Cover letter

Title: Comparison Between the Dentapen and Vibraject: a Randomized Clinical Study on the Administration of Local Anaesthesia in Adult Patients.

Date: January 14, 2025

STUDY PROTOCOL

Ethical Approval

The study was conducted in compliance with the Helsinki Declaration. Each participant in this study was given a thorough explanation of the procedures and signed a consent form attesting to their comprehension. Ethical approval was obtained from the research centre at Riyadh Elm University prior to conducting this research (FPGRP/2023/715/906/892). The informed consent was obtained from the participants who volunteered in this research.

Outcome Measurement

In this study, each patient received two injections in both sides of the maxilla buccally next to the first molar, with the type of injection being randomly assigned. Immediately following each local anaesthesia injection, patients were requested to rate their pain intensity using the Visual Analogue Scale. Additionally, heart rate measurements were taken before and after each injection to monitor physiological responses to pain.

After both injections were completed, patients were asked to indicate their preferred injection. This preference was based on their subjective experience and was recorded by selecting the injection number (either the first or second) in the order they were administered for each patient. This method aimed to provide insights into patient comfort and pain perception associated

Inclusion Criteria:

- Individuals classified under American Society of Anesthesiologists classes I and II, indicating a healthy or mild systemic disease status.
- Individuals aged from 18 up to 65 years, encompassing both male and female patients.

- Individuals who required local anesthetic injections bilaterally in the buccal side of the upper posterior teeth. These injections were necessary for various dental procedures, including restorative, endodontic, or prosthodontic treatments, and volunteers as well were to be administered across both sides of upper posterior teeth.
- Individuals must be in good health, not currently taking any medication, and have no contraindications to the use of local anesthesia.
- Individuals who have the ability to understand both oral and written instructions, ensuring effective communication and comprehension throughout the study.

Exclusion Criteria:

- Individuals with allergies to local anesthetics, this is to prevent adverse reactions.
- Pregnant or nursing women, this is to avoid any potential risks to their health or that of their infants.
- Individuals who were actively taking drugs that could alter pain perception or anxiety levels, such as nonsteroidal anti-inflammatory drugs, opioids, or antidepressants. This was to ensure that the study's findings on pain perception were not influenced by external substances
- Individuals with heavy alcohol consumption. .
- Patients with active pathologies at the injection site, this is to avoid complications and to ensure the accuracy of the study's results.
- Individuals who could not commit to the study's schedule or were unable to give informed consent. This ensured that all participants were fully aware of and agreeable to the study's procedures and requirements.
- Patients who required intravenous sedation for their dental procedures.

Sample Size

The study was designed with a carefully considered sample size to ensure statistical significance and reliability of the results. The sample size for the study was determined utilizing the G-power calculator, resulting in a decision to allocate 40 participants to each of the two groups, with each participant receiving two different injections, thereby evaluating 80 sites in total. This approach allowed for a comprehensive comparison between the two injection types, as each patient served as their control.

Study Design

The study commenced with an initial assessment to determine patient eligibility. Once eligibility was confirmed, the patient was scheduled for their first injection, during which their baseline heart rate was measured before any procedures. Following this, the patient received the first local anaesthesia injection using one of the two methods being compared in the study. After the injection was administered, the patient's heart rate was measured again to record any changes that may have occurred due to the injection then the patient will be asked to evaluate pain intensity with Visual Analogue Scale.

The patient then returned after one hour, and the patient's heart rate being recorded before the administration of local anaesthesia. For this second injection, the alternative injection method was used on the other side, ensuring that each patient experienced both types of injections. Following the second injection, the patient's heart rate was measured once more to capture the immediate physiological response and the patient will be asked again to evaluate pain intensity with Visual Analogue Scale.

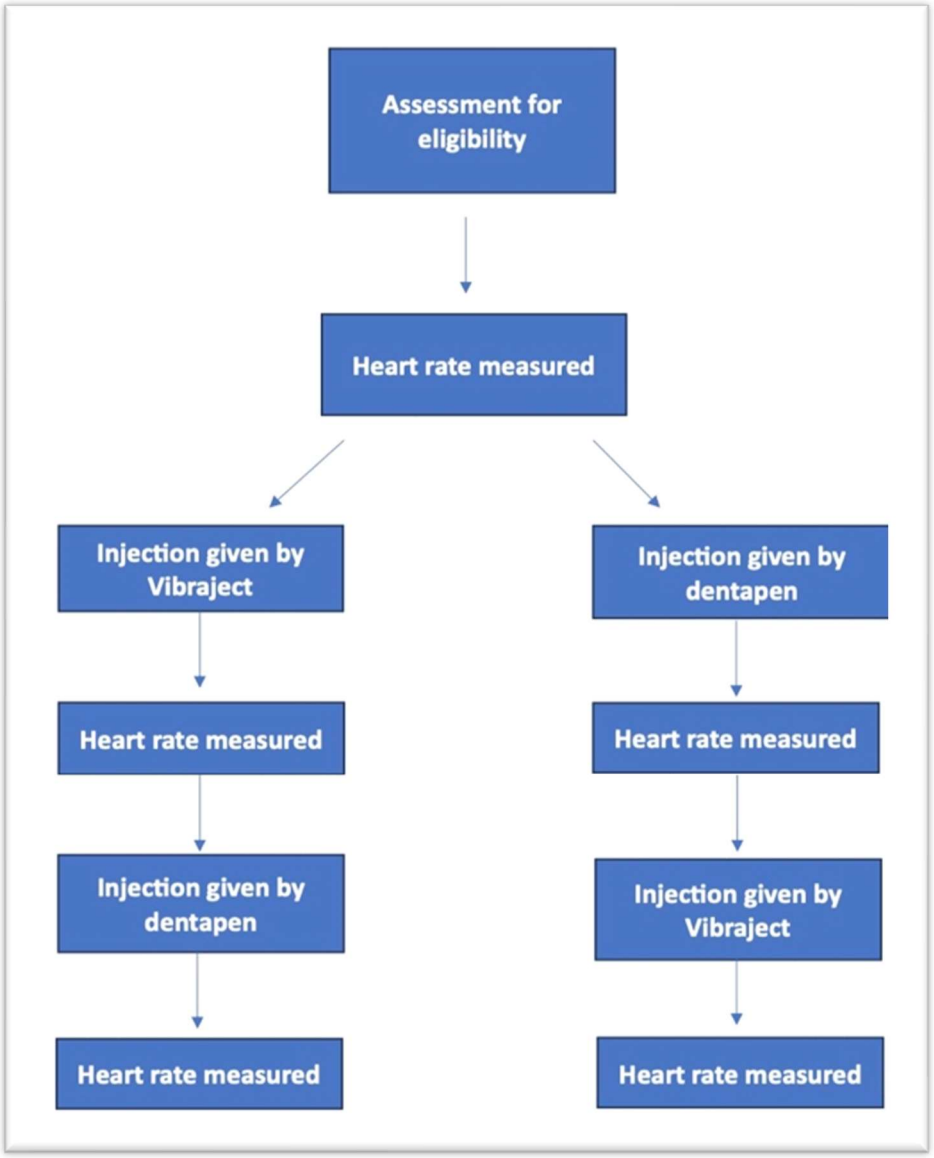

Figure 1: Flow chart of the study

This study design is a split mouth clinical trial which allowed for a within-subjects comparison, where each patient's reaction to both injection methods could be directly compared. The heart rate measurements before and after each injection provided objective data on the physiological response to the injections.

Steps of the Experiment

The experimental protocol was meticulously structured to evaluate the efficacy and patient response to two different local anaesthetic delivery systems. The steps were as follows:

Step I: Before administering a local anaesthetic, the patient's heart rate was checked with a pulse oximeter (Beurer Finger Pulse Oximeter). The results were recorded.

Step II: Patients were randomly assigned to get the injection of local anaesthetic at their initial appointment either with the Dentapen system (ramp-up) or with Vibraject. To simplify the protocol, a 27-gauge needle was used for all dental injections with bevel side directly headed to the injected site.

Step III: In the next appointment, after of one hour on a digital timer, the other technique was used for the same patients on the other side. Hence, each patient was given local anaesthesia twice, once with the Dentapen system (ramp-up mode) and once with Vibraject.

Step IV: Immediately after each local anaesthesia injection operation, the patient was asked to use the Visual Analogue Scale to score the intensity of reported pain.

Step V: After administering a local anaesthetic, the patient's heart rate was measured with a pulse oximeter (Beurer Finger Pulse Oximeter). The results were recorded.

Step VI: After both injections were administered to each patient, they were asked which injection they would prefer by selecting the injection number (first or second) according to their order for each patient.

Risk of Bias

To mitigate the risk of bias in this study, several blinding strategies were employed. All patients were blinded to the sequence in which the two anaesthetic techniques were administered. To further reduce variability and potential bias, all procedures were conducted by the same operator and he was trained to ensure all injections to go with same protocol and procedures. This approach eliminated any differences that could arise from operator technique, thus ensuring consistency across all injections. The individual responsible for performing the data analysis was also blinded to which technique was used for each patient. The blinding of the analyst was achieved by using coded data that concealed the identities and the specific techniques used for each patient, thereby maintaining the objectivity of the data interpretation.

Additionally, patients were asked to wear an eye mask during the injection process. The use of masks prevented patients from seeing the syringe and the method of injection being used, which could potentially influence their perception and subsequent reporting of pain. This step was crucial to maintain the integrity of the study's double-blind design, where neither the patients nor the individuals analyzing the data were aware of which technique was being used at any given point, thus preserving the study's methodological rigour.

Injection with the Dentapen® System (Ramp-up Mode)

According to the manufacturer's protocol, the Dentapen electronic syringe was used to administer local anaesthesia. To administer local anaesthesia, a cotton-tipped applicator with 20% benzocaine gel (Topox; Sultan Healthcare, Inc., York, PA) was applied topically after drying the mucosa and placed for 60 seconds using a digital timer. After 60 seconds, the target site was wiped with 2-inch cotton gauze before injecting 0.5 cartridge (0.9 mL) of 3% mepivacaine hydrochloride with no epinephrine (Henry Schein, Melville, NY) which was stored in room temperature. The

needle was advanced into the tissue until it was estimated to be over the root apex while remaining parallel to the tooth's long axis (needle placement). The Dentapen was activated after aspiration to deposit the solution at a medium rate (1 mL/60 s) using the ramp-up mode. Following cartridge deposition, the operator adjusted the participant to an upright seated position so that he or she could independently record his or her perceived pain on the Visual Analogue Scale.

Figure 2: Dentapen used in the study.

Injection with Vibraject

After drying the mucosa, a cotton-tipped applicator with a 20% benzocaine gel (Topox; Sultan Healthcare, Inc., York, PA) was placed for 60 seconds using a digital timer. After 60 seconds, the target site was wiped with another 2-inch by 2-inch cotton gauze and injecting 0.5 cartridge (0.9 mL) of 3% mepivacaine hydrochloride with no epinephrine (Henry Schein, Melville, NY) which was stored in room temperature. The needle was advanced into the tissue until it was estimated to be over the root apex while remaining parallel to the tooth's long axis. The Vibraject was activated after aspiration to deposit the solution slowly at approximately 50 seconds (time necessary to infiltrate 0.5 mL of anesthetic with the dentapen system) for both groups. The time factor was therefore limited to prevent a possible confounding effect in the patients' pain perception. Following cartridge deposition, the operator adjusted the participant to an upright

seated position so that he or she could independently record his or her perceived pain on the Visual Analogue Scale. The Vibraject was selected as the vibrator due to its simple design, battery operation, and ability to be easily attached to a syringe with minimal adjustment to conventional injection procedures. Also, compared to other vibration gadgets, it is reasonably affordable.

Figure 3: Vibraject used in the study.

Visual Analogue Scale scale

The Visual Analogue Scale score was stratified into distinct categories: "0" denoted absence of pain, scores ranging from "1-3" indicated mild pain, "4-6" signified moderate pain, "7-9" represented severe pain, and the maximum score of "10" was designated as indicative of the utmost intensity of pain conceivable.

Statistical Analysis

The statistical analysis for this study was conducted using SPSS Version 20 (IBM-SPSS Inc., Chicago, IL), a robust statistical software package that allows for detailed data management and analysis. The primary statistical tests employed were the paired T-test for analysing the heart rate data and the Wilcoxon test for the Visual Analogue Scale pain scores.

The paired T-test was chosen for the heart rate data as it is designed to compare the means of two related groups, such as the same patients' heart rates before and after each injection. This test is particularly suitable for assessing whether there is a statistically significant change in heart rate following the administration of local anaesthesia.

For the Visual Analogue Scale pain scores, the Wilcoxon test was utilized. This non-parametric test is ideal for data that are not normally distributed and is used for comparing two related samples, matched samples, or repeated measurements on a single sample. In this study, it was employed to evaluate the differences in pain scores between the two different injection techniques on the same patients.

A p-value of 0.05 or less was considered statistically significant. This conventional threshold indicates that there is only a 5% likelihood that the observed differences occurred by chance. Thus, if the p-value is less than or equal to 0.05, the results are deemed statistically significant, suggesting a real difference between the two techniques that is not due to random variation.

RESULTS

Table 1 shows the demographic characteristics of the study population, offering insights into both age and gender distribution. The mean and standard deviation for age provides a central tendency and variability measure, while the gender distribution details the proportion of males and females in the sample. The mean age of the patients was 36.1 (SD 9.33) years, with the majority being males (87.5%).

Table 1: Descriptive statistics of study participants (N=40), highlighting age and gender distribution

Study variables	**N (%)**
Age in years (mean ± SD)	36.1 ± 9.33
Gender	
• Male	35 (87.5%)
• Female	05 (12.5%)

Figure 4 presents the study population's preferred method for injecting anaesthesia. The highest number of the participants showed interest in the Dentapen® method (n = 25, 62.5%) while 15 participants showed inclination towards the Vibraject method (37.5%).

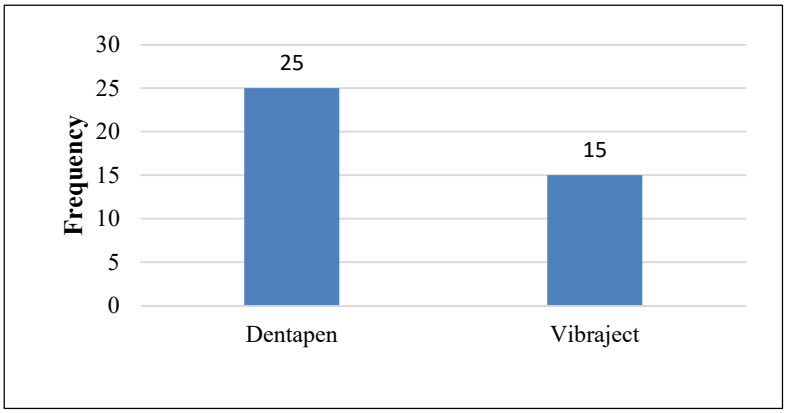

Figure 4: Preferred method of injecting local anaesthesia by the study population

Table 2 demonstrates descriptive statistics related to heart rate measurements, including mean, standard deviation, and standard error of the mean for different conditions. The mean heart rate before treatment is slightly lower for Dentapen® (70.225) compared to Vibraject (70.775). The mean heart rate after treatment is higher for Dentapen® (71.75) compared to Vibraject (71.05). Both Dentapen® and Vibraject showed an increase in mean heart rate after treatment.

Table 2: Heart rate before and after the procedure

		Mean	**N**	**Std. Deviation**	**Std. Error Mean**
Overall	Heart rate before	70.5000	80	10.16572	1.13656
	Heart rate after	71.4000	80	9.59905	1.07321
Dentapen®	Heart rate before	70.2250	40	10.04984	1.58902
	Heart rate after	71.7500	40	9.94794	1.57291
Vibraject	Heart rate before	70.7750	40	10.40091	1.64453
	Heart rate after	71.0500	40	9.35058	1.47846

Table 3 indicates a statistically significant increase in mean heart rate measurements following Dentapen® injection ($p=0.010$). However, no significant differences were observed in the mean heart rate measurements between the overall and Vibraject before and after injection ($p>0.05$).

Table 3: Comparison of mean heart rate measurements before and after injections with Dentapen® and Vibraject

	Paired Differences					
	Mean	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**	**t**	**P-value §**

					Lower	Upper		
Overall	Heart rate before - Heart rate after	-.90000	4.18133	.46749	-1.83051	.03051	-1.925	0.058
Dentapen®	Heart rate before - Heart rate after	-1.5250	3.56613	.56386	-2.66550	-.38450	-2.705	**0.010 **
Vibraject	Heart rate before - Heart rate after	-.27500	4.67940	.73988	-1.77155	1.22155	-.372	0.712

§ P-value has been calculated using paired sample t-test.
** Significant at p<0.05 level.

Table 4 depicts the mean Visual Analogue Scale score. The mean score of Vibraject (2.175) was observed higher than that of Dentapen (1.550). However, the results yielded an insignificant difference (p=0.105). The overall mean Visual Analogue Scale score was 1.863.

Table 4: Comparison of Visual Analogue Scale between Dentapen® and Vibraject

	Mean	N	Std. Deviation	Std. Error Mean	P-value §
Overall	1.863	80	1.605	0.179	
Dentapen®	1.550	40	1.467	0.232	0.105
Vibraject	2.175	40	1.693	0.268	

§ P-value has been calculated using Mann Whitney Z-test.

REU Informed Consent Statement Form for Clinical Studies

You are kindly invited to participate in a research study, the title of which is:

Comparison Between the Dentapen and Vibraject: a Randomized Clinical Study on the Administration of Local Anaesthesia in Adult Patients.

The aim of this study is as follows:

Aims of the research:

This study compares the pain that patients feel when receiving local anesthetic injections in their maxillary posterior teeth on the buccal side using Vibraject-assisted injection and the controlled flow technique with the Dentapen® system (ramp-up mode).

Secondary Objectives of the Study:

- Measure the heart rate before and after the injections.
- Measure the patients' preferences regarding the two injection techniques.

My name is Dr. Hassan Ali Al-Muashi and I will be the responsible researcher.

Contact number 0551118659

If you agree with your desire to participate in this scientific research, you will be among the 40 volunteers who will participate in this research.

The procedure will be on two appointments. On the first appointment, you will be given an injection with one of the two devices randomly selected in the upper jaw next to the back molars. Then, after a one hour, you will also be given another injection with the other device in the opposite area.

Immediately after the two injections, you will be asked to evaluate the severity of the pain you felt, as well as your heart rate will be measured before and after each injection.

After completing the second appointment, you will also be asked to choose which of the two needles you prefer to inject in the future.

The benefit of this study is to compare the two devices that cause less pain to the patient to be used in the future.

There is no cost to participate in this study.

Your participation in this research is an option for you to decide to participate or not. If you decide to participate in this study, you will be asked to sign the consent form. After signing the consent form, you can still withdraw at any time without giving reasons. Withdrawing from this study will not affect your relationship with the researcher or your treatment, and there will be no cost to withdraw.

If you withdraw from the study before data collection is complete, your data will be returned to you or destroyed.

Confidentiality statement:

Please do not write any identifying information.

The researcher will make every effort to maintain your confidentiality, including the following:

Assign names/code numbers to the participants, which will be used in all research notes and documents.

Keep interview notes, transcripts, and any other identifying information of the participant in a filing cabinet as a lock in the researcher's personal possession.

Contact info.

If you have any questions at any time about this study or experience negative effects as a result of participating in this study, you can contact the researcher whose contact information is available on the first page.

If you have any questions regarding your rights as a research participant, or if problems arise that you do not feel you can raise with the PI directly by telephone at 0551118659 or at the email address rahhal95@hotmail.com

Acknowledgment to participate in the research.

I have read the contents of this document, and/or they have been fully explained to me. All my inquiries were answered clearly, and I understand that my participation is voluntary and that I can withdraw at any time without giving reasons and without cost, and I was provided with a copy of this document. I voluntarily agree to participate in this scientific research.

FULL NAME _____

Date _____

SIGNATURE _____

Thumb print (if applicable)