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Research Article

The Effects of Vibration on Pain and Anxiety during Local Anesthesia Administration

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Abstract

Introduction: Local anesthesia (LA) is essential for most oral and maxillofacial procedures. It is important that clinicians obtain adequate pain control during not only dental treatments but also LA injection.

Materials and methods: This study evaluated the effects of vibration on pain and anxiety levels during LA injection in 50 patients using a visual analog scale (VAS) and Spielberger's State–Trait Anxiety Inventory (STAI).

Results: The VAS and STAI scores for the vibration group were significantly lower than those for the control group ($p < 0.001$).

Conclusion: During LA injection, vibration is a useful technique that reduces pain without causing anxiety.

INTRODUCTION

Dental fear and anxiety are the most common reasons that people avoid dental appointments. Fear and anxiety in dental clinics usually result from local anesthesia injections. Therefore, control of pain and anxiety during local anesthetic injections has clinical importance in dental practice [1,2].

Pain due to local anesthesia is caused not only by mechanical trauma to the region of the injection but also by the rapid expansion of the tissues into which the anesthetic solution is injected. In fact, tissue tension can cause more pain and discomfort than the needle puncture [3].

Dentists and other clinicians have used various methods to prevent pain while administering local anesthesia such as using topical anesthetics, [4]. suggestion, [5], slow infiltration, [6] transcutaneous electrical nerve stimulation (TENS), [7] computer-assisted local anesthesia (such as Wand), [3], and vibration [8,9].

In 1965, Melzack and Wall proposed the "gate control" theory, which holds that stimulating nerve fibers that conduct non-noxious stimuli brings about a reduction in pain sensation [10]. Therefore, stimulating larger-diameter A-beta fibers by applying pressure or vibration can interrupt nociceptive signals and thereby reduce the perception of pain [8,11]. It was found that counter-stimulation caused by vibration while injecting an anesthetic agent can reach the brain before pain is perceived [1].

We hypothesized that vibration concurrent with local anesthetic injection would decreased pain and anxiety levels. Therefore, this study evaluated the effects of vibration-assisted local anesthesia on pain and anxiety.

MATERIALS AND METHODS

This study enrolled 50 patients (30 females, 20 males) who were referred to the Department of Oral and Maxillofacial Surgery at Karadeniz Technical University, Faculty of Dentistry for tooth extraction. The patients ranged in age from 19 to 68 (mean 38.4) years. Data were collected from September 26, 2012, to October 10, 2012. The study was approved by the Karadeniz Technical University Research Ethics Committee. Informed consent was obtained from all patients. The selection criteria were systemically healthy patients who needed bilateral tooth extraction in the mandible or maxilla. The exclusion criteria were drug abuse, excessive alcohol consumption, neurosensory disturbances, and psychiatric disorders.

Local anesthesia administration

Local infiltration (LI) and inferior alveolar nerve (IAN) block

were administered as injections for the maxilla and mandible. LI anesthesia was performed on the maxilla in 28 patients and the mandible in 21 patients. Nine of 49 patients had both LI and IAN block anesthesia done bilaterally. The 98 infiltrations applied involved 18 IAN blocks and 80 LI.

The study was conducted as a split-mouth study. In all patients, all injections on the right side were given together with stimulation by a vibration device (Dental Vibe; BING Innovations, Florida, USA) (vibration group), whereas conventional injections were performed on the left side (control group) (Figure 1). The two tips of the Dental Vibe were placed on the oral mucosa to enclose the injection site before administering local anesthesia (Figure 2). The device was located medial to the mandibular ramus for IAN block injections (Figure 3), and it was placed on the buccal or palatal/lingual side of the maxillary or mandibular alveolar processes for local infiltrations in both the maxilla and mandible. Then, the DentalVibe was started, and the needle was inserted between the two tips of the device. For all injections, articaine hydrochloride with 0.001 adrenaline (Ultracaine; Pharma Vision, Istanbul, Turkey) was injected through a 27G dental needle. The same oral and maxillofacial surgeon performed all infiltrations. The same amount of local anesthetic (average 2.1 (range 1.5–3.0) mL) was administered on both sides.

Anxiety and pain measurement

After injecting the local anesthetic, subjects were asked to rate their pain using a 100-mm visual analog scale (VAS) and to complete the Spielberger State–Trait Anxiety Inventory (STAI) to evaluate their anxiety. The VAS and STAI were administered for the vibration group first and then for the control group. The pain scores were compiled for the buccal and lingual/palatal sides separately.

Statistical analysis

The results were analyzed using paired *t*-tests to compare the pain and anxiety levels during injection at both sites in each patient. The confidence interval was set as 95%.

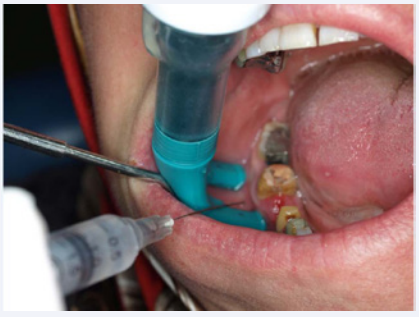


Figure 1 The vibration device (DentalVibe).



Figure 2 Local anesthetic administration to the buccal side with DentalVibe.



Figure 2 Local anesthetic administration for an inferior alveolar nerve block with DentalVibe.

RESULTS

From the 50 patients, one female patient who could not complete the VAS and could not respond the STAI questions was excluded from the study. In total, 49 patients were evaluated. For the control group, the mean pain levels as measured by VAS scores were 43.08 ± 22.44 and 63.49 ± 24.55 for the buccal and lingual/palatal sides, respectively; for the vibration group, the respective mean VAS scores were 14.89 ± 16.07 and 30.46 ± 20.91 (Table 1). The VAS scores for pain level in the vibration group were significantly lower than those in the control group ($p < 0.001$).

For the maxilla, in the control group, the mean VAS scores were 46.50 ± 24.15 and 68.54 ± 24.24 for the buccal and palatal sides, respectively, whereas for the vibration group, the respective scores were 14.89 ± 16.07 and 30.46 ± 20.91 (Table 2). Thus, the VAS scores were significantly lower in the vibration group ($p < 0.001$).

For the mandible, the mean VAS scores in the control group were 38.52 ± 19.56 and 56.76 ± 23.89 for the buccal and lingual sides, respectively, whereas in the vibration group, the respective mean VAS scores were 13.95 ± 18.21 and 19.19 ± 17.11 (Table 3). Thus, the VAS pain scores were significantly lower in the vibration group than in the control group ($p < 0.001$).

Regarding anxiety, the STAI scores also differed significantly between the vibration and control groups. In the control group, the mean STAI scores were 47.11 ± 4.86, 44.86 ± 4.86, and 46.14 ± 4.94 for the maxilla, mandible, and both, respectively. In the vibration group, the respective STAI scores were 38.68 ± 4.02, 38.19 ± 3.64, and 38.47 ± 3.83 (Tables 1–3). The values in the vibration group were significantly lower than those in the control group ($p < 0.001$).

DISCUSSION

Pain control during local anesthesia (LA) is one of the most important steps in dental procedures [3]. As invasive dental procedures usually start with LA, pain management at this stage is crucial. Some people avoid, cancel, or do not appear for dental appointments due to the fear of dental pain during injection [1]. Dental fear is commonly associated with traumatic or painful dental experiences, including undergoing LA and tooth extraction

Table 1: Pain and anxiety scores for the maxilla.

	Mean	N	Std. Deviation	Std. Error Mean
Control Buccal VAS	43.08	49	22.442	3.206
VIBE Buccal VAS	14.49	49	16.846	2.407
Control Palatal VAS	63.49	49	24.557	3.508
VIBE Palatal VAS	25.63	49	19.997	2.857
Control Anxiety	46.14	49	4.937	.705
VIBE Anxiety	38.47	49	3.830	.547

Table 2: Pain and anxiety scores for the mandible.

	Mean	N	Std. Deviation	Std. Error Mean
Control Buccal VAS	46.50	28	24.159	4.566
VIBE Buccal VAS	14.89	28	16.070	3.037
Control Palatal VAS	68.54	28	24.242	4.581
VIBE Palatal VAS	30.46	28	20.912	3.9521
Control Anxiety	47.11	28	4.856	.918
VIBE Anxiety	38.68	28	4.019	.760

Table 3: Pain and anxiety scores in all patients.

	Mean	N	Std. Deviation	Std. Error Mean
Control Buccal VAS	38.52	21	19.562	4.269
VIBE Buccal VAS	13.95	21	18.219	3.976
Control Palatal VAS	56.76	21	23.891	5.213
VIBE Palatal VAS	19.19	21	17.119	3.736
Control Anxiety	46.86	21	4.861	1.061
VIBE Anxiety	38.19	21	3.642	.795

[12]. Strategies have been developed to minimize this pain and create a more pleasant dental experience. The literature includes many studies on LA injection using different techniques for pain management during injection.

Topical anesthetics numb the surface of an area and are indicated for pain relief on needle insertion. Although this decreases the pain on insertion of the needle, the complete elimination of the pain during injection depends on factors such as the type, amount, and injection rate of LA and the dentist's expertise. Furthermore, topical anesthetics have limited ability to penetrate deep into tissue. Topical anesthetics might relieve the discomfort of surface penetration but are less likely to be effective at a depth [13]. Therefore, techniques such as TENS and Wand have been developed for this purpose. TENS activates large-diameter nerve fibers, which have a lower threshold of response to electrical activity than do smaller-diameter fibers. This closes the central gating mechanism to small-diameter nerve transmission.

This "gate control" mechanism also applies for vibration. The vibration impulses travel very quickly along thick, myelinated, A-beta nerve fibers at 75 meters/second. By contrast, the pain sensation travels slowly along thin, unmyelinated, C nerve fibers at 2 meters/second [8]. When these stimuli are applied simultaneously, the vibration sensation reaches the sensory area of the brain first and causes the release of inhibitory neurotransmitters, preventing the activation of projection neurons at the synaptic junction in the dorsal horn of the spinal cord, which results in closure of the gate to the pain sensation. Therefore, vibration reduces the perception of pain. Owing to this effect, vibration is being used with Botox injections, hair restoration, and invasive dental procedures [11,14,15].

Besides procedural factors, psychological factors appear to play an important role in the perception of pain, most notably anxiety or fear. Several studies have demonstrated that dental anxiety prolongs the duration of pain and increases its intensity [6]. Our patients had no prior experience with DentalVibe, which might cause an overestimation of the fear or pain involved in the procedure. Therefore, we administered both a VAS and the STAI to evaluate the levels of pain and anxiety resulting from LA.

In a preliminary study, Nanitsos *et al*. [8] evaluated the effects of vibration on anticipated and actual pain from regional anesthetic injections in the oral cavity. They assessed the injection pain using a VAS and the McGill pain descriptor. Their results suggested that vibration could be used to decrease pain during LA administration, in keeping with our findings. However, they did not evaluate the anxiety level related to vibration or injection. Additionally, in that study, vibration was applied extra-orally, this might decrease the effectiveness of anticipated gate control mechanism due to the distance between the injection and application sites.

Our study evaluated pain and anxiety levels during LA injection with and without vibration. The VAS scores were significantly lower in the vibration group for both the maxilla and mandible, which can be explained by the "gate control mechanism," as mentioned above. Moreover, the STAI scores were also significantly lower in the vibration group for both the maxilla and mandible. This situation likely arose because vibration is generally well tolerated and did not cause anxiety.

In a pilot study, Saijo *et al*. [9] evaluated injection pain when vibration (VibraJect) was applied with an automated electric syringe under single-blind randomized conditions. The degree of pain at needle insertion and anesthetic injection was evaluated on a VAS pain-rating score. The results suggested that VibraJect did not reduce the injection pain when it was applied under blinded conditions. They also stated that vibration without blinding could have reduced patient discomfort if the patient had a marked fear of injection. Furthermore, the design of the device is an important factor in anxiety. Because DentalVibe looks like a cheek retractor, we applied the DentalVibe without blinding, and it was generally well tolerated and reduced injection anxiety.

In conclusion, although the number of the patients and lack of placebo groups were limitations of this study, DentalVibe appeared to reduce pain during LA injection without causing anxiety. Further studies with larger groups and with placebo administration are recommended.

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