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Comparative Evaluation of Effectiveness of Buzzy Bee Device and Thaumaturgy in Alleviation of Pain and Anxiety in Children

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Introduction

Pain is a complex and multifaceted phenomenon that serves as a crucial biological warning system, signaling actual or potential tissue damage.

It encompasses sensory, emotional, cognitive, and social dimensions, making it not only a physical sensation but also a subjective experience shaped by individual context. Understanding pain involves an interdisciplinary approach that integrates neurobiology, psychology, and clinical science. Meanwhile, the Joint Commission on Accreditation of Healthcare Organizations refers to pain as the "fifth vital sign," emphasizing its importance in medical care. Pain is often encountered for the first time during childhood, marking a significant event in a person's life.

If pain in children is not properly addressed, it can lead to both physical and emotional distress later in life. As a result, dentists have a significant responsibility in managing pain effectively.

Pain management in children includes both pharmacologic and non-pharmacologic approaches. Pharmacologic treatments, such as local anaesthesia are commonly used for pain relief due to their fast action and ease of use. However, the administration of analgesics itself can be painful. Additionally, the excessive or inappropriate use of analgesics can have drawbacks, including strain on individuals and healthcare systems, negative impacts on certain bodily functions, and the development of tolerance, especially with the increased use of narcotics.

Non pharmacologic approaches are cost-effective, non invasive, painless, and free of harmful side effects, and they can be independently carried out. These methods can be divided into cognitive-behavioral techniques and peripheral-physical techniques.

Peripheral techniques, which include interventions like skin stimulation, are used to alleviate or reduce pain. These techniques are temporary and do not provide long-lasting relief. Skin stimulation can be applied in various

ways, such as directly on or near the painful area, or on the opposite side of the body. Other peripheral techniques include the use of heat or cold, menthol application, vibration, transcutaneous electrical nerve stimulation, massage, and touch.

Harbert suggested that applying cold to the palatal area before an injection can significantly reduce the perception of pain. More recently, combining cold gels with a vibrating device has shown encouraging results. The theory behind using such vibrating devices is that they create a distracting sensory environment, causing the brain to process the vibrations, which helps facilitate the delivery of the anesthetic. The rationale for using both cold (temperature) and vibration (stimulation) lies in the understanding that pain perception involves both attention and psychological components. The cold stimulus adds an additional layer of sensory input, effectively "masking" the pain signals and disrupting the pain pathway.

Dental pain and anxiety is a widespread psychological concern, often described as a near-universal instinctual reflex. It tends to be particularly pronounced in children, making it a significant challenge in pediatric dentistry. Uncooperative behavior in dental settings is frequently linked to the behavioral expressions of anxiety, which can manifest in various ways, such as resistance, fear, or withdrawal.

Addressing the anxiety often requires a tailored approach, combining psychological strategies, effective communication, and behavior management techniques to ensure a positive dental experience. Although local anaesthesia has proven to be efficient in management of pain in children, the injection of local anesthesia continuous to cause discomfort and pain while administration and also remains as one the reasons for dental fear and anxiety in pediatric dental office. Cognitive behavioral techniques act through changes in sensory factors in relieving pain. Using these methods, it diverts the attention of the child from the painful procedure and reduces tension, pain, and anxiety. Cognitive and behavioral methods appropriate for the child's age and developmental level should be used.

According to Rachman, conditioning (direct response), modeling, and information (indirect responses) are three factors promoting dental anxiety in children. Hmud and Walsh (2009) identified the “4S factors” for children's dental anxiety; these include sights (e.g., feeling of uneasiness and worry), sounds (drilling), sensations (high-frequency vibrations with a high annoyance factor), and smells (odors, such as eugenol and bonding agents).[1]

One alternative method for reducing injection pain is the pre-cooling of the injection site. This approach involves applying cold stimuli to the area before local anesthetic (LA) administration, offering a simple, effective, and cost-free solution. More recently, combining cold gels with a vibrating device has shown promising outcomes. These vibrating devices are thought to create a distracting environment that alters how the brain processes sensory input, making it easier for the anesthetic to be delivered. The rationale behind using both cold (temperature) and vibration (stimulation) stems from the understanding that pain is influenced by both physiological and psychological factors. The cold element, in particular, disrupts the pain signal pathway, leading to a "masking effect" that reduces the sensation of pain.

Buzzy device is a ladybug-shaped, palm-sized device employed as anew strategy to reduce needle-related pain in children, developed by the paediatrician Amy Baxter. It is a plastic reusable bee 2.5cm sized, non invasive device with a plastic battery and vibration motor. Ice

pack is placed under Buzzy and has a local cold application with vibration effect. It consists of two parts: the body of a bee and detachable icewings. The Buzzy device is primarily based on Melzack and Wall's(1965) gate control theory of pain and the descending inhibitory mechanism. Apparently, the vibration is hypothesized to block the afferent pain-sensitive fibers (A-delta and C-fibers) by stimulating the non-noxious A-beta fibers, which will further stimulate an inhibitory interneuron, thereby reducing the pain information transferred to the spinal cord.[1]

Furthermore, while a protracted cold treatment (30 - 60 secs) is placed closer to the nociception site, it activates the c-nociceptive fibers and further blocks the A-delta pain transmission signal[14]. Additionally, gentle stroking of the mucosa with topical anesthesia while administering the injection has been proven to be utilitarian in medicine.

According to the theory stated by McCaul and Mallot, a patient's perception of pain can be decreased if their mind is diverted away from an unpleasant stimulus. Another theory explaining distraction is the limited attention capacity theory, which suggests that human capacity to concentrate on one stimulus is limited. Therefore, to perceive pain, one should concentrate on the stimuli causing pain. Many other neurophysiological studies have signified the role of distraction in reducing pain levels, as there is a strong connection between the perception of pain and the attention a child gives to the unpleasant stimulus. Thus, based on these theories, distraction can be considered a major tool for managing the behavior of children in dental clinics. The distraction techniques influence the child's brain waves, aiding in relaxation and there by reducing pain and anxiety.

Magic tricks are also one of the most effective tools in reducing anxiety in children related to dental treatment. A number of studies have been conducted to evaluate the effectiveness of magic tricks in reducing dental anxiety. Magic tricks are also one of the most effective tools in reducing anxiety in children related to dental treatment. The literature reports that Buzzy device and thaumaturgy could be potential measures for pain and anxiety alleviation; however, no study has compared these techniques. Hence, the present study was conducted to compare and evaluate the efficacy of Buzzy device and thaumaturgy on dental anxiety and pain perception during LA administration in children.

Management of strong-willed children is extremely time consuming. In addition, the overprotective and overindulgent parental attitudes are on the rise, where aversive techniques, such as hand over mouth exercise (HOME) and physical restraints, are difficult to implement. Thereby, pharmacological behavior management techniques have an edge over the conventional techniques.

There is a need for an effective method of dealing with strong-willed children. Thaumaturgy is a new technique that has been used in this study to manage strong-willed children. Thaumaturgy is a tool that distracts and relaxes child and helps the dentist to perform necessary treatment. Thaumaturgy has emerged as a novel technique designed to address these challenges. This method involves using distraction and relaxation

techniques to help children feel more at ease during dental procedures. It acts as a psychological tool, redirecting the child's focus away from the dental environment and reducing anxiety.

Two thumb sleeves incorporated with a lighting device were worn on the thumb of the operator, which could be activated/deactivated at the operator's will. Various creative hand movements were performed to sustain the subject's interest.

Aim: To compare and evaluate effectiveness of conventional technique, buzzy bee device and thaumaturgy in alleviation of pain and anxiety in children aged between 6 – 10 years.

Materials and Methods: Written informed consent was obtained from the parents or guardians of the children enrolled in the study. Data was collected from the children of age group 6 to 10 years visiting the department of Pedodontics and Preventive Dentistry, V.S Dental college and hospital, Bangalore, who will require administration of LA.

Selection Criteria

Inclusive Criteria

- Children between the age group of 6 to 10 years requiring local anesthesia for pulpal therapy, extractions, any surgical procedures, etc.
- Children whose behaviors were positive and definitely positive according to Frankl Behavior Rating Scale.
- Patients who are able to follow the instructions.
- Children getting signed written informed consent from their parents/guardian to participate in the study and who has given consent to participate in the study.

Exclusive Criteria

- Special healthcare needs who required pharmacological behavior management were excluded from the study, systemic illness, abscesses, and space infections.
- Uncooperative patients.

Methods of Collection of Data

- Disposable sterile gloves
- Sterile mouth mirror
- Kidney tray
- Disposable syringe
- Local anesthesia- lignocaine and adrenaline injection 2%-1:80000
- Buzzy bee
- Thumb sleeves
- Visual analogue scale chart

Sample Size Determination

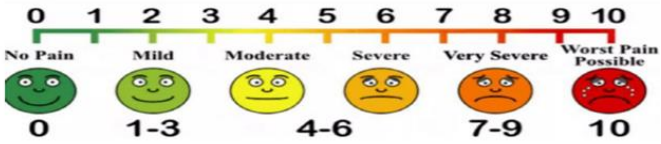
- Total no. of groups = 3
- Max Mean Value (of the 4 groups) = 4.78
- Min Mean Value (of the 4 groups) = 3.06
- Mean Difference = 1.72
- Pooled Standard Deviation = 1.30
- α (Type I error) = 0.05
- β (Type II error) = 0.20
- 1-β (Power of the test) = 0.80
- Required sample size per group = 13 (rounded off to 15)

- Total Sample Size = 15 x 3 = 45 (15 samples per group)
- To determine the appropriate sample size for the study, a power analysis was conducted considering a total of three comparison groups. The maximum mean value observed among the groups was 4.78, while the minimum mean value was 3.06, resulting ina mean difference of 1.72. A pooled standard deviation of 1.30was used to estimate the variability across groups.
- The analysis was conducted with a Type I error rate (α) of 0.05and a Type II error rate (β) of 0.20, corresponding to a statistical power of 0.80 (1−β). Based on these parameters, the required sample size per group was calculated to be 13, which was conservatively rounded up to 15 participants per group to ensuread equate power.
- Thus, the total sample size for the study was 45 participants, with15 participants allocated to each of the three groups.

Methodology

- Study was conducted on 30 children requiring local anesthesia for dental procedures like extraction, pulpal therapy, any surgical procedure visiting the department of pediatric and preventive dentistry, VS Dental College and Hospital, Bangalore.
- Children were randomly divided into 3 groups based on computer generated randomization technique.
- Group 1 - Conventional technique (Control group)
- Group 2 -Local anaesthesia administration using Buzzy device
- Group 3- Local anaesthesia administration using thaumaturgy(thumb sleeves)
- Tell show do technique was used to explain the kids about the procedure.

Visual Analogue Scale



Group 1

Control group – Local anaesthesia was administered to the injection site by conventional method for pulpal therapy, extractions, any surgical procedures, etc.

Group 2

The Buzzy device consists of two main parts: an external vibrating component that resembles the body of a honeybee, and a pre-cooling component designed to look like the bee's wings. This non-invasive, child-friendly, and affordable tool has been shown to help reduce pain perception in children undergoing local anesthetic (LA) administration. Upon sitting in the dental chair, the child is first introduced to the device through a simple explanation of its function. The child is then given the opportunity to interact with the Buzzy to become familiar with it. Following this, the device is attached to the frozen wing, and Buzzy is placed extra-orally, just above the cheek area where the LA will be administered. The placement of Buzzy bee device, which was strategically placed to distract and desensitize the area. Once the child was comfortable and distracted by the device's sensory input, the local anaesthetic was carefully administered ensuring minimal discomfort and optimizing child's overall experience.

Group 3: Using the thumb sleeves with LED lights incorporated in it to distract the child, the needle is gently inserted into the mucosa and LA is administered slowly and steadily to minimize discomfort.

Materials for assessing a child's level of anxiety Subjective scales for reporting pain were recorded using: Visual Analogue Scale (VAS)

Null Hypothesis: There is no significant difference in the mean VAS recorded in the three groups i.e. $\eta1 = \eta2 = \eta3$.

Alternate Hypothesis: There is a significant difference in the mean VAS recorded in the three groups i.e. $\eta1 \neq \eta2 \neq \eta3$

Level of Significance: $\alpha=0.05$

Statistical Technique Used: Kruskal-Wallis test followed by Mann-Whitney test (If there is a significant difference among the groups in KW test).

Decision Criterion: The decision criterion is to reject the null hypothesis if the p-value is less than 0.05. Otherwise we accept the null hypothesis. If there is a significant difference between the groups, we carry out multiple comparisons (posthoc test) using Mann-Whitney test.

Computations: The following tables give us the results from Kruskal-Wallis test and the P-Value. *

Group	Female		Male		Total
	n	%	n	%	
Control	14	93%	1	7%	15
Thaumaturgy	7	47%	8	53%	15
Buzzy Bee	8	53%	7	47%	15

Comparison of FAS values amongst the three groups

Group	Mean	Std Dev	SE of Mean	Min	Max	Kruskal-Wallis χ^2	P-Value
Control	8.13	1.64	0.42	4	10	29.904	<0.001*
Thaumaturgy	7.47	1.06	0.27	6	9		
Buzzy Bee	3.33	0.98	0.25	2	5		

*denotes significant difference Higher mean VAS value was recorded in control group followed by Thaumaturgy and Buzzy Bee group respectively. The difference in mean VAS value amongst the groups was found to be statistically significant (P<0.001). In order to find out among which pair of groups there exist a significant difference, we carry out multiple comparisons using Mann-Whitney test.

Results

No statistically significant difference was observed between Control and Thaumaturgy group (P>0.05). Statistically significant difference was observed between Control and Buzzy Bee group (P<0.001) as well as between Thaumaturgy and Control group (P<0.001).

Discussion

Pain is a personal experience that involves factors such as fear, anxiety, trust, personality, and the degree of control over an uncomfortable stimulus. According to the American Dental Association (ADA), the fear of pain is the primary reason many people avoid dental visits. Insufficient pain management is a major contributor to the development of dental fear and

anxiety. Dental anxiety is a complex condition that involves social, cognitive, and physiological factors. Relying on just one factor to evaluate this anxiety may not yield a comprehensive or accurate assessment.

The present study included 45 children, with equal allocation into three group. According to the Frankl Behavior Rating Scale, cooperative children who fell under positive and definitely positive categories were included.

The present study was conducted to evaluate the effectiveness of buzzy bee device and thaumaturgy technique during injection of local anesthesia. The pain due to local anesthesia can be decreased by a number of method which include pharmacological and non pharmacological methods.

In this study buzzy bee is used while giving any injection in children to reduce the pain due to prick. Bilsin and colleagues reported that Buzzy device distraction is superior in controlling pain in children undergoing LA procedures.

Buzzy Bee Device

Mechanism of action - The gate control theory of pain given by Melzack and wall best explains the analgesic action of mucosal vibrator. According to the theory the A-B nerve fibers, which transmit signal from vibration and touch receptors in the skin stimulate inhibitory interneurons of the spinal cord. These neurons decrease the pain signals.

The vibrating method on the injection site before local anesthesia might be a distraction for children, especially those who do not prefer flavored materials that stimulate nausea or can have harmful effects if swallowed. In addition, the vibrating technique is considered to be a time-saving method compared with cooling effect and is easier. The present study showed that the use of buzzy bee during injection reduces patient discomfort and vibration, gives a massaging effect which helps in providing a soothing effect.

Dak-Albab et al. employed a vibrating dental device, Dental Vibe(Injection Comfort System), on children and reported that vibration was a practical and more accessible method than gels in decreasing pain related to dental injections. Similarly, Shaefer et al. and Nanitsos et al. reported that vibrating devices effectively reduced pain during LA with a dental visit device and vibrating massager, respectively.

A systematic review and meta-analysis by Ballard et al. (2019)stated that the Buzzy device appears to be a promising technique for procedural pain management in children. Suohu et al. (2020) and Bilsin et al. (2020) reported that pain at the injection site was significantly decreased when vibration and external cooling were used on local anesthetic sites during dental treatment in children.

The first randomized controlled trial by Peretz and Gluck compared magic tricks with the Tell-Show-Do technique and concluded that magic tricks were more effective than the Tell-Show-Do technique. Magic tricks facilitated two types of cooperative behavior: moving the child to the dental chair and enabling the dentist to take radiographs more easily. Another clinical trial by Thosar et al. compared thaumaturgy (magic tricks) with audio-visual aids and concluded that magic tricks were equally effective as audio-visual aids for reducing anxiety in children during dental treatment.

Similar results were seen in a study by Nagar et al., where they compared different modes of distraction—magic tricks, audio visual distraction, and audio distraction—and found that the highest anxiety alleviation was seen with the magic trick group.

Another study by Konde et al. assessed various magic tricks, such as the thumb and light trick, book trick, and

item elimination trick, in various age-groups and concluded that the thumb and light and book tricks were beneficial in children from ages 2 to 6years for anxiety reduction, while the book and item elimination tricks were beneficial in children above 6 years of age.

In a pilot randomized trial by Asokan et al., magic tricks were found to be correspondingly beneficial in reducing the anxiety of children when compared to a dental game on mobile and the Tell-Show-Do technique. A study by Kothari et al. compared magic tricks with conventional behavior management techniques and concluded that children in the magic trick group exhibited lower anxiety during the administration of local anesthesia when compared to other conventional techniques.[21]

Another positive finding observed in the present study is that the majority of the children in this group intended to play with the device throughout the treatment, as it provided distraction from the sound and sight of dental instruments.

Conclusion

In our study, the application of external cooling and vibration was significantly effective on pain while giving injection.

There was a statistically significant difference between the control group and the experimental group in terms of pain score Buzzy bee device can be effective alternative for reduction of pain due to injection. The present study included limited number of patients. Similar study involving larger sample size is required. In conclusion, within the limitations of the contemporary study, Buzzy device distraction and Thaumaturgy are a valuable behavior guidance modalities in diminishing dental anxiety and fear in children undergoing LA administration.

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