

Bupivacaine for Root Canal Treatment – Practitioner Behaviors and Patient Perspectives: Survey Studies

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Introduction and Objectives: Local anesthesia is essential in dentistry in providing intraoperative analgesia and anesthesia. However, knowledge related to its use for management of post-operative pain is limited. Perioperative pain management is especially important for root canal treatment (ie, endodontic therapy), performed by endodontists. In this study, we sought to better understand endodontists' attitudes regarding the use of long-lasting anesthetic, namely 0.5% bupivacaine HCl with 1:200,000 epinephrine, for the management of post-endodontic pain. Additionally, we aimed to understand the perspectives of dental patients about receiving longer lasting anesthesia for endodontic therapy and to determine factors that affect their anesthetic preferences within the orofacial region.

Methods: An email invitation to participate in an anonymous online survey was sent to members of the American Association of Endodontists. Also, 82 patients attending an in-person visit to an endodontic clinic were recruited to the study.

Results: Data from 474 endodontic practitioners and 82 patients included in analysis. Among practitioners, the majority reported to either never (33.31%) or rarely (34.84%) using bupivacaine. Most chose "I don't think I need it" (47%) and "patient discomfort because of longer duration of soft tissue anesthesia" (30.81%) as reasons for not preferring the use of bupivacaine. Of the practitioners who reported at least rare use, most chose bupivacaine for post-operative pain management (78.02%). Conversely, 52% of patients reported that they were likely/most likely to request long-lasting anesthetics for post-operative pain control.

Conclusion: Bupivacaine is rarely used as a post-operative pain management strategy for endodontic therapy. Specifically, bupivacaine is not preferred not because of adverse events, toxicity, or slow onset concerns, but rather, because of longer duration of soft tissue anesthesia. However, our data suggest that patients may be willing to receive long-lasting anesthesia. Further patient-centered research should investigate the use of long-lasting anesthetic agents for management of post-endodontic pain.

Keywords: bupivacaine, long lasting local anesthesia, post-operative pain, root canal treatment, endodontics

Introduction

Toothache is one of the most prevalent orofacial pain types reported in the United States.¹ Dental pain often occurs when bacteria reach the pulp tissue subsequent to hard tissue damage such as caries or fracture.² When infection and inflammation of the tooth become severe, endodontic therapy (ie, root canal treatment) or tooth extraction are the most common treatment modalities. While endodontic treatment is highly successful in relieving pain,³ patients have been reported to suffer from moderate to severe pain after endodontic treatment for up to seven days, with pain being the most severe during the first two days.⁴ Therefore, post-operative pain management is a crucial component of endodontic practice. Various pharmacological modalities for the management of post-operative pain such as non-steroid anti-inflammatory drugs (NSAIDs), acetaminophen, and corticosteroids have been investigated and are often implemented in routine clinical practice.^{5,6} While these approaches are generally effective, contraindications for administration of

these drugs limit their use.⁷ Importantly, multimodal analgesia is recommended to provide more potent pain relief, and to lower dosage of drug intake.⁸

Bupivacaine is a long-lasting anesthetic (LLA) which is used to manage post-operative pain either alone or when included in a multimodal analgesia regimen.⁹ Administration of bupivacaine can provide post-operative pain relief for 12 hours or more and works by blocking sensory afferent stimulation and inhibiting peripheral and central sensitization.^{9–12} The use of a long-lasting anesthetic, such as bupivacaine, as a post-surgical pain management strategy in medicine is widely accepted.¹³ Despite local anesthesia (LA) being an essential component of any dental treatment to provide intra-operative anesthesia and analgesia, knowledge regarding the use of local anesthesia by endodontic practitioners, specifically the use of long-lasting anesthetics, for post-endodontic pain management is limited.^{9,14,15}

The purpose of this study was to investigate endodontic practitioners' knowledge and attitudes regarding the use of long-lasting anesthetic, namely 0.5% bupivacaine HCl with 1:200,000 epinephrine, for the management of post-endodontic pain. Additionally, we sought to understand the perspective of dental patients about receiving longer lasting anesthesia and to determine factors that affect their anesthetic preferences.

Materials and Methods

Endodontic Practitioner Survey

This study was approved by the Institutional Review Board of New York University (IRB-FY2019-2718) and was conducted in accordance with the Declaration of Helsinki. An email invitation to participate in an anonymous online survey was distributed to 4190 American Association of Endodontists members. The survey was designed to determine the type of local anesthetic preferred by endodontic practitioners, the factors influencing their decision regarding the use of anesthetics, specifically the use of long-lasting anesthetics, as a post-endodontic pain management strategy. Potential explanatory variables included age of respondents, years of endodontic practice, and type of current endodontic practice setting. The survey was created using Qualtrics software (Provo, UT), evaluated by an epidemiologist, and pilot tested by a group of endodontic residents and faculty. At the beginning of the survey, participants first completed and signed the consent form. The consent was obtained anonymously, no identified data was asked during the consent procedure. The subject could either consent or reject to participate by clicking the appropriate box. If the subject did not consent, she/he was directed to the end of the survey. Potential participants were assured that no identifiers, including IP addresses, would be collected. The survey was sent to prospective participants in April 2019 and a reminder email was sent 2 weeks later.

Dental Patient Survey

This study was approved by the Institutional Review Board of New York University (IRB-FY2019-2499) was conducted in accordance with the Declaration of Helsinki. Patients attending the New York University College of Dentistry post-graduate endodontic clinic between January 2019 - May 2019 were invited to participate in this study. Participants were at least 18 years of age, and could independently complete the English language survey. Participants were introduced to the study by research personnel, informed that participation was voluntary and completing the survey would take 5–10 minutes. Participants who were interested in joining the study were then consented. The study survey data were collected and managed using REDCap (Research Electronic Data Capture). The survey questions asked about demographics, previous root canal treatment history, pain history and participants' perspective on receiving long lasting anesthesia. A brief script explaining the purpose and use of long lasting anesthesia was provided within the questionnaire. An optional Pain Catastrophizing Scale (PCS) questionnaire was available to participants.

Statistical Analysis

Data were imported into Stata version 16 (StataCorp, College Station, TX) from Qualtrics and REDCap. Descriptive analyses of variables was performed to identify frequency, mean and standard deviation, and tabulation and ranking were performed when appropriate. Chi-square tests and univariate analyses were used for categorical and continuous variables. A p-value less than 0.05 was considered statistically significant. Figures were created using GraphPad Prism version 8.0 for MacBook (GraphPad Software, San Diego, California USA).

Results

Endodontic Practitioner Sample

Of the 4190 AAE members who were invited to participate in the study, 474 endodontic practitioners completed the online survey, representing a response rate of 11%. The mean number of years of practice was 16 years (SD \pm 10.01, range 1–45 years). Distribution of age, years of practice, current practice setting, and geographic location of current practice is presented (Table 1).

Local Anesthesia Selection Criteria

Local anesthetic agents chosen by participants for endodontic practice, reasons for their choice, local anesthesia available in current endodontic practice settings, and preferred local anesthesia for endodontic treatments are described in Table 2. Participants indicated the main criterion when choosing appropriate local anesthesia was efficacy (96%), while 51% reported safety. The most preferred local anesthesia by practitioners was Lidocaine HCl 2% and Epinephrine 1:100,000 (81%), and bupivacaine HCl 0.5% and Epinephrine 1:200,000 was preferred by 23% of participants.

Post-Operative Endodontic Pain Management with Local Anesthesia

The majority of endodontic practitioners reported either *never* using bupivacaine (never as an infiltration injection (34%) and never as an inferior alveolar nerve block (IANB) (32%)) or *rarely* using bupivacaine (rarely as an infiltration injection (37%) and rarely as an IANB (33%)) (Table 2). Of those who at least reported rare use of bupivacaine, most reported to using bupivacaine for post-operative pain management (78%) (Figure 1). For the question “why don’t you prefer bupivacaine?”, when we excluded responses solely selecting “I use bupivacaine” for this question, the reminder most often chose “I don’t think I need it” (47%) and “patient discomfort because of longer duration of soft tissue anesthesia” (31%) as reasons for not using bupivacaine (Figure 1, Table 2).

Post-Operative Pain Management with Additional -Post Treatment- LA Injection

The use of local anesthetic agents as a post-operative pain management strategy with additional post-treatment local anesthetic injection was relatively low (rarely=59%). Of those who reported at least rare use of providing additional injection of local anesthetic for post-operative pain management, 61% chose bupivacaine (Table 2). Age, years of practice or practice setting were not associated with participants’ attitudes towards using bupivacaine or use of LA as a post-operative pain management strategy (Table 3).

Table 1 Demographic Information of Practitioner Survey Respondents

Age Range (Years) N=465	N (%)
28–35	71 (15)
35–45	144 (31)
45–55	115 (25)
55–79	135 (29)
Number of years of practice N= 467	N (%)
1–10	180 (38)
10–20	124 (27)
20–45	163 (35)
Current practice setting N=471	N (%)
Private Practice (solo)	193 (41)
Private Practice (group)	219 (46)
Other ^a	59 (13)

Note: ^aOther: public health center, university setting, currently training residents/post-graduate students and self-reported “other”.

Abbreviation: N (%), number of respondents (percentage out of total number of respondents).

Table 2 Practitioner Survey – Local Anesthetic Preferences

1.How do you choose the anesthetic agent you use for endodontic treatment?*	
	N (%)
Evidence based findings	301 (63)
Prior training	288 (61)
Prior experience	234 (49)
Anecdotal reviews	29 (6)
2.What are your main selection criteria for the anesthetic agent for endodontic treatment?*	
	N (%)
Efficacy	453 (96)
Safety	241 (51)
Onset time	142 (30)
Price	9 (2)
3.Which local anesthetic solutions do you have in your practice available to you?*	
	N (%)
Lidocaine HCl 2% and Epinephrine 1:100,000	448 (94)
Lidocaine 2% and Epinephrine 1:50,000	383 (81)
Articaine HCl 4% and Epinephrine 1:100,000	440 (93)
Mepivacaine HCl 3%	420 (89)
Bupivacaine HCl 0.5% and Epinephrine 1:200,000	340 (71)
Other	94 (20)
4.Which anesthetic solutions do you prefer using for non-surgical and/or surgical endodontic treatment for a healthy individual?*	
	N (%)
Lidocaine HCl 2% and Epinephrine 1:100,000	383 (81)
Lidocaine 2% and Epinephrine 1:50,000	161 (34)
Articaine HCl 4% and Epinephrine 1:100,000	350 (74)
Mepivacaine HCl 3%	117 (25)
Bupivacaine HCl 0.5% and Epinephrine 1:200,000	110 (23)
Other	32(7)
5.How often do you use Bupivacaine HCl 0.5% and Epinephrine 1:200,000 for infiltration anesthesia? (N=455)^a	
	N (%)
Always	10 (2)
Often	30 (7)
Sometimes	91 (20)
Rarely	168 (37)
Never	156 (34)
6.How often do you use Bupivacaine HCl 0.5% and Epinephrine 1:200,000 for inferior alveolar nerve block anesthesia? (N=467)^b	
	N (%)
Always	16 (3)
Often	36 (8)
Sometimes	111 (24)
Rarely	153 (33)
Never	151 (32)

(Continued)

Table 2 (Continued).

7. How often do you administer an additional inferior alveolar nerve block/infiltration anesthesia between appointments and/or post-obturation/surgery before patient leaves the chair for management of post-operative pain? (N=471) ^c	
	N (%)
Always	3 (1)
Often	9 (2)
Sometimes	86 (18)
Rarely	280 (59)
Never	93 (20)
8. Which anesthetic do you administer for additional inferior alveolar nerve block/infiltration anesthesia between appointments and/or post-obturation/surgery before patient leaves the chair for management of post-operative pain? (N=378)*	
	N (%)
Lidocaine HCl 2% and Epinephrine 1:100,000	137 (36)
Lidocaine 2% and Epinephrine 1:50,000	6 (2)
Articaine HCl 4% and Epinephrine 1:100,000	49 (13)
Mepivacaine HCl 3%	15 (4)
Bupivacaine HCl 0.5% and Epinephrine 1:200,000	232 (61)
9. What purposes do you prefer Bupivacaine HCl 0.5% and Epinephrine 1:200,000 in your practice? (N=473)*	
	N (%)
Post-operative pain management	291 (62)
Treatment with longer duration	170 (36)
Surgical endodontic treatment	163 (34)
Pain management for symptomatic cases when treatment cannot be initiated immediately.	158 (33)
For patients with a history of chronic/persistent pain	87 (18)
Routine non-surgical endodontic treatment	68 (14)
Other	25 (5)
10. Why do not you prefer Bupivacaine HCl 0.5% and Epinephrine 1:200,000? (N=473) *	
	N (%)
I use bupivacaine.	99 (21)
I do not think I need it.	180 (38)
Patient discomfort because of longer duration of soft tissue anesthesia	118 (25)
Slower onset of local anesthesia	91 (19)
Lower success rate	44 (9)
Higher cost	16 (3)
Incidence of adverse events and toxicity	13 (2)
Other	34 (7)

Notes: N=474 for questions #1, 2, 3, 4. *Multiple answers may be selected. ^aAnesthetic agent is infiltrated into the buccal mucosa of the tooth's apical area. ^bInferior alveolar nerve is a branch of the mandibular nerve (V₃), the third division of trigeminal nerve. The inferior alveolar nerve block induces anesthesia unilaterally at mucous membranes of the lower lip, the lower teeth and the labial gingiva of the anterior teeth, to the midline of the side on which the block is administered. ^cIn dental practice, anesthesia is provided before the initiation of the treatment to mainly provide intra-operative anesthesia. If anesthesia is given at the end of the dental appointment, the main purpose would be to manage post-operative pain. **Abbreviation:** N (%), number of responders (percentage of responders out of total number of participants).

Patient Survey

Study Sample

Eighty-two participants were included in this study. Patient demographics, history of previous root canal treatment, and type of appointment (treatment, dental emergency due to pain or swelling etc.) are listed in Table 4. Presence of pain in the tooth being treated, pain intensity using a Numerical Rating Scale (0–10), pain duration and frequency, pain medication use, and pain catastrophizing scale results are also reported (Table 4).

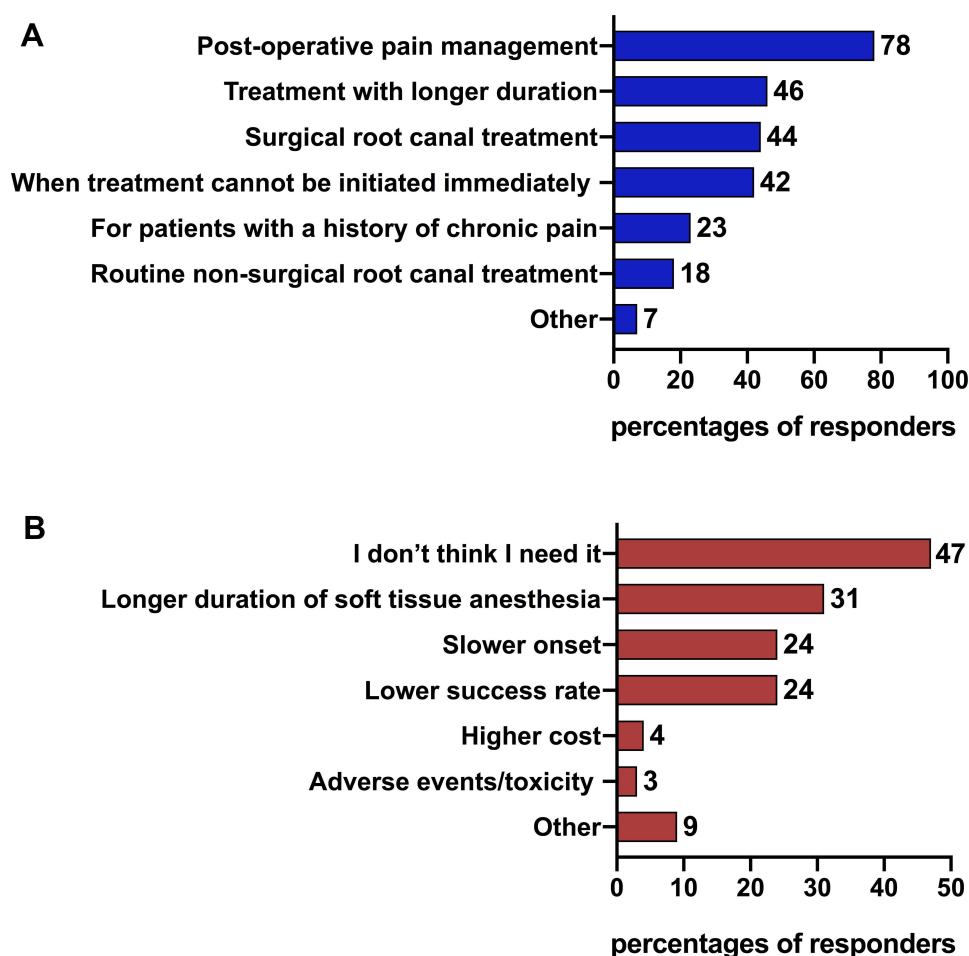


Figure 1 (A) What purposes do practitioners prefer Bupivacaine HCl 0.5% and Epinephrine 1:200,000 in their practice? (select all that apply, Percentages were calculated by excluding 100 subjects who said they never use bupivacaine either with infiltration or IANB in question 9 Table 2) (N=373)). (B) Why do not practitioners prefer Bupivacaine HCl 0.5% and Epinephrine 1:200,000? (select all that apply) (Percentages were calculated by excluding 90 subjects solely selected "I use bupivacaine" in question 10 Table 2) (N= 383)).

Patients' Attitudes Towards Longer Lasting Anesthesia

When asked how likely they were to request administration of LLA from their endodontist for their treatment, 52% reported they were likely/most likely to request long-lasting anesthesia. When asked how likely they were to request an extra injection of long-acting anesthesia at the end of their endodontic treatment for pain management, 41% of respondents reported "likely/most likely" (Figure 2). We performed univariate analysis and chi-square tests to determine associations between previous root canal therapy experience, presence and intensity of pain, pain medication use, and PCS scores, and patients' request of LLA, these factors were not significantly associated with requesting long lasting anesthesia following treatment. When PCS was dichotomized as <30 and >30, there was a trend that patients with >30 PCS scores were tend to request LLA more frequently than patients who reported <30 PCS scores ($p=0.07$).

Discussion

A significant proportion of the endodontic patient population presents with pain, and obtaining profound anesthesia and analgesia before beginning root canal therapy is crucial. Moreover, patients have been reported to experience moderate to severe pain for up to seven days after endodontic treatment.⁴ However, the use of LA, more specifically LLA, for post-endodontic pain management is not well understood. The administration of LLA is widely accepted in medicine, including bupivacaine, as well as extended-release bupivacaine formulations which can last up to 4 days.¹⁶ A published guideline for the management of post-operative pain after general surgery strongly recommends the use of site-specific peripheral

Table 3 Practitioner Survey – Subcategory Analysis for Bupivacaine Use

Age Groups	Bupivacaine Availability N(%)	Bupivacaine Infiltration Use N(%)		Bupivacaine IANB Use N(%)*		Additional Post-Treatment Anesthesia Injection N(%)	
		Always/ Sometimes/ Often/Rarely	Never	Always/ Sometimes/ Often/Rarely	Never	Always/ Sometimes/ Often/Rarely	Never
28–35 years	55 (77.4)	52 (75.3)	17 (24.6)	45 (63.3)	26 (36.6)	53 (74.6)	18 (25.3)
35–45 years	107 (74.3)	87 (62.1)	53 (37.8)	91 (63.6)	52 (36.3)	116 (80.5)	28 (19.4)
45–55 years	82 (71.3)	73 (65.7)	38 (34.2)	87 (76.3)	27 (23.6)	91 (79.1)	24 (20.8)
55–79 years	92 (68.1)	83 (64.3)	46 (35.6)	91 (68.4)	42 (31.5)	112 (82.9)	23 (17.0)
p value	0.484		0.29		0.133		0.553
Years of Practice							
1–10	134 (74.4)	118 (67.4)	57 (32.5)	112 (62.5)	67 (37.4)	139 (77.2)	41 (22.7)
10–20	89 (71.7)	74 (61.6)	46 (38.3)	89 (72.3)	34 (27.6)	101 (81.4)	23 (18.5)
20–45	114 (69.9)	104 (66.6)	52 (33.3)	114 (70.8)	47 (29.1)	134 (82.2)	29 (17.7)
p value	0.645		0.56		0.13		0.464
Practice Setting							
Solo practice	131 (67.8)	118 (62.7)	70 (37.2)	128 (67.0)	63 (32.9)	156 (80.8)	37 (19.1)
Group practice	162 (73.9)	139 (66.8)	69 (33.1)	146 (67.2)	71 (32.7)	169 (77.1)	50 (22.8)
Other & university setting	47 (79.6)	42 (71.1)	17 (28.8)	42 (71.1)	17 (28.8)	53 (89.8)	6 (10.1)
p value	0.151		0.444		0.825		0.092

Notes: *Inferior alveolar nerve block. p-values for bupivacaine infiltration use, bupivacaine IANB use and additional post-treatment anesthesia injection result from comparing frequencies of reports of never in each group.

Abbreviation: N(%), number of responders (percentages).

regional anesthesia with high quality level evidence for acute post-operative pain control.¹³ However, while LA is an essential component of any dental treatment to provide intra-operative anesthesia and analgesia, our study suggests that within endodontic practice bupivacaine is not widely used, where most practitioners reported never or rarely using bupivacaine. Our results also indicate that practitioners' attitudes towards use of LA as a post-operative pain management strategy did not differ according to age, years of practice or practice setting. Although the use of bupivacaine was infrequent, 78% of those who reported at least rare use stated the primary purpose of use as "post-operative pain management". These results reveal that LA selection is mostly based on intra-operative pain management needs and is rarely chosen for post-operative pain control following endodontic treatment.

Interestingly, only a small proportion of endodontic practitioners reported "slower onset time", "lower success rate" and "adverse events/toxicity" as reasons for not using bupivacaine.^{17,18} The majority of respondents stated that "they don't think they need it" (47%), despite the evidence that patients may suffer from moderate to severe pain following endodontic treatment⁴ and NSAIDs and/or acetaminophen are often prescribed.⁵ A study by Pak et al found that 81% of patients reported moderate pre-operative pain intensity when they attend a dental clinic.⁴ Moreover, pre-operative pain is a predictor of post-operative pain,¹⁹ highlighting the necessity of adequate post-operative pain management required for patients who present with ongoing pre-operative pain. Therefore, LLA is a pain management option for patients at risk of post-operative pain,⁹ that can be delivered before endodontic treatment initiation or as a supplemental injection at the end of the treatment.

Another significant finding of the study is that almost a third of practitioner respondents chose "patient discomfort because of longer duration of soft tissue anesthesia" as the reason for not using bupivacaine. It is possible that longer duration of soft tissue anesthesia around the orofacial region can pose discomfort and soft tissue injury, and some patients may dislike longer term soft tissue numbness as it may alter important orofacial function such as eating and speaking.^{9,10}

Table 4 Patient Survey Characteristics

Age, years, mean \pm SD, (range)	47 \pm 18 (18–92)
Sex, n (%)	
Female	48 (59)
Male	34 (41)
Ethnicity, n (%)	
Hispanic or Latino	31 (38)
Non-Hispanic or Latino	50 (62)
Race, n (%)	
White/Caucasian	36 (46)
Black/African American	16 (20)
Asian	9 (12)
Other	11 (22)
Treatment and Pain related characteristics	
Type of Current Appointment	
Treatment	25 (31)
Consultation	36 (44)
Dental Emergency	14 (17)
Follow-up	7 (8)
Previous RCT Experience, n (%)	57 (69)
Previous RCT Experience Reported Painful	24 (42)
Current pain intensity, mean \pm SD	2.7 \pm 3.3
Average pain intensity in previous 3 months, mean \pm SD	2.8 \pm 3.5
Reported Pain in the previous 3 months n (%)	54 (66)
Duration of Pain n (%)	
Less than 1 week	34 (63)
Up to 1 month	15 (28)
More than 1 month	5 (9)
Pain Medication Use n (%)	35 (65)
Pain Medication Use within the Last 6 hours n (%)	19 (35)
Pain Catastrophizing Scale(PCS)	
Mean \pm SD, (range)	25.5 \pm 12.9
Frequency of Patients Reporting PCS scores above 30	27 (33)

Abbreviations: N (%), number of respondents (percentage out of total number of respondents); SD, standard deviation; RCT, root canal treatment.

Interestingly, our data suggest that approximately half of the patient respondents would very likely/likely consider requesting LLA as an anesthetic choice, knowing that LLA causes soft tissue numbness for an extended duration. Although our findings did not capture that patients with higher intensity or longer duration of pre-operative pain preferred LLA more often, there was a trend where patients with higher pain catastrophizing scale scores preferred LLA more often. Comprehensive, clinical studies are needed to investigate patients' experience with LLA when applied within the orofacial region and which patient population might benefit more from LLA.

It is noteworthy to mention that in this study 23% of the practitioners who reported at least rare use of bupivacaine, stated the purpose of use as “for patients with a history of chronic/persistent pain”. Studies report the incidence of chronic pain after endodontic therapy as high as 3–12%.^{20–22} Given that pre-operative and post-operative pain are

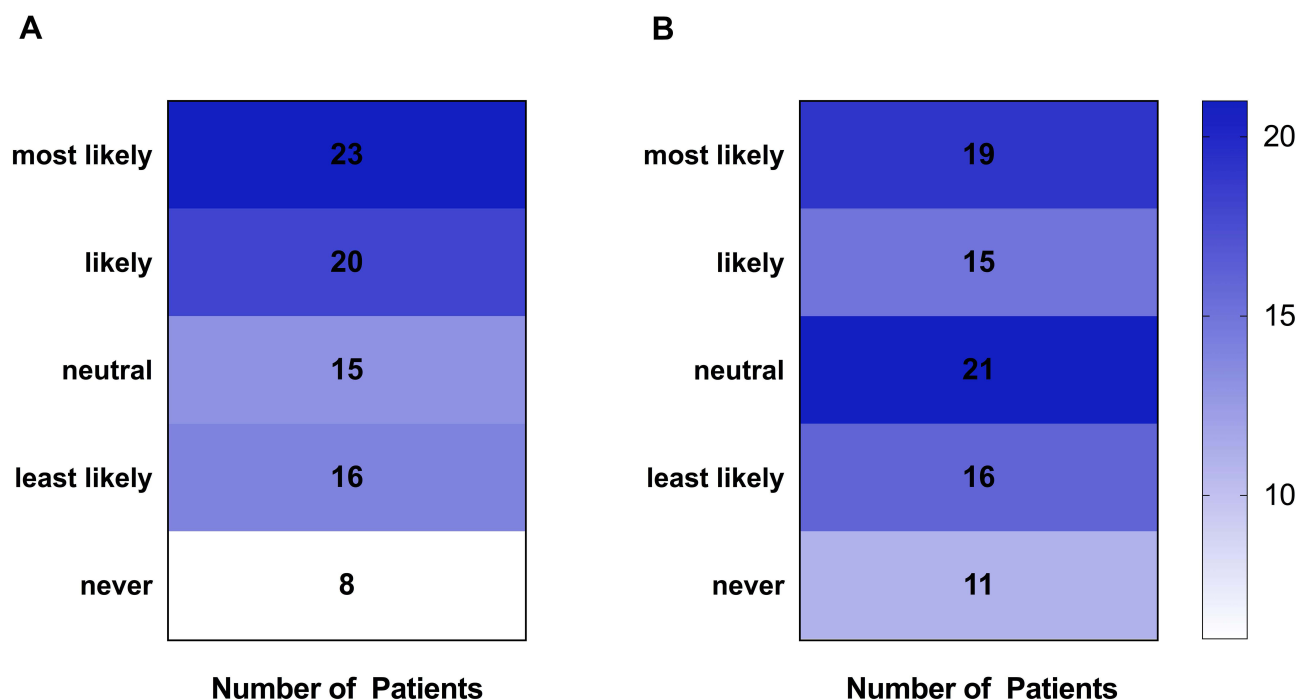


Figure 2 (A) How likely would you be to request longer lasting anesthesia for your endodontic treatment? **(B)** How likely would you be to request an extra injection of longer lasting anesthesia, at the end of your treatment in an effort to manage your pain? In both heat maps, numbers represent patients.

predictive of pain chronification after endodontic treatment,^{20,22,23} the use of bupivacaine can be considered as a preventive measure for persistent pain after treatment, especially for patients who are at increased risk.²⁴ What is more, an additional post-treatment injection of LA could be indicated as a preventive measure for persistent pain after endodontic treatment for those patients who are at risk.^{13,24} An additional injection with bupivacaine can help blocking sensory afferent stimulation hence limiting peripheral and central sensitization and prevent chronification of post-operative pain.^{9–12} In this survey, the majority of practitioners (59%) reported rare use of an additional injection after endodontic therapy for management of post-operative pain. Of those who reported at least rare use, 61% preferred using bupivacaine. On the other hand, when we asked patients, about 40% said that they would most likely/likely want to receive an additional injection at the end of their treatment for managing post-treatment pain. These findings suggest that patients may be informed about bupivacaine as a post treatment pain management option and can be given the option of additional bupivacaine administration.

The primary limitation in this study is the low response rate (11%). However, as we sampled a professional homogenous group with similar distribution among age groups and years of endodontic practice, we believe that non-response bias likely does not significantly impact the results of this study.²⁵ One barrier our group faced regarding distribution of the survey was the email address list limited use clause (maximum of two email communications), meaning we could not send additional survey invitations or reminders to prospective participants. An important point to highlight is the possibility that those who did not respond to the survey, may not have bupivacaine available to them in their endodontic practice setting. Further investigation to capture the perspectives of these individuals may be warranted. Finally, the survey was distributed only to AAE members, whose practice is focused on endodontics and the preferences and attitudes of general dental practitioners may be different, as seen from previous studies.^{14,26,27}

Conclusion

Findings from this study suggest that bupivacaine is rarely used by endodontic practitioners as a post-operative pain management strategy following root canal treatment. However, endodontic patients might prefer receiving long lasting anesthesia for endodontic pain control. Based on the perspectives captured in this study, further patient-centered

clinical studies should be conducted to investigate the use of LLA during or after procedures within the orofacial region.

Data Sharing Statement

The original data used to support the findings of this study are available from the corresponding author upon request.

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Disclosure

The authors declare that they have no conflicts of interest.

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