double-blind trial compared the efficacy of buccal infiltration with 4% articaine and 2% lidocaine (both with 1:100,000 epinephrine) in securing mandibular first molar pulp anesthesia. Injections were given at least 1 week apart in 31 healthy adult volunteers. Electronic pulp testing was undertaken at baseline and at 2 minute intervals until 30 minutes postinjection. A successful outcome was recorded in the absence of pulp sensation on two consecutive maximal pulp tester stimulations (80 μ A). 64.5% of articaine and 38.7% of lidocaine infiltrations were successful ($p = 0.008$). Articaine infiltration produced significantly more episodes of no response to maximum stimulation in first molars than lidocaine (236 and 129, respectively, $p < 0.001$). Mandibular buccal infiltration is more effective with 4% articaine with epinephrine compared to 2% lidocaine with epinephrine. Both injections were associated with mild discomfort. (*J Endod* 2006;32:296–298)

Key Words

Articaine, lidocaine, local anesthesia, lower molar teeth

From the Departments of Oral and Maxillofacial Surgery and Restorative Dentistry, School of Dental Sciences, University of Newcastle upon Tyne, Framlington Place, Newcastle upon Tyne, England.

Address requests for reprints to J.G. Meechan, Department of Oral and Maxillofacial Surgery, School of Dental Sciences, University of Newcastle upon Tyne, Framlington Place, Newcastle upon Tyne, England, NE2 4BW, U.K. E-mail address: J.G.Meechan@ncl.ac.uk.

0099-2399/\$0 - see front matter

Copyright © 2006 by the American Association of Endodontists.

doi:10.1016/j.joen.2005.09.016

A range of local anesthetic drugs have been employed in dentistry, with lidocaine HCl currently considered the gold standard (1). The performance of articaine HCl, introduced in the United Kingdom and the United States in 1998 and 2000, respectively, has been reported as comparable to lidocaine with epinephrine (2). Articaine is the most commonly used dental anesthetic in Germany, Italy, The Netherlands, and Ontario, Canada (3).

Mandibular molars are usually anesthetized by regional blockade of the inferior alveolar nerve. Inferior alveolar nerve blocks (IANB) are not 100% effective in obtaining pulpal anesthesia of mandibular teeth (4). Other techniques such as intra-osseous and periodontal ligament anesthesia may be used to supplement or replace the regional block (5). Another method that might be considered as a supplemental technique is infiltration anesthesia. The effectiveness of infiltration anesthesia has not been tested extensively in mandibular molars.

The aim of the present study was to compare the efficacies of 4% articaine with epinephrine 1:100,000 (Septanest, Deproco, Kent, UK) and 2% lidocaine with epinephrine 1:100,000 (Xylocaine, Dentsply Pharmaceutical, York, PA) in obtaining anesthesia of the pulps of lower first permanent molar teeth after buccal infiltration in volunteers.

Materials and Methods

The study was designed as a prospective randomized double blind cross-over trial, comparing lidocaine 2% with 1:100,000 epinephrine with articaine 4% with 1:100,000 epinephrine. A power calculation indicated that 31 subjects would provide a 90% chance of detecting an effect size of 0.83 (a change of 0.83 standard deviations) in a continuous outcome measure, assuming a significance level of 5% and a correlation of 0.5 between responses from the same subject. Ethical approval was obtained and 31 healthy adult volunteers aged between 20 to 30 years with at least one vital lower first molar were included. All participants provided informed, written consent. All local anesthetic injections (1.8 ml) were given by a single operator (IPC) in the mucobuccal fold adjacent to a mandibular first molar using a standard dental aspirating syringe fitted with a 30-gauge needle. This operator had no involvement with testing the outcome. The injections were administered at a rate of 0.9 ml per 15 seconds. The order of drug administration was randomized, with the second injection at least 1 week after the first. The randomization was determined using a computer-generated sequence of random numbers by one of the authors who was not involved in delivering the local anesthetic. The investigator who enrolled the volunteers was blinded to the order of injection. The same molar area was anesthetized at each visit.

Both the volunteer and the investigator of anesthetic efficacy were blinded to the drug being used. Pulp sensitivity was determined with an electronic pulp tester (Analytic Technology, Redmond, WA), at a rate of 5 μ A s^{-1} on the occlusal surface of the appropriate mandibular first molar twice before injection to establish a baseline reading. The same area on the tooth was tested at each time point. Toothpaste was used as a contact medium. Baseline was taken as the mean of these two readings. Pulp testing was then repeated once every 2 minutes after injection for 30 minutes. To confirm the validity of the reading, a control, unanesthetized tooth on the contralateral side of the mandible was tested at the same times. The change in pulp tester reading at first sensation from baseline was measured at each time point. Similarly, the number of episodes of no response at the maximum stimulation of 80 μ A were recorded. The criterion for successful anesthesia was no volunteer

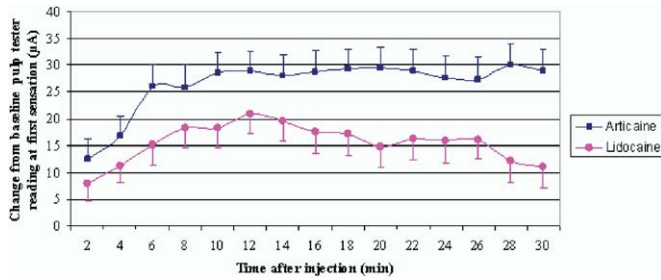


Figure 1. Change of mean pulp tester readings (μA) at first sensation from baseline and standard error of mean at time intervals after lidocaine and articaïne infiltration.

response to the maximum stimulation ($80 \mu\text{A}$) on two or more consecutive episodes of testing.

In addition to objective assessments of pulp anesthesia volunteers were asked to inform the investigator who was testing pulp sensitivity when subjective feelings of anesthesia in the lip and lingual mucosa appeared.

The discomfort experienced during each injection was self recorded by volunteers on 100 mm visual analogue scales (VAS) with endpoints tagged no pain (0 mm) and unbearable pain (100 mm).

Analysis was undertaken in SPSS version 11 for Windows (SPSS Limited, Chicago, IL). The tests employed were Pearson χ^2 , Fisher's exact test, McNemar test, Mann-Whitney, and Student's paired t test.

Results

Volunteers were recruited from the undergraduate and postgraduate student community at the University of Newcastle upon Tyne, England. The study sample ($n = 31$) included 15 males (48.4%) and 16 females (51.6%). The mean age was 22.8 years (SD 2.1 years). Thirteen volunteers received articaïne at the first visit.

Changes from baseline pulp tester readings (μA) at first sensation in first molars at time intervals after injection are shown in Fig. 1. The greatest changes were recorded 28 minutes after articaïne ($30.1 \mu\text{A}$) and 12 minutes after lidocaine administration ($20.7 \mu\text{A}$). Over the 30 minutes of the trial, the mean change from baseline pulp tester readings at first sensation was significantly greater after articaïne than lidocaine ($t = 10.9, p < 0.001$).

The number of episodes of no sensation on maximal ($80 \mu\text{A}$) stimulation in first molars over the period of the trial was greater after articaïne (236) than lidocaine (129). This difference was significant ($p < 0.001$). Figure 2 shows the percentage of volunteers showing no response at maximal stimulation at each time point.

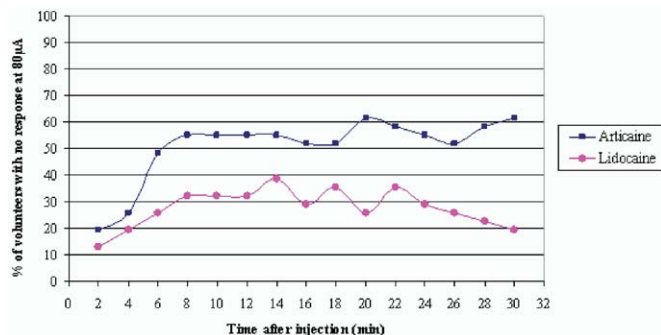


Figure 2. Percentage of volunteers reporting no sensation on maximum stimulation ($80 \mu\text{A}$) in first molars at time intervals after lidocaine and articaïne infiltration.

TABLE 1. Number (N) and percentage (%) of anesthetic success for the 31 volunteers' first molars

Local Anesthetic	Anesthesia Success			
	No		Yes	
	N	(%)	N	(%)
Articaïne	11	(35.5)	20	(64.5)
Lidocaine	19	(61.3)	12	(38.7)
McNemar Test	$p = 0.008$			

No: failure to achieve two consecutive episodes of maximal ($80 \mu\text{A}$) stimulation without sensation. Yes: no sensation in first molar on maximal ($80 \mu\text{A}$) stimulation occurring on two or more consecutive occasions.

Twenty (64.5%) volunteers experienced anesthetic success (two or more consecutive episodes of maximal stimulation ($80 \mu\text{A}$) without sensation) after articaïne injection, compared with 12 (38.7%) after lidocaine. This difference was significant ($p = 0.008$) (Table 1).

The maximum duration of anesthesia possible in this trial was 28 min. Six subjects achieved 28 minutes of continuous anesthesia after articaïne compared with two volunteers after lidocaine.

All volunteers reported lip numbness after each local anesthetic injection. The onset of lip numbness ranged between 12 to 188 seconds after lidocaine (mean 46.9 seconds, SD 33.1 seconds) and 10 to 142 seconds after articaïne (mean 51.2 seconds, SD 26.6 seconds). The difference was not significant ($t = 0.547, p = 0.588$).

Lingual mucosa numbness was reported by seven subjects after articaïne and three after lidocaine buccal infiltration. This difference was not significant ($p = 0.167$).

There was no significant difference in injection discomfort between treatments. The mean VAS scores following lidocaine and articaïne infiltrations were 17.8 mm (SD 14.9 mm) and 20.9 mm (SD 17.9 mm), respectively ($t = 1.0, p = 0.320$).

No adverse events were recorded during any visit.

Discussion

A few studies have investigated the use of infiltration anesthesia in the adult mandible. Yonchak et al. (6) investigated lower incisor anesthesia following buccal or lingual infiltrations. They reported success rates of 45% after labial injections of 2% lidocaine with 1:100,000 epinephrine and 50% after lingual infiltrations of the same solution for lateral incisor pulpal anesthesia. For central incisors the corresponding success rates were 63% and 47%. Meechan and Ledvinka (7) reported similar findings for lower central incisor anesthesia after infiltration with 2% lidocaine with 1:80,000 epinephrine, with success rates of 50% following the buccal or lingual injection of 1.0 ml of solution. Haas et al. (8) reported no difference in the efficacies of 4% articaïne and 4% prilocaine (both with epinephrine 1:200,000) in obtaining pulpal anesthesia in mandibular teeth. They noted success for lower second molar pulpal anesthesia after mandibular buccal infiltration in 63% (12/19) of subjects after 4% articaïne and 53% (10/19 subjects) after 4% prilocaine. Rood (9) investigated the use of infiltration anesthesia to overcome failed inferior alveolar nerve block injections in a range of clinical dental procedures. In that study 331 cases received an IANB injection and 79 experienced failure. After supplementary buccal infiltration with 1.0 ml of 2% lidocaine with 1:80,000 epinephrine, 70 patients experienced successful pulpal analgesia. The remaining nine received lingual infiltration, of whom two reported no pain during subsequent treatment.

A number of studies have reported no significant differences between 4% articaïne and 2% lidocaine for different intra-oral local anesthetic techniques (4, 10–12), however, none has investigated buccal infiltration for lower first molars. One study (11) suggested that although articaïne and lidocaine did not differ significantly in providing successful pulpal anes-

sia for maxillary canines, the former seemed to provide a longer duration of action. Another study (4) reported no difference between articaine and lidocaine after regional block of the mandible in 72 patients diagnosed with irreversible pulpitis. Articaine was ineffective in 76% of cases compared to 77% after lidocaine inferior alveolar nerve block injection (4). Similarly, there was no difference between 4% articaine and 2% lidocaine both with 1:100,000 epinephrine in obtaining pulpal anesthesia after inferior alveolar nerve blocks in a prospective randomized double-blind cross-over study with 57 volunteers (13).

To the best of our knowledge, no study has compared the efficacy of lidocaine and articaine when administered as buccal infiltrations in the mandible. We found that articaine produced greater changes from baseline pulp tester readings than lidocaine (Fig. 1). Although this difference is worth noting the important result clinically is no response at maximum stimulation (80 μ A). We used two or more consecutive pulp tester readings at 80 μ A without sensation as the criterion for success as similar criteria have been used in other studies (6, 10, 14–21). We found greater success in obtaining anesthesia in the first permanent lower molar with articaine. Our success with articaine (64.5%) was similar to that reported by Haas et al. (8). In the present study pulpal anesthesia was considered successful in only 38.7% of cases after the use of 2% lidocaine with epinephrine. This was less than that reported by Haas et al. (8) with 4% prilocaine for mandibular second molar teeth. This could be the result of testing a different tooth; however it may be that the lack of success with lidocaine is because of the lower concentration. This needs to be investigated further. Our results show that the difference between articaine and lidocaine was most obvious towards the end of the study period. This agrees with the findings of Oliveira et al. (11) and Costa et al. (22) who suggested that articaine provided longer lasting pulpal anesthesia than lidocaine. In the present study the percentage of patients showing no response at maximal stimulation (80 μ A) reduced at all reference points after 22 min when lidocaine was used (Fig. 2). This was not the case with articaine as the greatest percentage of nonresponders was noted at the end of the trial (Fig. 2). An investigation of longer duration is required to determine the timing of the peak effect and duration of anesthesia of articaine after mandibular infiltration.

All the volunteers in this study reported lip numbness after each injection. Few reported subjective anesthesia of the lingual mucosa that suggests a limited ability of the anesthetic to diffuse through the entire thickness of the mandibular alveolus, and agrees with the findings of Haas et al. (8).

A score of less than 30 mm is considered to represent mild discomfort when using VAS to record pain (23). The results of the present study suggest that buccal infiltration in the mandible produces only mild discomfort. The results are comparable to those reported for buccal infiltrations in the maxilla in a similar volunteer population (24).

In conclusion, 4% articaine with epinephrine was more effective than 2% lidocaine with epinephrine in producing pulp anesthesia in lower molars after buccal infiltration. Both solutions produced mild discomfort during mandibular buccal infiltration.

Acknowledgments

Three of the four authors affirm that they have no financial affiliation (e.g. employment, direct payment, stock holdings, retainers, consultancies, patent licensing arrangements, or honoraria), or involvement with any commercial organization with direct financial interest in the subject or materials discussed in this manuscript, nor have any such arrangements existed in the past three years. One of the authors declares that he has received honoraria from Dentsply who supply lidocaine with epinephrine and has received research funding in the past for studies unrelated to the

present study from Deproco, who supply articaine with epinephrine. No financial support was received for the present study. There are no other areas of potential conflict of interest to disclose.

References

1. Rowson JE, Preshaw PM. The use of lignocaine in dental practice: results of a survey of a group of general and hospital dental practitioners. *J Dent* 1997;25:431–3.
2. Malamed SF, Gagnon S, Leblanc D. Articaine hydrochloride: a study of the safety of a new amide local anesthetic. *J Am Dent Assoc* 2001;132:177–85.
3. Gouws P, Galloway P, Jacob J, English W, Allman KG. Comparison of articaine and bupivacaine/lidocaine for sub-Tenon’s anaesthesia in cataract extraction. *Br J Anaesth* 2004;92:228–30.
4. Claffey E, Reader A, Nusstein J, Beck M, Weaver J. Anesthetic efficacy of articaine for inferior alveolar nerve blocks in patients with irreversible pulpitis. *J Endod* 2004;30:568–71.
5. Meechan JG. Supplementary routes to local anaesthesia. *Int Endod J* 2002; 35:885–96.
6. Yonchak T, Reader A, Beck M, Clark K, Meyers WJ. Anesthetic efficacy of infiltrations in mandibular anterior teeth. *Anesth Prog* 2001;48:55–60.
7. Meechan JG, Ledvinka JI. Pulpal anaesthesia for mandibular central incisor teeth: a comparison of infiltration and intraligamentary injections. *Int Endod J* 2002; 35:629–34.
8. Haas DA, Harper DG, Saso MA, Young ER. Lack of differential effect by Ultracaine (articaine) and Citanest (prilocaine) in infiltration anaesthesia. *J Can Dent Assoc* 1991;57:217–23.
9. Rood JP. The analgesia and innervation of mandibular teeth. *Br Dent J* 1976; 140:237–9.
10. Berlin J, Nusstein J, Reader A, Beck M, Weaver J. Efficacy of articaine and lidocaine in a primary intraligamentary injection administered with a computer-controlled local anesthetic delivery system. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2005;99:361–6.
11. Oliveira PC, Volpato MC, Ramacciato JC, Ranali J. Articaine and lignocaine efficiency in infiltration anaesthesia: a pilot study. *Br Dent J* 2004;197:45–6.
12. Malamed SF, Gagnon S, Leblanc D. Efficacy of articaine: a new amide local anesthetic. *J Am Dent Assoc* 2000;131:635–42.
13. Mikesell P, Nusstein J, Reader A, Beck M, Weaver J. A comparison of articaine and lidocaine for inferior alveolar nerve blocks. *J Endod* 2005;31:265–70.
14. Dagher FB, Yared GM, Machtou P. An evaluation of 2% lidocaine with different concentrations of epinephrine for inferior alveolar nerve block. *J Endod* 1997; 23:178–80.
15. Hannan L, Reader A, Nist R, Beck M, Meyers WJ. The use of ultrasound for guiding needle placement for inferior alveolar nerve blocks. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1999;87:658–65.
16. McLean C, Reader A, Beck M, Meyers WJ. An evaluation of 4% prilocaine and 3% mepivacaine compared with 2% lidocaine (1:100,000 epinephrine) for inferior alveolar nerve block. *J Endod* 1993;19:146–50.
17. Nist RA, Reader A, Beck M, Meyers WJ. An evaluation of the incisive nerve block and combination inferior alveolar and incisive nerve blocks in mandibular anesthesia. *J Endod* 1992;18:455–9.
18. Yonchak T, Reader A, Beck M, Meyers WJ. Anesthetic efficacy of unilateral and bilateral inferior alveolar nerve blocks to determine cross innervation in anterior teeth. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2001;92:132–5.
19. Reitz J, Reader A, Nist R, Beck M, Meyers WJ. Anesthetic efficacy of a repeated intraosseous injection given 30 min following an inferior alveolar nerve block/intraosseous injection. *Anesth Prog* 1998;45:143–9.
20. Gallatin J, Reader A, Nusstein J, Beck M, Weaver J. A comparison of two intraosseous anesthetic techniques in mandibular posterior teeth. *J Am Dent Assoc* 2003; 134:1476–84.
21. Clark S, Reader A, Beck M, Meyers WJ. Anesthetic efficacy of the mylohyoid nerve block and combination inferior alveolar nerve block/mylohyoid nerve block. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1999;87:557–63.
22. Costa CG, Tortamano IP, Rocha RG, Francischone CE, Tortamano N. Onset and duration periods of articaine and lidocaine on maxillary infiltration. *Quintessence Int* 2005;36:197–201.
23. Collins SL, Moore RA, McQuay HJ. The visual analogue pain intensity scale: what is moderate pain in millimetres? *Pain* 1997;72:95–7.
24. Meechan JG, Howlett PC, Smith BD. Factors influencing the discomfort of intraoral needle penetration *Anesth Prog* 2005;52:91–4. Appendix Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.joen.2005.09.016.