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A Survey on the Usage of Articaine Among General and Pediatric Dentists

Robert Louis Hollowell III
Virginia Commonwealth University

A SURVEY ON THE USAGE OF ARTICAINE AMONG GENERAL AND PEDIATRIC DENTISTS

A thesis submitted in partial fulfillment of the requirements for the degree of Masters of Science in Dentistry at Virginia Commonwealth University.

by

ROBERT LOUIS HOLLOWELL, III
B.S., The University of North Carolina at Chapel Hill, 1999
D.D.S., The University of North Carolina at Chapel Hill, 2004

Director: TEGWYN H. BRICKHOUSE D.D.S., PH.D.
ASSISTANT PROFESSOR, DEPARTMENT OF PEDIATRIC DENTISTRY

Virginia Commonwealth University
Richmond, Virginia
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Abstract

A SURVEY OF THE USAGE OF ARTICAINE AMONG GENERAL AND PEDIATRIC DENTISTS

By Robert Louis Hollowell, III, B.S., D.D.S.

A thesis submitted in partial fulfillment of the requirements for the degree of Masters of Science at Virginia Commonwealth University.

Virginia Commonwealth University, 2007

Major Director: Tegwyn H. Brickhouse, D.D.S., Ph.D.
Department of Pediatric Dentistry

Purpose: The purpose of this study is to determine the impact that the introduction of articaine has had on local anesthetic selection by general and pediatric dentists for use in three different age groups of children.

Methods: Using a cross sectional survey design, a questionnaire regarding the use of local anesthetics in children was mailed to a random sample of 500 general dentists from North Carolina, 500 general dentists from Virginia, and all 230 pediatric dentists from North Carolina and Virginia. The 16-item questionnaire included questions regarding the preferred local anesthetic to use in three different age groups, 2-3 years of

age, 4-6 years of age, and 7-10 years of age. Furthermore, the questionnaire also included questions specifically on articaine use in the three different age groups and any related side effects. The association between dental practitioner type and anesthetic use was tested using chi-square or Fisher's exact test.

Results: A sample of 337 dentists completed the questionnaire. There was no significant difference in preference of articaine except in older patients aged 7-10 years old where general dentists prefer articaine significantly more than do pediatric dentists (28.1% versus 15.9%). Lidocaine with epinephrine was the local anesthetic that was most preferred in all age groups by all practitioners. Pediatric dentists preferred lidocaine more often than general dentists and general dentists preferred lidocaine without epinephrine more often than pediatric dentists. Twenty-one percent of all dentists surveyed have used articaine in children under 4 years of age and 13% list articaine as the preferred local anesthetic for children under 4 years of age.

Conclusion: While lidocaine with epinephrine is still the preferred local anesthetic for use in children, the use of articaine in children is very prevalent among general and pediatric dentists. Articaine use becomes more prevalent as the age of the patient increases and many pediatric and general dentists are using articaine in children under four years of age.

Introduction

One of the most important events that shape the relationship between a dentist and a child dental patient is the successful administration of local anesthesia for an operative procedure. Prevention of pain during operative procedures can nurture the relationship of the patient and dentist, building trust, allaying fear and anxiety, and promoting a positive dental attitude.[1] Dental injections are associated with anxious thoughts and fears in children and can be one of the most difficult aspects of treating a child dental patient.[2] In addition, practitioners have to take special consideration of the smaller size of children because child patients are more likely to experience toxic reactions from local anesthetics than adults because of their smaller anatomic proportions.[3] For these reasons it is paramount that the practitioner chooses a local anesthetic that will minimize the number of injections and amount of anesthetic used while still allowing the required anesthesia to be obtained. With each local anesthetic available for use the practitioner must take into account the duration of action, potency, mechanism of action, metabolism and excretion.[4] Even after considering all of these factors there are still several local anesthetic agents that practitioners can use in children that would satisfy the requirements for safe local anesthesia in most operative cases.

Articaine (Septocaine, Zorcaine) is a relatively new amide local anesthetic being used in the United States that was recently approved for sale in the U.S. by the U.S. Food and Drug Administration in 2000.[5] Before its U.S. approval, articaine has been in clinical use in many countries since 1976 and is the most widely used dental local anesthetic in several European countries.[5-7] Studies have confirmed that articaine is a safe, well-tolerated and effective local anesthetic for use in both adults and children.[5,6]

Articaine has two unique properties related to its molecular structure that make it an attractive local anesthetic for clinical use. First, articaine contains a thiophene group (in place of the benzene ring found in other amide local anesthetics) that increases its liposolubility and potency.[5-10] This unique property allows articaine to more easily diffuse through soft tissue and bone than other local anesthetics.[8] Though much of the information is anecdotal, many dentists believe that this property of articaine allows for an increased success rate of local anesthesia.[8] Second, articaine contains an ester group that allows it to be metabolized both in the plasma and tissue into its inactive metabolite, articainic acid. Studies have shown that there is a large difference between the serum concentration of articaine and articainic acid reflecting the fast hydrolysis of articaine in the tissue and blood.[8,9] This allows most articaine to reach the systemic circulation as an inactive metabolite thus decreasing the risk of systemic intoxication.[8,9]

Articaine has been proven to be safe in children ages 4-10 in several studies.[6] However, the use of articaine in children under 4 years of age is not recommended since

no data exists to support this usage. Despite this, a retrospective study of the use of articaine in children under 4 years of age has previously been compiled. In this study 211 patients under the age of 4 received 240 doses of articaine without any adverse effects being reported. Sixty-four of these 211 patients received articaine in addition to oral sedation and 28% of these 64 patients actually received doses of greater than 5 mg/kg with no adverse effects. A larger prospective clinical study is needed to provide sufficient data to allow articaine to be recommended for use in children under the age of four.[3]

Literature review reveals that there have not been any studies that examine dentists' preferences for using articaine in children. The most recent study that examined local anesthetic use in children was in 1992 which surveyed local anesthetic usage in pediatric patients by Florida dentists. In this study it was determined that 69 percent of the dentists surveyed preferred lidocaine with epinephrine as their local anesthetic agent of choice when treating children.[4] However, this study did not include the effect of articiane on local anesthetic selection because articaine was not FDA approved for use in the U.S. at the time of the study. The purpose of the current study was to determine what affect the introduction of articaine has had on the preferred local anesthetic used in children at different ages as well as to determine if there is any difference in articaine use in children between pediatric and general dentists.

Materials and Methods

A brief survey was mailed to 1130 dentists. These 1130 dentists were comprised of 500 randomly selected dentists from members of the North Carolina Dental Society (NCDS), 500 randomly selected dentists from members of the Virginia Dental Association (VDA), all 117 American Academy of Pediatric Dentistry (AAPD) members from North Carolina, and all 113 American Academy of Pediatric Dentistry members from Virginia. Only those surveys received within one month of the mailing date were included in the study.

The first three questions of the survey were used to gather some demographic information about the respondents and also to determine if any of the respondents would be ineligible for inclusion in the survey. Respondents were asked to answer "yes" or "no" regarding if they treat children. Any respondents that replied "no" that they do not treat children were not eligible to have their survey included in the data.

Questions 4-12 asked respondents about the use of different local anesthetics in different age groups in their practices. The local anesthetics include were lidocaine with epinephrine, lidocaine without epinephrine, articaine or other. Since the literature reports

that the efficacy of 4% articaine 1:200,000 epinephrine and 4% articaine 1:100,000 are the same, there was no differentiation made between the two on the survey[11]. The age groups included in the survey were ages 2-3, ages 4-6 and ages 7-10. Questions 14-16 asked practitioners to indicate if they had ever had any self reported side effects that they would attribute to the use of articaine. The association between dental practitioner type and anesthetic use was tested using chi-square or Fisher's exact test. The use of articaine across different age groups and the practitioners' change across time were modeled using repeated-measures logistic regression (SAS PROC GENMOD with an exchangeable correlation structure).

Results

Of the 1230 dentists surveyed a total of 447 surveys were returned yielding a gross response rate of 36.3%. Of these 447 respondents, 74 did not indicate that they do operative procedures on children and so these 74 surveys were not included in subsequent analyses. After excluding these surveys, 373 surveys were analyzed yielding a final response rate of 30.3%. Furthermore, some respondents did not answer all of the questions in the survey so these surveys were excluded from the analysis of the question(s) in which they did not answer. The response rate for dentists from North Carolina was 29% (N=179) and the response rate for dentists from Virginia was 31.6% (N=194). The response rate for pediatric dentists was 59.1% (N=136) and the response rate for general dentists and other specialists was 21.9% (N=219). Pediatric dentists represented 36.5% of the total respondents and general dentists represented 58.8% of the total respondents. The remaining 17 respondents indicated another specialty or did not indicate a practice type. For the purpose of analysis, these other practice/specialty types were included with pediatric dentists as their responses were more similar to this group.

For questions 4 through 6, respondents were asked to indicate which local anesthetic they prefer to use in three patient age groups (2-3 years, 4-6 years, 7-10 years).

The results are summarized in Table 1 and in Figure 1. There was no significant difference in preference of articaine between providers except in older patients aged 7-10 years old where general dentists prefer articaine significantly more than do pediatric dentists (28.1% versus 15.9%). While the results were not statistically significant, articaine preference did rise slightly as age increased across all practitioner groups. There was a significant difference in the preference of both lidocaine with epinephrine and lidocaine without epinephrine between general and pediatric dentists. In the age group 2-3 years old, 51.5% of general dentists that treat 2-3 year olds prefer lidocaine with epinephrine which is significantly less that the 77.3% of pediatric dentists that treat 2-3 year olds (chi-square = 18, $p < .0001$). Also, general dentists use lidocaine without epinephrine more often than do pediatric dentists (14.9% versus 5%) in 2-3 year olds. These patterns are consistent across the three age groups (chi-square < 1, p-value > 0.7).

For questions 7 through 12, respondents were asked to indicate whether they currently use articaine and whether they have ever used articaine in the same three patient age groups (2-3, 4-6, 7-10). For each of the six questions, a 'yes' or 'no' response was indicated. To determine if there is a "current" versus "ever" difference and whether there was an age-group difference a repeated-measures logistic regression was used. The results indicated that there was no difference in practitioner type on "current" or "ever" use of articaine (chi-square = 1.54, df = 2, p-value > 0.4). However, there was a significant increase in articaine use (chi-square = 21.5, p-value < .0001) and a significant difference in articaine use as the age groups increased in age (chi-square = 88.15, df = 2, p-value < .0001). These two effects were independent of each other [the interaction test]

(chi-square = 1.81, p-value > 0.4). The results are summarized in Table 2. Furthermore, the model estimates revealed that 19.8% of dentists surveyed were using Articaine in 2-3 year olds, 40.1% use articaine in 4-6 year olds and 49.9% use articaine in 7-10 year olds. There was no significant difference between those practitioners that have ever used articaine and those practitioners that still currently use articaine.

Finally, in questions 14-16 respondents were asked to indicate if any of their patients had experienced any adverse effects of local anesthesia that the respondent would attribute to articaine. Of the 74 respondents that had ever used articaine in 2-3 year olds, two respondents indicated witnessing adverse effects in anesthetized patients that they would attribute to articaine, both being cases of prolonged anesthesia. In the 149 respondents that had ever used articaine in the 4-6 age group, there were 3 respondents that indicated witnessing adverse effects in anesthetized patients that they would attribute to articaine. These adverse effects in the 4-6 year age group were 1 case where the child developed a rash, 1 case of prolonged anesthesia, and one case of symptoms indicative of a toxic dose of local anesthetic. In the 194 respondents that indicated that they had ever used articaine in 7-10 year olds, there were seven cases of adverse effects: 2 possible allergic reactions, 2 cases of prolonged anesthesia, 1 allergy to preservative, 1 case of severe drowsiness, and 1 case of transient parasthesia.

Discussion

Similar to the 1992 study by Cheathem et al, this study showed that lidocaine w/ epinephrine is still the local anesthetic of choice among all the dentists surveyed (62.7% prefer it in 2-3 year olds, 62.8% in 4-6 year olds, 63.9% in 7-10 year olds).[4] These numbers are all lower than the 69 percent of practitioners who preferred to use lidocaine with epinephrine in children in the 1992 survey by Cheatham et al.[4] This small decrease in lidocaine with epinephrine preference may be explained partly by the introduction of articaine into the market. In this survey, articaine use as the preferred anesthetic among all dentists rose with age from 13% in 2-3 years olds to 23.1% in 7-10 year olds. Much of this increase in articaine use was not only at the expense of lidocaine w/ epinephrine but also at the expense of other anesthetics that are preferred for use in children. However, the lidocaine with epinephrine preference stayed very steady throughout the three age groups while the other preferred local anesthetics shifted from lidocaine without epinephrine and other anesthetics to an increasing preference for articaine as the age of the patient increased. As the age of the patient increases articaine seems to take over the niche held by the local anesthetics other than lidocaine with epinephrine. So, it appears that the introduction of ariticaine into clinicians' armamentarium has affected the preference of local anesthetics that clinicians use in children.

There was a difference in preferred local anesthetic for use in children between general dentists and pediatric dentists. In all age groups pediatric dentists preferred lidocaine with epinephrine much more than general dentists (77.3% vs 51.4% in 2-3 year olds, 76.6% vs 53.7% in 4-6 year olds, and 74.8% vs 56.2% in 7-10 year olds). However, general dentists used much more lidocaine without epinephrine through all age groups. The preference of articaine rose slightly among the three age groups with greater increases in aritcaine preference by general dentists leading to a significantly larger preference of articaine in 7-10 year olds by general dentists. The reasons for these differences in preferred local anesthetic are speculative. It would appear that general dentists may possibly be more concerned about the effect that epinephrine may have on children while this does not appear to be as much of a concern among pediatric dentists. Also, general dentists may be more likely to use articaine, especially in older children, because that is what they use on their adult patients as well. Pediatric dentists tend to prefer lidocaine with epinephrine and this may be because it has been successful for them for many years. Many pediatric dentists became very good gaining local anesthesia using lidocaine with epinephrine and many may see no need to try a different local anesthetic. On the other hand, most general dentists are not as experienced as pediatric dentists at providing local anesthesia for children and may be looking for any advantage that the introduction of a new local anesthetic could provide.

This survey also examined how many dentists currently use articaine in children (even if it is not their preferred local anesthetic) and how many dentists have ever used articaine in children. As with the rest of this study, the number of dentists who have ever used aritcaine in children or currently use articaine in children increased with age among the three groups ages 2-3 years old, 4-6 years old, and 7-10 years old. There was very little decrease from the number of dentists that have ever used articaine to the number of dentists that currently use articaine. This indicates that there are not many dentists that use articaine and then later decide not to use it at all. Most dentists in this survey that used articaine appear to have liked it enough to continue to use it. On the other hand, it appears that as many as 48% of dentists surveyed have never used articaine. It is possible that if more dentists had tried articaine then there may be a larger percentage of dentists that prefer articaine in the three age groups.

In this study, articaine was the preferred local anesthetic in children ages 2-3 years in 13% of all dentists (15.5% general and 9.9% pediatric). Furthermore, 21% (n=74) of all respondents reported having used articaine at some point in 2-3 year olds. This indicates that many dentists are using articaine in patients younger than 4 years of age despite the fact that its use is not recommended in this age group. Of these 74 respondents only two had witnessed an adverse effect of local anesthesia that they would attribute to articaine and in both of these incidences the effect was prolonged anesthesia. Similar to the study by Wright et al, this study reported very few adverse affects of using articaine in this age group. This study gives more support to the argument that a larger

prospective study should be done in order to provide sufficient data to allow articaine to be recommended for use in children under the age of four.

There are several properties of articaine that would make it appear to be a very good agent to use in gaining local anesthesia in children. While most other local anesthetics have a benzene ring as their aromatice ring, articaine has a thiophene ring allowing it to possess greater lipid solubility than lidocaine.[5-9] This greater lipid solubility enhances diffusion through tissue and nerve sheaths as well as neural membranes and increases the potentcy of the local anesthetic by allowing for higher intranerual concentration, more extensive longitudinal spreading and better conduction blockade [8,9] Malamad states that the potency of Articaine is 1.5 that of lidocaine and 1.9 that of procaine.[10] This indicates that septocaine may be superior to lidocaine for obtaining local anesthesia but the evidence to support this is mostly anecdotal. While some studies have shown articaine to be superior in vitro there are few double-blinded studies that support the statement that articaine is superior to lidocaine.[12] In fact, double-blinded studies have confirmed that the efficacy of septocaine is comparable to but not superior to that of lidocaine.[7] A recent study by Uckan et al. showed that there was not a difference in extracting permanent bicuspids anesthetized with a buccal infiltration of articaine only and extracting bicuspids with articaine buccal infiltration and palatal infiltration.[13] However, this study is not in agreement with an earlier study by Haas where articaine was unable to induce palatal anesthesia.[14] To this date, there is little

evidence other than anectodal evidence to support articaine being superior over other local anesthetics.

Another property of articaine that makes it an attractive local anesthetic agent for use in children is its ester group. Articaine is classified as an amide because of its linkage of its intermediate chain but the thiophene ring also contains an ester side chain.[5-10] Because of this ester lingkage, articaine in plasma is biotransformed by hydrolysis by plasma esterases rendering the molecule inactive.[5-10] So, any excess articaine molecules that are not bound to proteins in sodium ion channels are taken up into plasma and quickly hydrolyzed into inactive metabolites. This results in articaine having a half-life of only 20 minutes compared with the half life of approximately 90 minutes of most other amides requiring hepatic clearance.[5-10] There are a lack of any reports of overdose mortalities attributed to articaine which could be a result of its rapid clearance.[15] Even with this rapid clearance, practitioners should take note of the maximum recommended does of articaine for children. It must be noted that 4% articaine has nearly twice the concentration of active anesthetic than 2% lidocaine. A review of the literature and text books reveal that the maximum dose of articaine for children is 5mg/kg or 7 mg/kg.[16] The 4th edidtion of Malamed's Handbook of Local Anesthesia stated that the maximum articaine does for children was 5 mg/kg while the updated 5th edition states that it is 7 mg/kg.[17] The Septocaine package insert in the U.S states that the maximum does of articaine for children is 7 mg/kg while the septocaine package insert in Canada list the

maximum does for children at 5 mg/kg.[9] More studies into the maximum recommended does for children may be needed in order to come to a unified conclusion.

Articaine use in children may be less prevalent than lidocaine with epinephrine use due to some highly publicized but yet rather rare side effects. Several papers have been published claiming that 4% articaine causes a higher incidence of paresthesia than other local anesthetics when doing an IAN block.[18,19] While this may be true, the overall incidence of paresthesia attributed to mandibular blocks with articaine is still very low and was estimated in one paper to be 2.05 per million injections.[20] Malamed reports that there is not any scientific evidence that supports that articaine should be avoided in mandibular blocks.[21] Furthermore, Malamed's randomized double blind study on 1,325 patients found that there was no difference in the amount of paresthesia caused by lidocaine and articaine.[5]

This study had several limitations. There were a limited selection of anesthetics included in the survey and many local anesthetic choices were just included in the "others" selection. Also, the observed side effects found in the different age groups were self reported by the dentists. There were not any questions asking about the education of the survey respondents so educational differences regarding articaine could not be determined.

In conclusion, the introduction of articaine has affected the use of local anesthetics in children. When the preferred local anesthetics used in children were examined, it was found that as the age of the patient increased the preference of articaine increased. When the differences in local anesthetic use among general dentists and pediatric dentists were examined it was found that pediatric dentists preferred lidocaine with epinephrine more than general dentists and general dentists preferred articaine more than pediatric dentists in older patients. In children under the age of four 21% of dentists surveyed had used articaine.

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Table 1: Preferred Local Anesthetic.

	Preferred Anesthetic % (N)				
Specialty type	Lidocaine with epinephrine	lidocaine without epineprhine	articaine	other	total
		Age Group: 2-3			
General	51.4% (93)	14.9% (27)	15.5% (28)	18.2% (33)	181
Pediatric and other	77.3% (109)	5.0% (7)	9.9% (14)	7.8% (11)	141
All	62.7% (202)	10.6% (34)	13.0% (42)	13.7% (44)	322
		Age Group: 4-6			
General	53.7% (117)	10.1% (22)	24.8% (54)	11.5% (25)	218
Pediatric and other	76.6% (111)	1.4% (2)	14.5% (21)	7.6% (11)	145
All	62.8% (228)	6.6% (24)	20.7% (75)	9.9% (36)	363
		Age Group: 7-10			
General	56.2% (122)	6.5% (14)	28.1% (61)	9.2% (20)	217
Pediatric and other	74.8% (113)	1.3% (2)	15.9% (24)	7.9% (12)	151
All	63.9% (235)	4.3% (16)	23.1% (85)	8.7% (32)	368

Table II**:** Repeated-measures logistic regression.

	Current Users		Ever Used	
Age Group	Yes/Total	%	Yes/Total	%
2 to 3	63/347	18.2	74/350	21.1
4 to 6	131/362	36.2	149/365	40.8
7 to 10	165/369	44.7	194/370	52.4
Model Estimates		32.7		52.4
Chi-square = 1.54, df = 2, p-value > 0.4				

Figure 1A: Preferred Local Anesthetic in 2-3 year olds

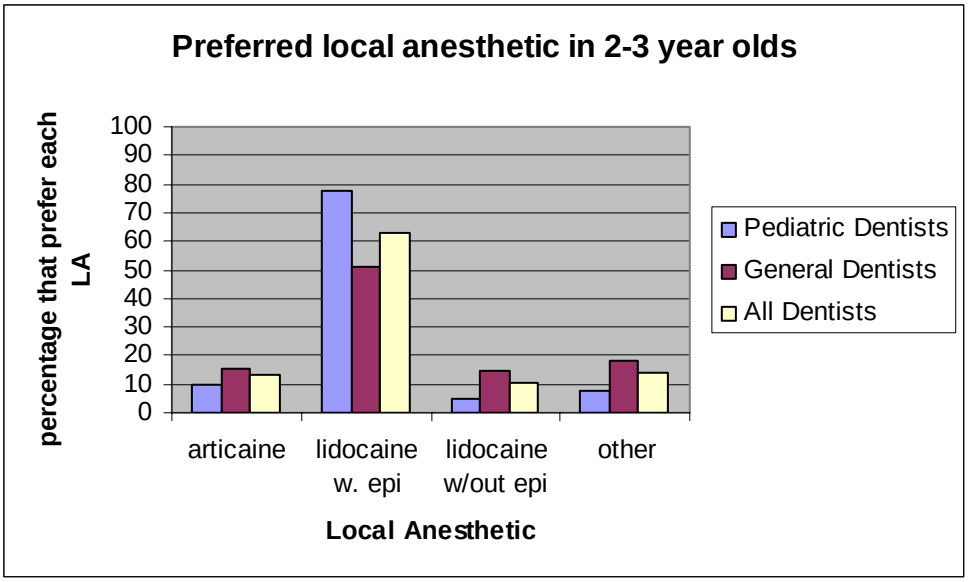


Figure 1B: Preferred Local Anesthetic in 4-6 year olds

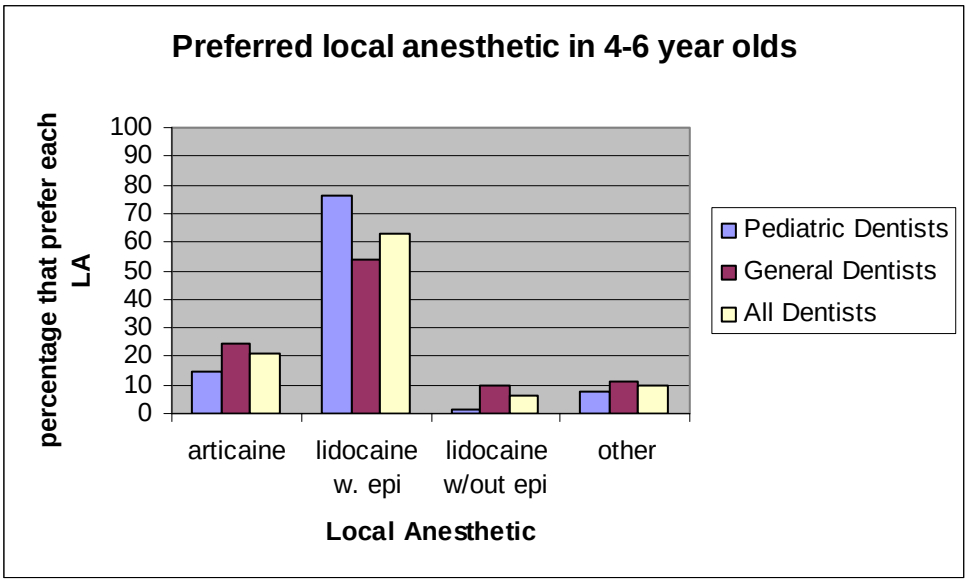
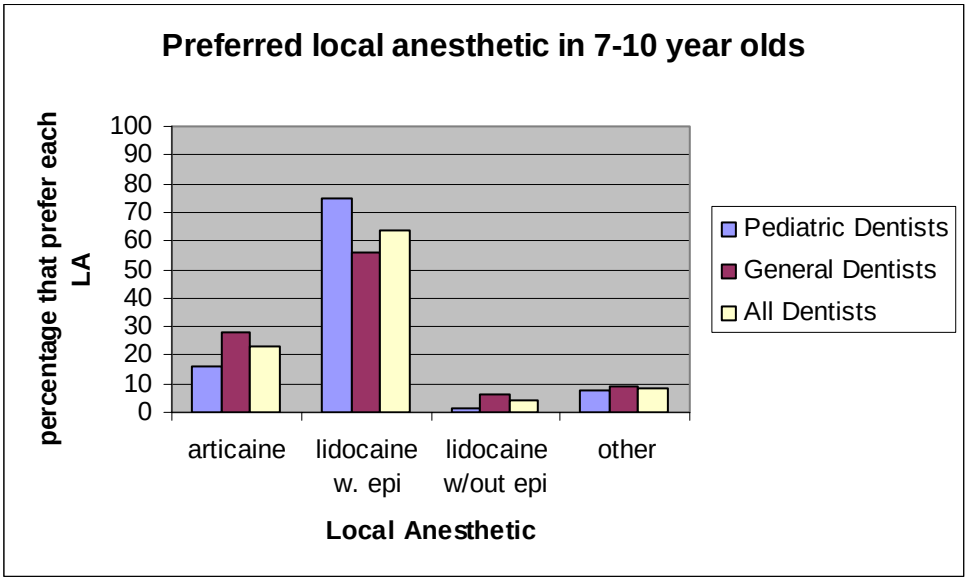


Figure 1C: Preferred Local Anesthetic in 7-10 year olds



APPENDIX A

COVER LETTER

Dear Doctor,

One of the most important events that shape the relationship between a dentist and a child dental patient is the successful administration of local anesthesia for an operative procedure. New trends in local anesthesia are constantly emerging that could possibly make the administration of local anesthesia more reliable and the resulting dental treatment more pleasant. One way for a dentist to find out about new trends in local anesthesia is by finding out what other dentists are doing to gain successful local anesthesia.

Included in this mailing is a brief questionnaire asking about your use in your practice of different local anesthetics on child dental patients of different ages. Please answer all questions that apply to you. This questionnaire is a part of a Masters Thesis project at Virginia Commonwealth School of Dentistry and has been IRB approved. This project is funded by a small departmental grant and is not industry funded. No individual identifying information will be used. The presentation of the data collected from this questionnaire will be in group format only. Your response will be part of a random sample and every response is important to creating a useful analysis and is greatly appreciated.

Sincerely,

Robert L. Hollowell D.D.S.
Department of Pediatric Dentistry
VCU School of Dentistry

APPENDIX B

SURVEY

1) In which state do you actively practice? □ North Carolina □ Virginia □ neither

If you answered "Neither" to the above question you do not need to answer any further questions.

2) Are you a Pediatric Dentist? □ Yes □ No

3) If you answered "No" to the above question, do you do operative procedures on children?
□ Yes □ No

If you answered "No" to question #3 then you do not need to answer any further questions.

For questions 4-6 please indicate your preferred local anesthetic to use in the following age groups. Please note that Septocaine is the US trade name for Articaine.

Age				
4) 2-3	□ Lidocaine w/ epi	□ Lidocaine w/out epi	□ Articaine	□ other
5) 4-6	□ Lidocaine w/ epi	□ Lidocaine w/out epi	□ Articaine	□ other
6) 7-10	□ Lidocaine w/ epi	□ Lidocaine w/out epi	□ Articaine	□ other

For questions 7-9 please indicate if you currently ever use Articaine (Septocaine) in the following age groups.

Age		
7) 2-3	□ Yes	□ No
8) 4-6	□ Yes	□ No
9) 7-10	□ Yes	□ No

For question 10-12 please indicate if you have ever used Articaine (Septocaine) in the following age groups.

Age		
10) 2-3	□ Yes	□ No
11) 4-6	□ Yes	□ No
12) 7-10	□ Yes	□ No

Do you use articaine (regardless of age group) in children for Inferior Alveolar Nerve Blocks?
13) □ Yes □ No

For questions 14-16 please indicate if you have had any adverse affects that you would attribute to the local anesthetic when using Articaine (Septocaine) in the age groups below.

	Age		
14)	2-3	□ Yes (please specify) _____	□ No
15)	4-6	□ Yes (please specify) _____	□ No
16)	7-10	□ Yes (please specify) _____	□ No

VITA

Robert Louis Hollowell, III was born on July 27, 1977 in Elizabeth City, North Carolina. He graduated from Perquimans County High School, Hertford, North Carolina in 1995. He received at BS in Chemistry from The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina in 1999. Dr. Hollowell received his Doctor of Dental Surgery from The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina in 2004.