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Vibration and audio-visual stimulation: How effective in reducing invasive nursing procedural pain?

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Original Article

Vibration and audio-visual stimulation: How effective in reducing invasive nursing procedural pain?

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Abstract

Introduction: The pain related to high-volume minor invasive nursing procedures usually dealt with non-pharmacological measures because they are safe, inexpensive and can be performed independently by a nurse. Mechanizing these measures may reduce the complexity and help to deliver consistent and standardized therapy most of the time. **Objectives:** This research inquires the analgesic use of machine delivered vibration and audio-visual stimulation, to reduce pain sensation during minor invasive nursing procedures. The study also tries to find out the association between the study subject's selected personal variables and the degree of effectiveness of these stimulations. **Methods:** Researcher developed and validated a machine that can produce Vibratory-Audio-Visual stimulation (VAVS) either in combination or individually on the patients. A quasi-experimental design was formulated by drawing 80 patients, who were receiving intramuscular (IM) injection over the deltoid area. The selected samples were further divided into 4 groups: 20 in each, - namely V*ibration only*, *Audio-Visual only*, *Vibratory-Audio-Visual*, and *No stimulation* groups - and determined the effectiveness of device delivered VAVS in reducing pain during IM injection using a Visual Analogue Scale. **Results:** One-way ANOVA revealed that there was a significant difference in pain scores across the study groups (F = 13.134, df = 3, p = .001). The Post Hoc test intergroup comparison showed that; the mean pain scores of '*Vibratory-Audio-Visual*' group and 'V*ibration only*' group were significantly reduced as compared with '*Audio-Visual only*' group and '*No stimulation*' group. **Conclusion:** The study recommends to use a mechanical vibration of 6100rpm; 32Hz within 10cm of the site of IM injection to reduce the invasive nursing procedural pain.

Keywords: Pain, Non-Pharmacologic Pain Management, IM Injection, Nursing Procedural Pain, Vibration, Audio-Visual Stimulation, Innovation

Introduction

It is usual in a hospital and community setting that the nurses carry out minor invasive procedures for therapeutic or diagnostic purpose. However, it is the investigator's observation that the pain perceived by the person during that procedure is taken into consideration very indifferently and seldom use any consistent procedure to reduce such pain. Although not commonly discussed in the adult literature, when surveyed, found that 21% to 90% of adults expressed some anxiety about the pain associated with needle-based procedures (John, 2004). A study found that up to 90% of young children show serious distress during vaccination. Non-pharmacologic interventions are suitable for high-volume procedures like injections with acute, transitory pain because they are safe, inexpensive and can be performed independently by a nurse (Cason & Grissom, 1997).

Figure 1 illustrates the various non-pharmacologic methods used for pain management. Mechanizing these measures may reduce the complexity and help to deliver consistent and standardized therapy most of the time. Moreover, as a nurse, it is unlikely to have the time to implement a practically difficult physical or cognitive-

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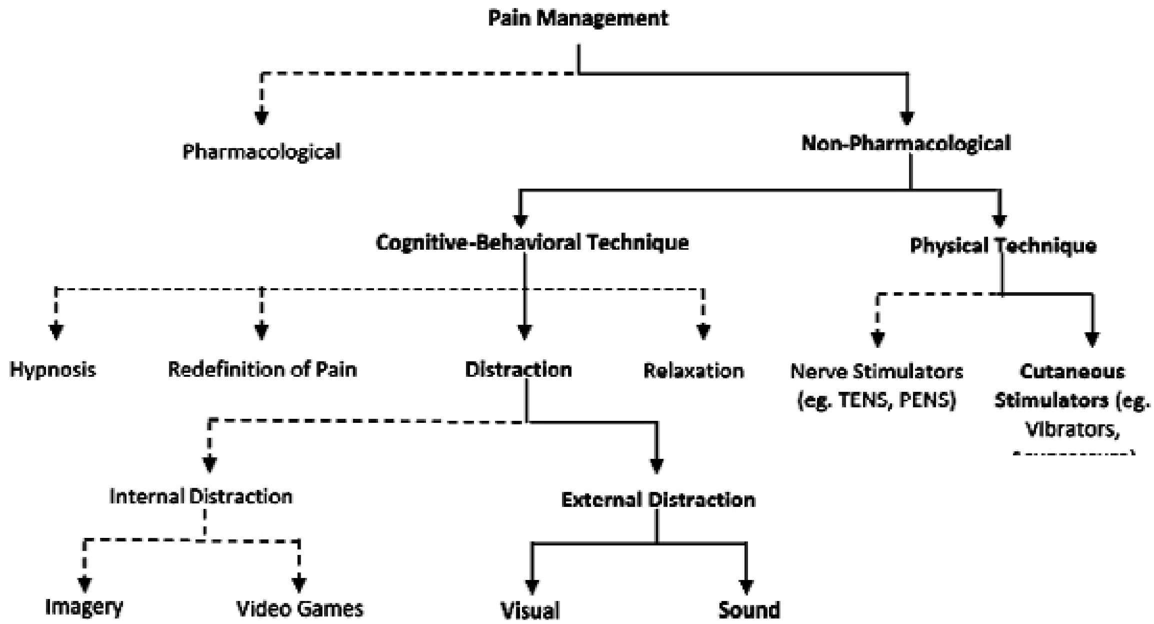

Figure 1: Pathways of Managing Procedural Pain and the Area of Interest of the Proposed Research is Highlighted (Benson, 2002)

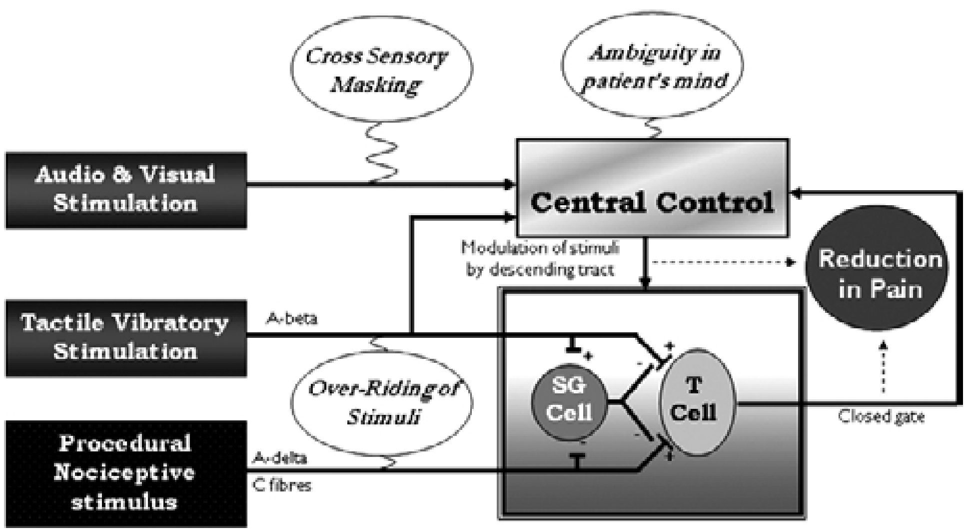

Figure 2: The circuit diagram of the gate-control theory of pain perception proposed by Melzack and Wall, is modified for the conceptualizing the mechanism of Vibratory Audio Visual stimulation in reducing pain perception

behavioural technique for these large volumes of minor invasive procedures. Thus, it is necessary to have an easily manageable way of effective non-pharmacological measure for this purpose.

Materials and Methods

A new Device

The researcher has developed a Vibratory-Audio-Visual (VAV) device within the conceptual framework of the *gate control theory of pain* proposed by Melzack and Wall (1982)

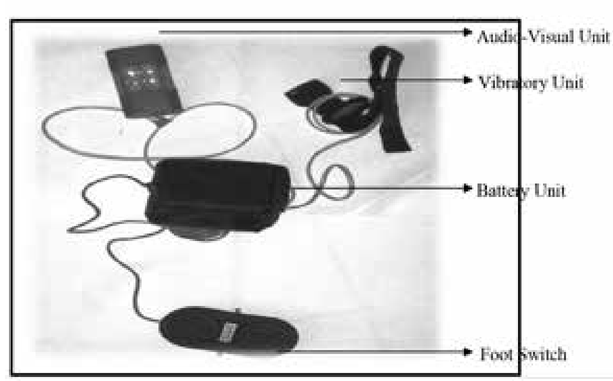

Figure 3: Vibratory Audio-Visual (VAV) device

Vibratory-Audio-Visual (VAV) Device help to give a fixed Vibratory (6100 rpm and 32 Hz), Audio (RMS amplitude-72.8dB) and Visual (Four red LED bulbs; Standard specifications) stimuli, either independently or simultaneously to the patient during IM injection.

Parts of Vibratory Audio Visual (VAV) Device

VAV device has four parts- *(i) Vibratory part; (ii) Audio-Visual Part; (iii) Battery Unit; and a (iv) Foot switch.*

Figure 4: Vibratory part of the device – (Vibratory tourniquet)

The vibrator machine of VAV device is extracted from an electronic razor. This eccentric weight vibrator works in 1.5-volt energy. The vibrator of the VAV device is attached to a Velcro Tourniquet; which can be comfortably worn over the arm where the procedure is being planned to do.

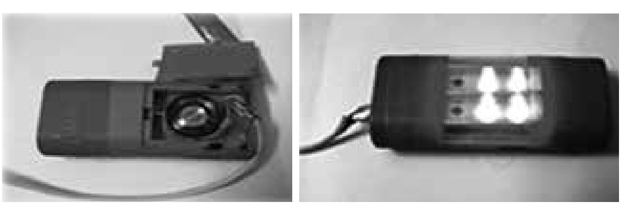

Figure 5: Audio-Visual part of the device – (A) Audio Unit; (B) Visual Unit

The Audio-Visual part has got a small musical speaker and four red LED bulbs. This part is given to the hands of the patient at the time of the procedure.

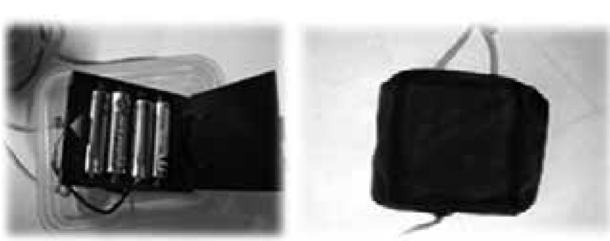

Figure 6: Battery Unit (A) Inside; (B) Outside

Four batteries were connected parallel to deliver 3 volts energy for the working of the device.

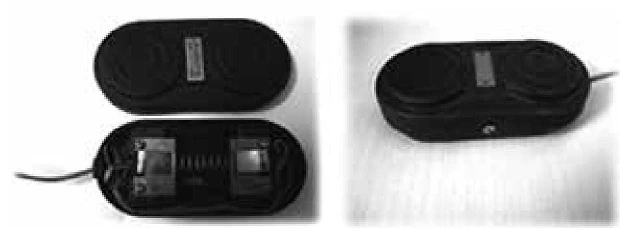

Figure 7: Foot Switch – (A) Inside; (B) Outside

The foot switch allows the nurse to manipulate the device. The switch can make the audio-visual part and vibratory part work either independently or simultaneously.

Validity and Reliability

The tool was given for validation to six experts in the different fields of health care sectors and the interrater agreement values are plotted to get content validity index (CVI). All the areas scored above the CVI mark of 0.7, with a total score of 0.736; which represents a good validity.

The reliability of the device is achieved by taking repeated measurements under standard laboratory conditions. Bio-Medical and Mechanical engineering departments of Manipal Institute of Technology (MIT) tested the electrical leakage and intensity of vibration of the device respectively. The department of Speech & Hearing; Manipal College of Allied Health Science (MCOAHS) tested the intensity of sound produced by the device. Details of the result obtained is given in table 1

Table 1:
Result of the reliability test of VAV device

SI No	Assessment parts	Values and Inference
1	Electric leakage	Tested and certified by the Bio-medical Engineering department, Manipal Institute of Technology, MU; as *no electric leakage* for the device.
2	Sound Intensity	Tested and certified by the Department of Speech and Hearing, MCOHAS, MU. *RMS amplitude= 72.8dB.* In accordance with OSHA standard and found to be safe for human use.
3	Vibration	Tested and certified by the mechanical engineering department, Manipal Institute of Technology, MU; as its intensity is *6100rpm, 32Hz,* which is well within normal limit.

SI No	Assessment parts	Values and Inference
4.	Light intensity	Red ordinary LEDs are with *standard specifications*; proven to be not harmful to human eyes

Research Questions

After making and calibrating the device, the following research questions were asked --

1. How efficient each of these VAV stimulations in reducing invasive nursing procedural pain?
2. Whether effectiveness can be increased by combining the stimulations?
3. What are the influences of personal variables in reducing pain when these stimulations are applied?
4. How well people will accept these kinds of interventions?

Design, Sampling and Setting

In order to answer these questions, a quasi-experimental pretest posttest control group study was designed. Purposive sampling technique was used to select 80 patients, who were receiving intramuscular (IM) injection over the deltoid area from a Government Community Health Centre in Kerala, India. The selected samples were further divided into 4 groups: 20 in each - namely *Vibration only*, *Audio-Visual only*, *Vibratory-Audio-Visual*, and *No stimulation* groups. *'No Stimulation'* group became the control group, who did not receive any stimulation during IM injection.

Implementation and Data Collection

After collecting a written consent from the patient, the VAV device was operated by the nurse using a foot control switch, just before inserting a 22 gauge, 1½ inch needle into the deltoid muscle. The vibrating unit was attached 10cm below the site of IM injection for Vibratory stimulation. Participants were asked to hold and look at the audio-visual part of the device during the procedure for Audio-Visual stimulation. VAV device gave vibration alone, audio-visual stimulation alone or both together to the participants according to the researcher's preference (Figure 8).

Demographic data collected from each patient and all the experimental groups were received prescribed stimulations in rotation. A Visual Analogue Scale (VAS) was used to rule out any pre-procedural pain as well as pain score after the intervention. At the end of the assessment, an opinionnaire was given to assess a person's subjective feeling about the intervention.

Figure 8: Patient Receiving Vibration and Audio-Visual Stimulation using VAV Device

Results

Analysis of the personal variables of patients revealed that 16 (20%) were below 20 years and 64 (80%) were above 20 years. As per gender, the samples drawn were almost equal. All the patients were from a rural places. Very few (7.5%) had chronic like COPD, Diabetes Mellitus and Hypertension. 55% of them received IM injection over the left deltoid region whereas the remaining 45% received over the right deltoid region. 78.75% of the medications injected were Tetanus Toxoid (TT), and remaining were Diclofenac Sodium (15%) and Anti Rabies Vaccine (6.25%) (Table 2).

Table 2:
Frequency and percentage distribution of participants selected personal variables

N=80

SlNo	Participant characteristics		Frequency	Percentage
1	**Age**			
	a.	below 20 years	16	20.0
	b.	above 20 years	64	80.0
2	**Gender**			
	a.	male	41	51.3
	b.	female	39	48.8
3	**Place**			
	a.	rural	80	100.0
	b.	urban	0	0.0
4	**Pre-existing Chronic Disease**			
	a.	yes	6	7.5
	b.	no	74	92.5
5	**Location of Needle prick**			
	a.	right deltoid	36	45.0
	b.	left deltoid	44	55.0

SlNo	Participant characteristics		Frequency	Percentage
6	**Medications Injected**			
	a.	Tetanus Toxoid	63	78.75
	b.	Diclofenac Sodium	12	15.0
	c.	Anti-Rabies Vaccine	5	6.25

The test to assess effectiveness of vibration and audio-visual stimulation using, oneway ANOVA revealed that there were significant differences in pain scores across the study groups (F = 13.134, *df* = 3, p = .001). The Post Hoc test intergroup comparison of each group with one another revealed that 'Vibration only' (μ diff = - .9912, p = .001) and 'Vibratory-Audio-Visual stimulations' (μ diff = -1.0780, p = .001) were effective in reducing procedural pain; however, among these two stimulations, no one showed any supremacy over other (μ diff = .0868, p = .975). It was also clear that the use of 'Audio-Visual stimuli' alone was not effective in reducing pain of IM injection (μ diff = - .2770, p = .542) (Table 2)

The study also found that there was no significant association between the effectiveness of vibratory, audio-visual stimulations and selected personal variables such as age, sex, location of IM injection (right deltoid or left deltoid) and/or medications injected to the participants (TT, Diclofenac Sodium, and Anti Rabies Vaccine).

Table 3:
Post-hoc test for multiple comparisons of study groups using ANOVA –Tukey HSD
Tukey HSD Dependent Variable: Square root Value of pain score*

(I)Type of Procedure	(J) Type of Procedure	Mean Difference (I-J)	Std. Error	Sig.
Vibration only	audio-visual only	-.7142(*)	.20711	**.005**
	VAV	.0868	.20711	.975
	no stimulation	-.9912(*)	.20711	**.001**
Audio-Visual only	vibration only	.7142(*)	.20711	**.005**
	VAV	.8009(*)	.20711	**.001**
	no stimulation	-.2770	.20711	.542
Vibratory Audio Visual	vibration only	-.0868	.20711	.975
	audio-visual only	-.8009(*)	.20711	**.001**
	no stimulation	-1.0780(*)	.20711	**.001**
No stimulation	vibration only	.9912(*)	.20711	**.001**
	audio-visual only	.2770	.20711	.542
	VAV	1.0780(*)	.20711	**.001**

* Square root Value of pain score is taken to achieve normal distribution values

Discussion

The present study results suggest to use a mechanical vibratory tourniquet of 6100rpm; 32Hz within 10 cm of the site of IM injection to reduce the invasive nursing procedural pain. The findings of this study are in congruence with some of the previous studies. A study conducted on vibration anaesthesia as a noninvasive method of reducing discomfort prior to dermatologic procedures using commercially available inexpensive massagers is an example (Smith et al., 2004).

One of the purposes of the current study was to combine the cognitive psychological technique and physical technique of non-pharmacological pain management. The current study suggests that physical technique like Vibration has got a significant advantage over cognitive-psychological technique like Audio-Visual stimulation in reducing acute pain due to invasive nursing procedures.

This research opens many doors for further evaluation. The stimulations used for the study were delivered at a constant intensity. No standardized optimum frequency of vibration is identified. Vibrator applied 10 cm below the site of IM injection was just the researcher's discretion. Sound of the audio stimulation and brightness and colour of LED lights were also kept constant. The best suitable intensity of each stimulation and the best way of application can be further explored.

Alleviating pain and suffering of the people is the philosophy of our health care system. In contrast to this, we often ignore pain induced by our health care system itself. Non-pharmacological method of pain management might be the safest and cheapest way to deal with those minor pains. However, at the application level, easiness and effectiveness of these methods need to improve. VAV device is a product of this thought and philosophy.

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