EFFECT OF THE VIBRATION ANESTHESIA DEVICE ON REDUCTION OF PAIN ASSOCIATED WITH LOWER EXTREMITY INJECTIONS

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INTRODUCTION

The most common anesthetic used to reduce pain associated with lower extremity injections in the clinical setting has been ethyl chloride cold spray. In other specialties of medicine, such as dentistry and dermatology, vibration is frequently used as an anesthetic modality to reduce the pain associated with needle stick injections. Podiatry has also adopted vibration as an alternate anesthetic modality in the clinical setting using the Vibration Anesthesia Device (VAD; Blaine Labs). The device is based on the gate control theory of pain proposed by Wall and Melzack in 1965. The VAD device works by providing vibratory sensation to the skin that should reduce or eliminate pain transmission to the brain. The brain should perceive the vibratory sensation before the sensation of pain, thus "gating" or "blocking" the sensation of pain. An assessment of the effectiveness of pain reduction associated with lower extremity needle-stick injections using both the VAD and cold spray will be evaluated in this study.

PURPOSE

The purpose of this study was to test the hypothesis that the VAD would provide equal or greater relief of pain associated with lower extremity needle-stick injections than traditional ethyl chloride cold spray. Mechanical vibration devices have been used to reduce pain associated with local injections since 1984 (1). Vibration has been employed for relief of pain associated with oral injections, dermatological injections, and orthopedic injections. Dr. Blaine produced the VAD, which administers vibratory stimuli that provides temporary localized anesthesia during an injection or other skin puncture.

Traditionally in office practices, many podiatric physicians employ ethyl chloride cold spray to anesthetize the local injection area. Ethyl chloride is a topical aerosol, anesthetic skin refrigerant that, when applied to the skin, creates an instant cooling effect on the surface by immediate evaporation of the product. Ethyl chloride and mechanical vibration work similarly in that they both decrease the nerve conduction velocity of the C-fibers and A-delta fibers comprising the peripheral nervous system. This interrupts the nociceptive inputs to the spinal cord (i.e., stimuli to the brain resulting in sensations of pain). The VAD is based on the gate control theory of pain proposed by Wall and Melzack (2) in 1965. This suggests that nociception (pain) is gated by non-nociceptive stimuli, such as vibration. In theory, the pain experience can be reduced by activation of nerve fibers that conduct non-noxious stimuli.

The VAD is comprised of a small motor powered by a single AA battery. Vibration is carried through two small u-shaped arms (Figure 1). When the button on the VAD is depressed, a light-emitting diode illuminates the area between the u-shaped arms. This illuminated area is where the injection needle should be targeted while vibration is simultaneously applied to the skin through the arms of the device.

METHODS

Thirty-six volunteers (72 feet) were recruited to assess pain level reported during lower extremity needle injections with the simultaneous use of VAD and cold spray. An initial baseline of cutaneous sensation and vibratory perceptive threshold were obtained using a 5.07 Semmes-Weinstein Monofilament and a 128 Hz Tuning Fork. If the subject

Figure 1. Vibration Anesthesia Device.

provided an affirmative response to sensation with both the monofilament and tuning fork, they were included in the study.

After an initial baseline was established, the effectiveness of the VAD in the reduction/elimination of pain associated with lower extremity needle injections was assessed. An injection was given but no fluid was injected as the pain associated with the injection of a local anesthetic (e.g., stinging effect) could mask the effects of the VAD or cold spray. Each individual was given a total of 5 injections, broken up into two sessions. Using a 25 gauge needle on day 1, and a 30 gauge needle on day 2, an injection was placed in the first lower extremity interspace, bilaterally. On day 1, the right interspace was injected with a 25-gauge needle with simultaneous use of the cold spray. The ethyl chloride was sprayed continuously for approximately 5 seconds at a distance of 5 inches from the site of the desired injection location. On the left foot, the same procedure was followed, except this time with the simultaneous use of VAD during the injection. The VAD was held firmly against the skin for 7 seconds prior to injection. On day 2, the same procedure described above was used to inject the first interspace, bilaterally, with the use of a 30-gauge needle. Lastly, on the second day, the right foot was also injected using a 30-gauge needle without the use of the VAD or cold spray.

The VAD was compared to ethyl chloride to assess if there was a reduction of pain associated with one anesthetic modality over the other. Also, the 2 anesthetic modalities were compared to using no anesthetic modality during a 30-gauge needle stick injection. Institutional Review Board approval was attained and each volunteer received a copy of the consent form.

One of the most common pain scales is the Wong-Baker Faces Pain Rating Scale (Figure 2). This scale was used to assess subjective pain associated with each injection. The Wong-Baker scale ranges from 0 to 5.

RESULTS

There were 36 subjects enrolled in this study, 17 males (47.2 %) and 19 females (52.8%). The overall model comparing all five modalities demonstrated a significant difference among the groups ($F[4, 175] = 118.349$, $P < 0.001$). A Student Newman-Keuls test was performed to identify those significant differences (Table 1).

When comparing the use of VAD to cold spray during a 25-gauge needle stick, there was significantly less pain reported with the use of cold spray ($P < 0.001$). A total of 22 of the 36 subjects reported no pain associated with the 25-gauge needle stick with a mean pain score of 0.53 when using cold spray as an anesthetic modality. A mean pain score of 3.14 was reported with use of the VAD and a 25-gauge needle, with all 36 volunteers reporting some pain.

When comparing the VAD to cold spray using a 30-gauge needle during the injection, 26 of 36 subjects reported no pain with the use of the VAD as the anesthetic modality. The mean pain score reported with a VAD and 25-gauge needle was 0.28. With the use of the cold spray and 30-gauge needle, 35 of 36 subjects reported no pain with a mean pain score of 0.03. Although there was less pain reported with the use of the cold spray when using a 30-gauge needle, there was no significant difference between the two anesthetic modalities in decreasing pain associated with needle stick injections ($P = 0.592$). Therefore, no differences could be detected in the subject's pain perception between the two anesthetic modalities during 30-gauge needle stick injections. Lastly, a 30-gauge needle stick injection was given without use of the VAD or cold spray and a mean pain score of 2.53 was reported with all 36 subjects reporting some pain.

Of interest, there was no difference noted between sexes for overall pain perception; however, women reported lower pain with the 30-gauge needle stick injection when using the VAD only. This suggests that more research is needed to detect any true difference between sex perceptions of pain with injections.

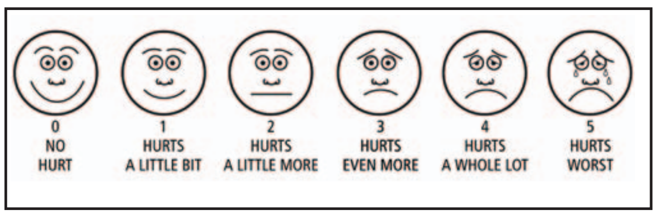

Figure 2. Wong-Baker Faces Pain Rating Scale. (From Wong DL, Hockenberry-Eaton M, Wilson D, Winkelstein ML, Schwartz P. Wongs Essentials of Pediatric Nursing, St. Louis: Mosby; 2001, p. 1301.

Table 1.

ANOVA: POST HOC TEST

Type of stick	N	Subset			
		1	2	3	4
Cold Spray – 30 gauge	36	0.03			
VAD – 30 gauge	36	0.28	0.28		
Cold Spray – 25 gauge	36		0.53		
No VAD or Cold Spray – 30 gauge	36			2.53	
VAD – 25 gauge	36				3.14
Significance		0.59	0.59	1.00	1.00

DISCUSSION

This study investigated the perception of pain associated with lower extremity needle stick injections comparing two various anesthetic tools used to modulate pain sensation and perception – vibration and traditional cold spray used in most podiatry offices. When vibration was used during the injections in this study, no significant differences were seen in pain perception with use of a 30-gauge needle. However, based on our subject population, less pain was reported with use of a 30-gauge needle and the VAD versus no anesthetic modality. When using a 25-gauge needle, the cold spray appears more effective in decreasing pain perception associated with lower extremity injections among our subjects.

Support for mechanical vibration as a means of pain reduction has been described in the literature. Vibration has been used as an interventional approach to pain management associated with oral injections (3), dermatological procedures (4), and heel stick injections in neonates (5). In this study, the use of the VAD did not prove superior to the use of traditional cold spray as an anesthetic device during needle stick injections.

This study used both 25- and 30-gauge needles, those commonly found in most podiatry clinics. The hypothesis that the VAD would provide equal or greater relief of pain associated with lower extremity needle injections when compared to ethyl chloride cold spray was not supported by the data gathered in this study. Of note, there was a significant difference between the use of 30-gauge versus 25-gauge needle stick injections when using the VAD as an anesthetic modality ($P < 0.001$). Furthermore, using the VAD with a 30-gauge needle did provide a decrease in pain perception compared to using nothing at all (i.e., no VAD or cold spray) and is an effective alternative to cold spray especially in cold intolerant patients.

Future studies are necessary to compare the use of various needle sizes and assorted local anesthetic agents along with the VAD to assess the reduction in injection pain. We always used the 25-gauge needle on day 1 and a 30-gauge needle on day 2 and to provide consistency, we always injected the right foot first with use of the cold spray. Perhaps, injecting with the VAD first would alter pain perception. Therefore, the order in which the anesthetic modality was used could affect the pain score reported by the subject. Also, due to our small population size, we did not investigate the use of the VAD on various lower extremity sites. Future studies can compare various injection sites with use of the VAD versus the cold spray. A larger subject population and a more random order of injection may contribute to different results than the ones obtained in this study. In addition, pain reported differences and sex as a variable should be further investigated.

REFERENCES

1. Reed ML. Mechanoanesthesia for intralesional injections. J Am Acad Dermatol 1984; 11: 303.
2. Melzack R, Wall PD. Pain mechanisms: a new theory. Science 1965;150: 971-9.
3. Hutchins HS. The effectiveness of topical anesthesia and vibration in alleviating the pain of oral injections. Anesth Prog 1997;44: 87-9.
4. Smith KC, Comite SL, Carver A. Vibration anesthesia: A noninvasive method of reducing discomfort prior to dermatologic procedures. Dermatology Online Journal 2004; 10:1.
5. Baba LR, McGrath JM, Liu J. The efficacy of mechanical vibration analgesia for relief of heel stick pain in neonates. J Perinat Neonat Nurs 2010;24:274-83.
6. Coghill RC, Talbot JD, Evans AC, Meyer E, Gjedde A, Bushnell MC, et al. Distributed processing of pain and vibration by the human brain. J Neurosci 1994;14:4095-108.
7. Fujita M, Mann T, Mann O, Berg D. Surgical pearl: use of nerve blocks for botulinum toxin treatment of palmar-plantar hyperhidrosis. J Am Acad Dermatol 2001;45:587-9.
8. Kakigi R, Watanabe S. Pain relief by various kinds of interference stimulation applied to the peripheral skin in humans: pain-related brain potentials following CO2 laser stimulation. J Peripher Nerv Syst 1996;1:189-98.
9. Lundeberg T, Abrahamsson P, Bondesson L, Haker E. Vibratory stimulation compared to placebo in alleviation of pain. Scand J Rehabil Med 1987;19:153-8.
10. Lundeberg T, Nordemar R, Ottoson D. Pain alleviation by vibratory stimulation. Pain 1984;20:25-44.
11. Lundeberg T. Vibratory stimulation for the alleviation of pain. Am J Chin Med 1984;12:60-70.
12. Lundeberg TC. Vibratory stimulation for the alleviation of chronic pain. Acta Physiol Scand Suppl 1983;523:1-51.