Comparison of the Effectiveness of Lidocaine in Permanent Maxillary Teeth Removal Performed with Single Buccal Infiltration Versus Routine Buccal and Palatal Injection

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Abstract

Purpose For many dental patients, palatal injection proves to be a very traumatic experience. Diverse methods have been suggested to reduce the discomfort of palatal injection. Nevertheless, the reliability of these methods is not obviously evident and they are not found to be universally effective. The desirable method to evade pain during palatal injection is just not to have one. Hence, the present study aims at investigating if lidocaine hydrochloride could provide palatal anesthesia in maxilla when only a buccal infiltration anesthesia is done for teeth extraction.

Patients and Methods One hundred and fifty patients requiring extraction of maxillary teeth were included in the study. Patients were randomly allotted to two groups, study and control. Patients in study group received a single buccal infiltration of 1.5 mL of lidocaine with epinephrine for extraction of maxillary teeth. Patients in control group received 1.5 mL of buccal and 0.3 mL of palatal infiltration of lidocaine with epinephrine for the extraction. After achieving adequate palatal anesthesia the tooth was extracted with consistent technique. Pain level experienced by the patients during injection procedure and during tooth extraction was rated in an 11-point pain rating scale. Time taken to achieve palatal anesthesia following a single buccal infiltration of anesthetic solution was evaluated by regular pin-prick evaluation of palatal tissues.

Results The overall success rate of palatal anesthesia achieved with a single buccal infiltration is 81.3 %. The

success rate reduced as we proceed from anterior to posterior maxilla. Time taken to achieve successful palatal anesthesia by single buccal infiltration is 7–9 min.

Conclusion The extraction of permanent maxillary anterior teeth and premolars is possible by depositing local anesthesia to the buccal vestibule of the tooth without palatal supplementation. However, the extraction of permanent maxillary posterior teeth with similar technique would result in fewer success rates suggesting its avoidance.

Keywords Palatal anesthesia · Maxillary teeth extraction · Lidocaine diffusion

Introduction

Anxiety and fear-related behaviors have long been recognized as the significant barrier to dental attendance [1]. The key factor as to why a patient may be apprehensive about the dental treatment is fear of pain [2]. Hence, anesthesia, in some form, is often a prerequisite for any dental procedure likely to be allied with pain [3]. Though dentistry has prided itself on being as close to “painless” as possible with the development of a range of local anesthetic drugs, the act of achieving pain control with these anesthetic drugs, through conventional injection itself frequently induces great anxiety or is associated with pain [3–5]. The pain during the administration of dental local anesthetics is found to be influenced by numerous factors. One among those is the site of oral cavity being injected. Amid the oral tissues, injection in the palatal mucosa, in particular the anterior part of the hard palate is perceived to be the most painful procedure in dentistry, and direct experience of this procedure is considered to be the most common source of fear of dental treatment [2, 6].

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Diverse methods have been suggested to reduce the discomfort of palatal injection. These include the application of topical anesthetics [7], pressure administration [8], topical cooling of palate [9], slow rate of injection [10], computerized injection systems [11], eutectic mixture of local anesthetic (EMLA) [3], and trans-cutaneous electronic nerve stimulation (TENS) [12]. Nevertheless, the reliability of various methods proposed is not obviously evident and they are not found to be universally effective [10, 13].

Badcock [14] quite correctly points out that the desirable method to evade pain during palatal injection is just not to have one. In accordance to this, recently, many reports have claimed that maxillary permanent teeth could be extracted by depositing local anesthesia to the buccal vestibule of the tooth without the need for palatal complementation [6, 14–17]. These studies evaluated the diffusion property of the local anesthetics from buccal vestibule to palatal aspect. However, majority of these studies employed articaine as the local anesthetic, owing to its high diffusion property through the hard and soft tissue [6, 15, 16]. Articaine, introduced three decades past lidocaine, has achieved broad use in dentistry, worldwide. The basis for this hasty pervasive use is the claim and belief that articaine has superior properties and success rate than lidocaine [18]. There are experimental evidences both supporting and opposing these claims [4, 6, 15, 19, 20]. However, these contentions still remain the centre of heated discussions among dental surgeons.

In contrast to the evidence available regarding articaine, sparse literature exists on the diffusion property of lidocaine, which is widely used and continues to be the gold standard among all local anesthetics [21]. Through the available reports it is evident that extraction of permanent maxillary tooth is possible with single buccal infiltration of 2 % of lidocaine without the need for palatal injection [21]. But those reports failed to point out which tooth was removed in the experimental trial. This is important, as the success of the technique depends on diffusion of local anesthetic from buccal vestibule to palatal aspect of the tooth, and when the bucco-palatal cortical distance increases, diffusion ability of the anesthetic solution to the palatal side will decrease, hence making the success rate in molar region debatable [16].

Hence, the present study was designed with the aim of investigating if lidocaine hydrochloride could provide palatal anesthesia in all parts of maxilla when only a buccal infiltration anesthesia was done for maxillary permanent teeth extractions. In addition, this study aimed to find the average time taken for the palatal tissue to get anesthetized when only a lidocaine buccal infiltration was done.

Patients and Methods

A prospective, randomized, double blind trial was designed to compare the efficiency of 2 % lidocaine with 1:80,000 epinephrine, in permanent maxillary teeth removal performed with single buccal infiltration and that performed with routine buccal and palatal injection.

Study Subjects

One hundred and fifty adults, recruited from patients referred to Department of Oral and Maxillofacial Surgery, were enrolled in this study. Recruitment was at the discretion of experienced clinicians with no involvement in the research. To qualify for our study, the patient had to be between 15 and 50 years old and in good health as determined by a health history questionnaire. We excluded potential subjects who were allergic to local anesthetics, who were taking medications that could affect anesthetic assessment, who had active sites of pathology in the area of injection and the teeth that needed surgical procedures for extraction. The study was previously approved by the Ethics and Research Committee of AIMST University, Malaysia (AUHAEC 74/FOD/2012). All the enrolled patients were explained in brief about the benefits and risks involved in the current procedure in their native language and an informed, written consent was obtained.

Study Design

The 150 participants were divided into two groups of 75 each, with one being the study group and the other control. The participants were allotted to the particular groups randomly using a computer generated sequence of random numbers.

The maxilla was divided into three regions based on the bucco-palatal cortical bone distance and 25 teeth were extracted from each region in both the groups as follows:

1. Anterior region: Central and lateral incisors and canine
2. Premolar region: First and second premolars
3. Posterior region: First and second molars.

Prior to the administration of local anesthetics, each patient given an explanation regarding the pain rating scale which is an 11-point numerical rating scale (between 0 and 10) anchored with the expressions “no pain” and “worst pain imaginable” on its ends.

Three experienced surgeons were involved in the study, with each allocated a specific role. 1.8 mL of 2 % lidocaine HCl with epinephrine 1:80,000 was used (Lidocaine 2 % E-80, Newstetic, Colombia). In the study group, 1.5 mL of local anesthetic solution in a cartridge ampoule syringe (Aspirating syringes, Schweickhard GmbH & Co, Germany)

with sterile dental needle (27G: 0.4×22 mm; Terumo corporation, Japan) was administered as a buccal infiltration adjacent to the tooth to be extracted according to conventional method [5], at a slow rate of administration, over approximately 1 min. The remaining 0.3 mL of the solution was left to use for palatal anesthesia if the patient would have pain during extraction.

On the control group, an identical protocol was applied for buccal injection and a palatal supplementation of 0.3 mL of 2 % lidocaine HCl with epinephrine 1:80,000 was given. Slow rate of administration, apparently 10 s, was the only adjunctive technique used to make the palatal injection comfortable. The local anesthetic procedure in all the subjects was carried out by the same operator. This operator had no involvement with testing the outcome.

Following completion of injection procedure, a pin-prick test was performed in three predetermined points on the buccal and palatal gingival tissue with a blunt dental probe and patient asked if it was painful. A sensation of pain was defined as a sharp, distinct pinprick. This was repeated every 2 min after the end of the injection procedure to a maximum of 10 min. The pin-prick test was performed by the second operator, who was blinded to the type of injection technique performed. In the study group, if palatal anesthesia cannot be achieved within 10 min following the injection procedure, then a palatal supplementation of remaining 0.3 mL of anesthetic solution was administered. However, to facilitate a consistent evaluation, the patients with unsuccessful palatal anesthesia were not involved in subsequent phase of the study.

The tooth was extracted after confirming the palatal anesthesia. However, during this latency period patients completed the pain rating scale, to record the amount of pain they experienced on injection. To ensure blinding, the surgeon who administered the anesthetic solution and the other who performed the pin-prick test were not involved in the extraction of the tooth.

The tooth was extracted with a consistent technique by the third operator, with minimal palatal tissue manipulation. During extraction the patient was consistently questioned about pain intensity experienced and if patients suffered intolerable pain, an additional buccal and palatal anesthetic injection was planned. Subsequent to extraction all the patients completed the faces pain rating scale, to record the amount of pain they experienced during tooth extraction.

Statistical Assessment

Statistical analyses were performed using the SPSS 13.0 package. The pain scores were statistically analyzed using

Table 1 Reason for extraction, number of teeth extracted and success rate

Extraction reason	Number of teeth	Success rate (%) (with palatal injection)	Success rate (%) (without palatal injection)
Orthodontic treatment	9	100	100
Periodontitis	57	100	80.6
Carious/apical lesion	54	100	74.0
Prophylactic extractions	30	100	84.6
Total	150	100	81.3

Table 2 Success rate in achieving palatal anesthesia in relation to the region extracted

Maxillary regions	Number of teeth	Success rate n (%)	
		Study	Control
Anterior region	50	25 (100)	25 (100)
Premolar region	50	23 (92)	25 (100)
Posterior region	50	13 (52)	25 (100)
Total	150	61 (81.3)	75 (100)

Mann–Whitney test. Statistical significance was accepted at 95 % confidence level.

Results

One hundred and fifty patients took part in the study, 67 males and 83 females with a median age of 35.9, range 15–50. All patients tolerated the extraction procedure well, and none of them reported severe pain. The reasons for extraction, number of teeth extracted, and success rates of all patients are compiled in Table 1. The overall success rate of palatal anesthesia achieved with a single buccal infiltration is 81.3 %. When extraction reasons are ranked according to success rate, the order is orthodontic treatment > prophylactic extraction > periodontitis > carious/apical lesion.

When success rate of palatal anesthesia is compared in respect to the various maxillary regions considered, it is evident that the success rate reduced as we proceed from anterior to posterior maxilla with 100 % success rate in anterior region, 92 % in premolar region and only 52 % success rate in molar region (Table 2). Time taken to achieve successful palatal anesthesia is summarized in Table 3, which implies that a 7–9 min latency period is required to achieve palatal anesthesia in the anterior and

Table 3 Time taken to achieve palatal anesthesia (mean $\pm$ SD) in minutes

Maxillary regions	Buccal aspect		Palatal aspect	
	Study	Control	Study	Control
Anterior region	1.20 $\pm$ 0.4	1.56 $\pm$ 0.5	7.1 $\pm$ 1.4	1.72 $\pm$ 0.7
Premolar region	1.60 $\pm$ 0.6	1.64 $\pm$ 0.7	7.8 $\pm$ 1.2	1.68 $\pm$ 0.7
Posterior region	1.80 $\pm$ 0.4	1.56 $\pm$ 0.6	8.8 $\pm$ 0.9	1.40 $\pm$ 0.5

Table 4 Comparison of pain level during injection and during tooth extraction

	Number of patients	Average pain level	Mean rank	Mann– Whitney test value	<i>p</i> value
Comparison of pain level during injection					
Study	75	0.91	40.48	220.5	<0.05
Control	75	3.03	109.06		
Comparison of pain level during extraction					
Study	61	0.61	74.34	1,931	0.071
Control	75	0.39	63.75		

premolar region and 8.5 to 10 min to achieve palatal anesthesia in molar region when only a buccal infiltration of lidocaine local anesthetic solution is administered. Fourteen patients (18.7 %) in the study group required a supplemental palatal anesthetic injection before teeth removal and they were excluded from further evaluation of pain during extraction.

Mann–Whitney test revealed a significant difference in the pain level experienced by the patients during injection among the study and control groups ($p < 0.05$), with study group experiencing minimal pain. Conversely, significant variation was not evident in the pain level elicited by the patients during permanent maxillary teeth removal amid the two groups ($p = 0.071$), indicating, a comfortable extraction through both the techniques (Table 4).

No adverse events were recorded during the procedure.

Discussion

The distress produced by intraoral injections is attributed to two factors; needle penetration and rate of deposition of anesthetic solution. Recent reports suggest that the perception of pain due to needle penetration in the palate does not vary between conventional and computerized syringe systems. However, the discomfort produced by deposition of solution varies among the different syringe types [2, 22]. In view of the fact that the palatal mucosa is compact and tightly bound to its underlying periosteum besides its abundant nervous complement, injections in the palate are

always extremely painful [23]. Though, a number of adjunctive techniques have been suggested in order to reduce the discomfort of the palatal injection [3, 7–12], none of them gained universal acceptance, and some of them even require specific equipment.

For many dental patients, palatal injections prove to be a very traumatic experience alike for many dentists the administration of palatal anesthesia is one of the most traumatic procedures they perform in dentistry [24]. The conventional teaching and anatomical description of the sensory innervations of the palate would suggest a routine use of palatal injection for most of the dental procedures involving maxillary dentition [14]. Whilst, this administration of a supplementary palatal injection may be avoided if any local anesthetic would permit use of buccal infiltration to gain palatal anesthesia, as buccal vestibular injections are more likely to be pain free [2]. Recently many reports suggested that, among local anesthetics articaine is able to reliably diffuse through tissues, which makes it possible to obviate the need for a palatal injection when infiltrated buccally while maxillary teeth are extracted. In converse we evaluated the bucco-palatal diffusion property of lidocaine, which is relatively minimally explored.

The results of this study suggest that maxillary teeth when attempted to extract with only a single buccal infiltration of 2 % lidocaine with 1:80,000 epinephrine, achieves 81.3 % success rate in contrast to 100 % success rate with the conventional injection technique (Table 2). However, when success rate at different maxillary regions is compared, 100 % success rate could be achieved in extracting anterior teeth but as we proceed towards the posterior region the success rate declined with 92 % in premolar and merely 52 % in molar region. This abate in success rate towards posterior region may be attributed to the distance between the buccal and palatal side of the maxillary alveolus. Our results are in contradict to Badcock et al., who achieved 100 % success rate in maxillary third molar extraction with only a single buccal infiltration evading palatal supplementation [14]. However, the author used 2.2 mL of lidocaine for the buccal infiltration, but in our study we evaluated the palatal anesthesia with buccal infiltration of only 1.5 mL of the anesthetic solution. Hence, the effect of dosage on the diffusion property of local anesthetic merits further investigation. Conversely, we found greater success in obtaining anesthesia in the anterior region owing to its shorter bucco-palatal distance, but it was difficult to achieve analogous success rate in posterior region. This was in accordance with previous reports that diffusion ability of local anesthetic to the palatal side will decrease while the bucco-palatal distance increases [16]. Hence, we claim that extraction of maxillary anterior tooth is possible by depositing 1.5 mL of

lidocaine as buccal suprapariosteal infiltration without palatal supplementation, therefore, avoiding the traumatic experience of injection in the anterior palate, which is considered most painful intra-oral injection [2].

When success rate was compared with the rationale for tooth extraction, orthodontic and prophylactic extractions acquired a better success rate in contrast to teeth associated with periodontitis and carious or periapical lesion (Table 1). To determine the reason for variation in success rate with regard to the rationale for tooth extraction is beyond the scope of this study. However, the effect of inflammation on the diffusion property of lidocaine cannot be overwhelmed.

Our results suggest that a latency period of 7–9 min is required to achieve an acceptable palatal anesthesia in the study group in contrast to utmost 2 min in the control group (Table 3). Though single buccal injection technique required a longer period to attain palatal anesthesia, this latency period could be appropriately used in explaining about the dental treatment procedure or even in counseling for oral hygiene [3].

We found a significant reduction in pain level in study population (0.91), where palatal injection was not complimented. In contrast, patients in control group who received a palatal injection preceded by a buccal infiltration reported an elevated pain level (3.03). The difference in pain level between the two groups is highly significant ($p \leq 0.05$) (Table 4). It suggests that palatal injection is painful as stated in literature and avoidance of palatal injection renders the anesthetic procedure significantly comfortable [23, 25–27]. Furthermore, when pain elicited during tooth extraction was compared among the groups, we could not obtain a significant difference in the pain level ($p = 0.071$), indicating that there was no disparity in pain level during tooth extraction despite avoiding palatal supplementation.

Fourteen patients in the study group required a complimentary palatal injection as palatal mucosal numbness was not evident after a latency period of 10 min following anesthetic procedure. However, in those patients additional buccal infiltration could have been administered with the intention of achieving palatal anesthesia by increasing the dose of buccal infiltration. Indeed it was not attempted, as this population was aware that they are involved in a research which may avoid palatal injection and were also informed that palatal injection was the universally accepted practice, moreover the subjects were conscious that they may probably be one among the study populace, possibly making them more anxious and sensitive to differences.

Studies demonstrated an order effect in injection procedure stating that the first injection is less painful in a series of injection procedures [26]. The sequence of injection followed in the present study is uniform with

buccal injection administered initially followed by palatal injection. However, the effect of this order of injection to the increased pain during palatal injection needs further exploration.

In the present study, no attempt has been made to eliminate the effect of recognized variables which influence pain perception such as age, sex, dose of local anesthetic used and concentration of vasoconstrictors in the solution. However, including these factors has implications when designing further studies.

Conclusion

- The extraction of permanent maxillary anterior teeth and premolars is possible by depositing 1.5 mL of lidocaine with 1:80,000 epinephrine to the buccal vestibule of the tooth without palatal supplementation.
- The simplicity of the described practice is that there is no additional expertise required as it is simply a modification of existing technique by the avoidance of the palatal injection.
- The extraction of permanent maxillary posterior teeth with a single buccal infiltration of lidocaine evading palatal complementation results in fewer success rate suggesting its avoidance.
- A prolonged latency period of 7–9 min is required for the bucco-palatal diffusion of lidocaine when injected into the buccal vestibule of maxillary teeth.
- Although the technique described cannot be claimed novel, it merits implementation in extraction of maxillary anterior teeth and premolars in anxious patients.

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