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The Efficacy of 95 Hz Topical Vibration in Pain Reduction for Trigger Finger Injection:

A Placebo Controlled Prospective Randomized Trial

Kevin W. Park, BA², Martin I. Boyer, MD¹, Ryan P. Calfee, MD, MSc^{1,3}, Charles A. Goldfarb, MD¹, and Daniel A. Osei, MD^{1,3}

¹Department of Orthopedic Surgery, Washington University School of Medicine

²Washington University School of Medicine

³Washington University Institute of Clinical and Translational Sciences

Abstract

PURPOSE—To determine if vibratory stimulation would decrease the pain experienced by patients during corticosteroid injection for trigger finger.

METHODS—A total of 90 trigger finger injections were randomized to one of 3 cohorts. With their injection, patients received either no vibration (control group), ultrasound vibration (sham control group), or vibration (experimental group). A commercial hand-held massaging device was used to provide a vibratory stimulus for the experimental group. Visual analog scale (visual analog scale) pain scores were obtained before and after the injection to assess the anticipated pain and actual pain experienced.

RESULTS—Anticipated pain and actual pain did not significantly differ among the groups. Anticipated VAS pain scores were 45, 48, and 50 and actual VAS pain scores were 56, 56, and 63 for the vibration, control, and sham control groups, respectively. When normalized using anchoring VAS pain scores for “stubbing a toe” or “paper cut,” there remained no between-group differences in injection pain scores.

CONCLUSIONS—Concomitant vibratory stimulation does not reduce the pain experienced during corticosteroid injections for trigger finger.

Keywords

injection; pain; steroid; trigger finger; vibration anesthesia

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Corresponding Author: Daniel A. Osei, MD BJC Institute of Health, Suite 5505 660 South Euclid Avenue, Campus Box 8233 St. Louis, MO 63110 Telephone: 314-747-2813 Fax: 314-747-2600 oseid@wustl.edu.

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INTRODUCTION

Corticosteroid injections remain a primary treatment option for a number of painful conditions of the hand including de Quervain tenosynovitis and trigger finger(1). As a result, 90% of orthopedists report using corticosteroid injections in their practice, each administering an average of over 300 injections annually (2).

The pain associated with corticosteroid injections can cause substantial discomfort and anxiety. Excessive fear of injections is reported by approximately 10% of patients, and needle phobia, characterized by an intense and persistent fear of injections, affects approximately 2% of the general population. (3,4). This fear is not reliably alleviated by the use of local anesthetics that require injections themselves, as the injection of the anesthetic agent may become the most painful portion of the procedure (5). In part, this has motivated research into alternative methods to reduce the pain and anxiety associated with injections, including distraction techniques, verbal reassurance, vapocoolant sprays, and anesthetic creams (6,7,8,9).

Recent studies in the dentistry and cosmetic surgery literature report that vibratory stimulation reduced the pain experienced during injections of local anesthesia and botulinum toxin (10,11,12). The mechanism of this vibration analgesia has been explained by the gate control theory, which purports that signals from large diameter A β fibers (encoding pressure and vibration) stimulate inhibitory interneurons in the spinal cord that impede signals from A δ and C fibers (encoding pain) (13).

The purpose of this study was to determine if vibratory stimulation would affect the pain experienced during corticosteroid injections for trigger finger. Our working hypothesis was that vibratory stimulation would decrease the pain experienced by patients during corticosteroid injections for trigger finger.

METHODS

After approval from our institutional review board, 90 patients (90 trigger finger injections) consented to participate in this randomized trial—a total of 40 men and 50 women with an average age of 59 years (SD 12). All subjects were recruited from the clinics of 4 fellowship-trained hand surgeons at our tertiary institution. Patients with the diagnosis of trigger finger who were advised by their surgeon to receive corticosteroid injections were eligible for inclusion. The diagnosis of trigger finger was made by the attending physician based on a history of painful finger flexion and extension, symptomatic clicking or locking of the finger at the proximal interphalangeal joint, and) the presence of tenderness over the A1 pulley. The choice to proceed with corticosteroid injection was made through a shared decision making process after discussion of risks and benefits of injection. After patients agreed to proceed with injection, but before the injection was administered, they were offered study enrollment. Patients were excluded if they were under the age of 18, had peripheral neuropathy, or if they were pregnant or nursing.

Consecutive trigger finger injections were assigned to one of 3 cohorts using a random number generator (Figure 1). Injections were accompanied by either no vibration (control

group), ultrasonic vibration (sham control group), or vibration (experimental group). A commercial hand-held massaging device (AcuVibe SoftTouch™, Long Beach, CA) was used to provide a 95Hz vibratory stimulus for the experimental group. The device was placed on the palm 2-3 cm proximal to the site of injection so as to be adjacent to the injection site without interfering with injection administration. The vibration was provided 3-5 seconds before the initial 30g needle stick and throughout the entire injection (consisting of 1.0mL of 40mg/mL methylprednisolone acetate with either 1.0mL 1% lidocaine or 0.5mL 0.5% bupivacaine and 0.5mL 1% lidocaine) (14). In all patients, the injection site was prepared using a povidone-Iodine swab, and device sterility was ensured by covering the contact point of the device with a sterile latex surgical glove. Consistent with previously published studies investigating vibration analgesia, no gel or cream was applied to the device or the site of injection (10,11). In the sham control group, patients were informed that they would receive an ultrasonic vibration that would be neither heard nor felt. The same device and protocol used in the experimental group was used with the exception that the device was turned off. In the control group, no device was used.

Pain scores were measured using a 10 cm (100 point) visual analog scale (VAS) ranging from no pain to most pain. Scores were obtained before the injection to assess anticipated pain (how painful patients imagined the injection would be) and between 2 to 5 minutes after the injection to assess actual pain experienced. Additionally, patients rated the pain associated with “stubbing a toe” and “paper cut.” These were chosen to provide common experiences with both a blunt and a sharp pain stimulus. The average of these anchoring pain scores for each subject were used to normalize the injection pain scores (15).

STATISTICAL ANALYSIS

An a priori power analysis indicated that 26 injections per group would be required to detect a 20 point change in VAS (20% effect size) with a SD of 25 points. Analysis of variance was used for the between-group comparison of parametric data and chi-square for categorical data.

RESULTS

There were no differences between the cohorts in terms of age, sex, location of injection, or whether a previous trigger finger injection was received or not (Table 1). In 46 of the 90 injections (51%), the patient had never received an injection for treatment of trigger finger. The long finger was the most commonly affected finger (49%).

Anticipated pain and actual pain did not significantly differ among the groups ($P = 0.66$ and 0.48 , respectively). (Figure 2).

Anchoring VAS pain scores for “stubbing a toe” or “paper cut” did not differ among the groups ($P = 0.76$ and 0.78). Pain scores for injection were normalized using a multiplier obtained from the average of the anchoring pain scores. This normalization, however, did not change the results—there remained no between-group differences in injection pain scores ($P = 0.87$ for anticipated pain, $P = 1.0$ for actual pain).

DISCUSSION

Our data support the conclusion that a 95 Hz cutaneous vibratory stimulus, applied for 3 – 5 seconds, did not reduce the pain experienced during trigger finger corticosteroid injections. The discrepancy between our data and those of similar literature may be due in part to the deeper injection into the flexor tendon sheath during trigger injection. This causes an abrupt yet transient increase in pressure within a confined space that contributes to the experienced pain, described by patients as fullness or pressure. The mechanism of this pain likely differs from that of superficial injections and may be encoded through a different pathway that is less affected by concomitant vibratory stimulation.

Our data indicated marked variability in the experience of pain (VAS score SD 22 - 30). This was expected provided the subjective nature of pain, and previous studies investigating pain associated with injections using an analog or numeric ordinal scale report comparable variability (10,16). Pain experienced during trigger finger corticosteroid injections are influenced by expectations, the presence or absence of depression, and sex, all of which can account for variability in reported pain scores (16). Psychological and sociological factors also play a role (17,18). This inherent limitation was addressed a priori by assuming a 25 point standard deviation to calculate the sample size needed to achieve 80% power. It is thus unlikely that reported pain variability alone accounts for the lack of significant pain reduction from vibration analgesia found in the study.

There are several limitations to this study. First, the corticosteroid injections, which included lidocaine and bupivacaine, were not pH buffered. Previous studies have suggested that local anesthetic injections buffered with sodium bicarbonate may reduce the pain associated with injection (19,20). Other studies, however, have found no effect on pain with buffering (21) and thus it is unclear whether pH buffering would have affected our results. Second, approximately 20% of patients received a pure 1% lidocaine rather than a 1% lidocaine and 0.5% bupivacaine mixture with the corticosteroid injection. This was solely due to the preference of the treating surgeon. Though possible, it is unlikely that this discrepancy affected our results, as a previous study found no difference in pain from injection of 1% lidocaine and 0.5% bupivacaine (22). Third, the vibration frequency used in this study was fixed at 95Hz, which corresponded to the high setting of the massaging device. Using the low setting, which produced vibration at 75Hz, may have produced different results. This, however, is unlikely as the pain-reducing effect of vibratory stimulation was unchanged by vibration frequency within the 10-200Hz range (23). Fourth, the vibratory stimulation used in the experimental group was initiated 3-5 seconds before the initial skin penetration of the injection. This protocol aimed to follow previously published recommendations for techniques of vibration analgesia for dermatologic procedures in which vibratory stimulation was initiated 2-3 seconds before the start of the procedure to provide adequate inhibition of pain transmission at the level of the spinal cord (14). It is possible, however, that a longer duration of vibratory stimulation may have resulted in a different analgesic effect. Finally, to control for possible treatment placebo effect, we used a sham group as part of our study design. Patients in the sham group were told that they were receiving an ultrasonic stimulus that was not perceptible but would potentially decrease pain. While no patients in the sham group questioned this treatment, it is possible that results observed from the sham treatment

group could have been affected if patients were aware that they did not receive the true stimulus. Regardless, concerns about placebo effect were insignificant, as we did not observe a pain relieving effect with vibration analgesia.

Based on these data, we recommend that vibration stimulation should not be used to reduce the pain experienced during corticosteroid injections for trigger finger. Vibratory stimulation, however, is only one of many methods of analgesia that have been explored to reduce the pain associated with injections. Given the psychological component of pain perception, several cognitive measures have been investigated (e.g. visual and auditory distraction, verbal reassurance, and hand-holding), which have yielded variable success (24,25,26,27). More commonly, however, are contact interventions—vapocoolant sprays, ice packs, and anesthetic creams (6,7,8,9). These have demonstrated effective pain reduction for injections of local anesthesia and botulinum toxin. And future studies could investigate their effectiveness for trigger finger and other injections in the hand.

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Figure 1.
Consolidated Standards of Reporting Trials (CONSORT) flow diagram.

Figure 2.
VAS pain scores of perceived and actual pain of trigger finger injection.

Table 1

Patient demographics and injection characteristics.

	Control	Sham Control	Vibration	Total
N	30	30	30	90
Age ($\pm$ SD)	61 ($\pm$ 13)	58 ($\pm$ 13)	57 ($\pm$ 11)	59 ($\pm$ 12)
Sex				
Male	12	15	13	40
Female	18	15	17	50
Location				
Thumb	8	5	5	18 (20%)
Index	3	4	6	13 (14%)
Long	13	16	15	44 (49%)
Ring	6	5	4	15 (17%)
Little	0	0	0	0
Initial injection for Trigger Finger				
Yes	15	17	14	46
No	15	13	16	44