Effectiveness of Virtual Reality Distraction on Pain Perception and Fear among Children with Cancer Undergoing IV Cannulation

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Abstract

Background: Cancer children are subjected to multiple cannulations during hospitalization. Pain and fear are most common during invasive procedures that are performed, especially IV cannulation, which can lead to worry. Exactly 25% of children are reported to have a fear of needle-related procedures. To examine the impact of virtual reality (VR) distraction on pain perception and fear in children with cancer undergoing IV cannulation. **Materials and Methods:** Using a quasi-experimental design, 80 cancer children with IV cannulation between ages 7–18 were recruited to the intervention and control group ($N = 40 + 40$) using the purposive sampling technique. The virtual reality distraction device was used 10 min before the peripheral IV cannulation procedure and remained in place until the procedure was completed in the intervention group, and no device was used in the control group. Wong–Baker Faces Pain Rating Scale and Children's Fear Scale were used to assess the pain and fear of children and their mothers. **Result:** Pain perception was found to be significantly lower in the VR distraction group among both children and mothers (1.82 ± 0.18, 8.01 ± 3.21) 95% confidence interval (CI) [0.82, 2.16] compared to the control group, respectively ($P = 0.001$**). Fear was found to be significantly lower in the VR distraction group among both children and mothers (0.81 ± 0.71, 3.01 ± 1.42) 95% CI [0.46, 0.91]. A strong positive correlation was found between children's and mothers' pain perception ($r = 0.91$, $P = 0.001$**) and fear ($r = 0.84$, $P = 0.001$**). **Conclusion:** VR distraction can be used as an effective device in pain and fear management among children undergoing IV cannulation.

Keywords: Cancer children, fear, IV cannulation, pain, virtual reality distraction

INTRODUCTION

Cancer is a very dreadful disease, much more so when the victims are children. It is very difficult to understand their traumatic experiences while, however, it deprives them of the very basic joys and needs of childhood. Cancer robs them of the joys of school life, peer group pleasures, and the very essence of childhood itself. The rigorous cancer treatment can be beyond their threshold of endurance.[1] Painful procedures[2] like blood access,[3] port access,[4,5] lumbar puncture, etc., can be very much traumatic. So, it is important to identify the ways and means to decrease the pain during those procedures. Various research studies have proved that the diversion of children is an effective intervention to decrease pain during painful procedures. Psychological interventions for needle-related procedural pain and distress in children,[6] MEDiPORT humanoid robot to reduce procedural pain and distress in children with cancer,[7] Robot-based distraction to reduce children's distress and

pain during intravenous insertion[8] are practical methods of diverting the patient's attention away from what may appear to be an unpleasant procedure. Distraction appears to involve competition for attention between highly noticeable feelings such as pain and purposefully directed focus on another information processing activity. Behavioral research in virtual reality (VR) and the virtual world has increased in recent years. VR[9] is a human-computer interface (the user's mind) that enables active interaction with a computer-generated world. A single-blinded prospective randomized study was carried out

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in India with a parallel design in 2019 to assess the effectiveness of counter-stimulation and distraction by virtual techniques on the perception of pain and anxiety during pulp therapy and tooth extraction among 70 children between the age of 7–12 years using "Wong–Baker Faces Pain Rating Scale," "visual analog scale," and "Venham's clinical anxiety rating scale." The study results revealed that the VR distraction method was more effective than counter-stimulation in reducing pain and anxiety among children who are undergoing pulpectomy and tooth extraction.[10] Hence, there is a need to identify the efficacy of the device serving as a distractive device, especially for children with cancer who are undergoing IV cannulation often.

MATERIALS AND METHODS

A quasi-experimental post-test-only control research design was conducted to collect data from 80 children aged 7–18 who were admitted to a selected medical college hospital in Mangalore from February 28th to June 30th, 2022. The children age group in this study was considered between 7 and 18 years old as the review indicates that the above-mentioned age group can report their pain perception and fear during IV cannulation. The declaration of the Indian Council of Medical Research (ICMR) 2017 guidelines ethical standards for using humans in the research were followed when conducting this study. Ethical clearance was obtained from the concerned ethics committee on March 23, 2021 (Ref.No: FMIEC/CCM/234/2021) and May 20, 2021 (Ref.No: IEC KMC MLR 05-2021/169). In November 2021, the protocol (REF/2021/09/047542) was added to ClinicalTtrials.gov.[11]

Children with all types of cancer undergoing IV cannulations, able to speak and understand Kannada and English, who had no auditory, visual, or cognitive impairments, absence of cardiac conditions, no end-of-life treatment, and no intellectual impairment, were chosen for the study using the purposive sampling technique. Investigators introduced themselves and obtained voluntary informed consent from parents, oral assent from children aged 7–11, and written assent from children aged 12–18. After confidentiality was ensured, using the purposive sampling technique, 40 children in the intervention group and 40 children in the control group were allotted. The sample recruitment process is depicted in Figure 1. During data entry, missing data tools were planned for rejection.

Tool and Data Collection Method

Content validity was performed for the tool with the help of 11 experts, including two pediatric oncologists, one clinical psychologist, one pediatrician, and seven pediatric nursing experts. The scale content validity (SCV) of the tool was one, indicating that it was valid. All the valuators' had agreed with the tool; however, there was some modification suggested in the demographic, which was incorporated. Pretesting of the tool was carried out among eight cancer children who underwent IV cannulation. Four children in the VR group and four children in the control group were allotted. Items of the tools were clear to the children, and they took an average of around 10 min to
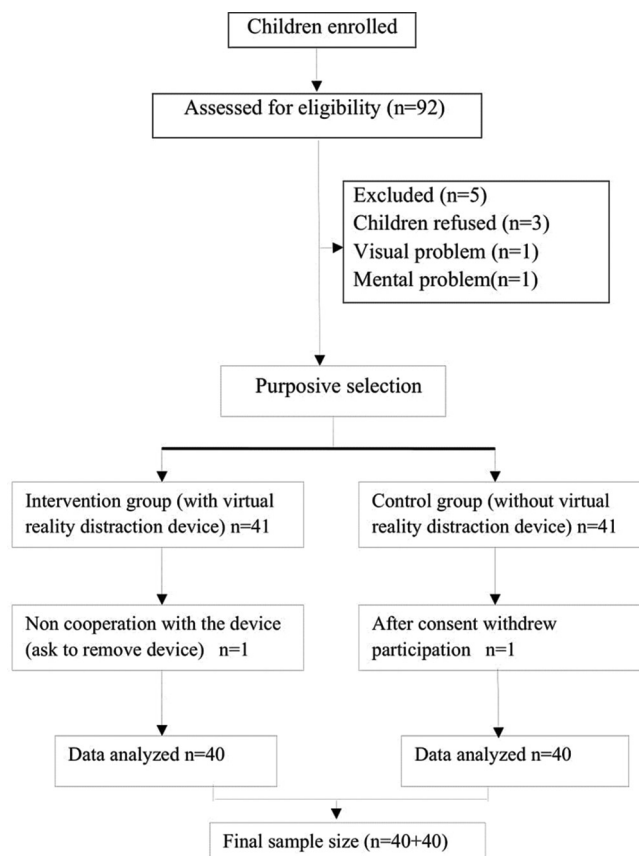
Figure 1: Flow diagram of sample recruitment

complete the tool. The instrument was found to be feasible; hence, we processed for the pilot study.

The language reliability of the Wong–Baker Faces Pain Rating Scale was assessed using the inter-rater method, and the Children's Fear Scale (CFS) was assessed using the test-retest method, and the correlation coefficient value was found to be 0.87 and 0.76, respectively. Cronbach's α was conducted for internal consistency, and the values were 0.82 and 0.72 for both tools, respectively. After obtaining permission, consent, and assent from the concerned, the study's purpose, nature, duration, and data collection instruments were explained. Recruitment of 80 children was conducted using the purposive sampling technique with a random assignment of 40 children to the intervention group and 40 children to the control group. The intervention group received a virtual headset from the investigator, whereas the control group did not receive any distracting interventions except standard care. The iPhone was inserted into the VR device, and the subjects were asked to choose videos that were validated by experts, such as Roller coaster, Chhota Bheem, Mr. Bean, Tom and Jerry, and Scuba diving, in which children were immersed, and distraction was achieved during IV cannulation. The children were instructed to remove the headset if it caused any unfavorable reactions, such as nausea, vomiting, or discomfort. Once the child was comfortable wearing the headset, the investigator asked some questions to ensure

that no external noise was disturbing the child. Ten minutes before the IV cannulation, the child spent the entire time in a VR environment. The IV cannulation was performed by a single nurse with 1 year of experience in the pediatric oncology unit and was assisted by a pediatric oncology assistant. The process took 5–10 min. This was performed by a single nurse to eliminate bias in the experimental and control groups in each of the settings chosen. The study was carried out in two hospitals, and both experimental and control group children underwent IV cannulation in the same procedure room of the chosen hospital. As a result, the videos were 20 min duration. The investigator and the mother remained with the child throughout the procedure. Data on the perception of pain and fear experienced by the child and perceived by the mother[12,13] during the procedure was collected by administering demographic proforma, W-BFPRS, and CFS. Perception of pain and fear was marked by both the mother and the child after the completion of the procedure. The mother's pain here is not the actual pain experienced by the mother but the psychological pain she encountered while her child suffers. At the end of the data collection, the children and their mothers were thanked for their cooperation. To avoid contamination, data was collected first from the control group, followed by the experimental group. The assessment of self-reported pain and fear of both the child and the mother was performed by the investigator alone to eliminate researcher bias. The collected data was kept private and coded for future analysis. The licensed Statistical Package for the Social Sciences (SPSS) version 23 was used to analyze the data. Frequency, percentage, mean, and standard deviation (SD) were used for descriptive statistics, and the Karl Pearson correlation, Mann–Whitney U test, and Chi-Square test were used for inferential statistics.

The sample size was calculated using the following formula:

$$n = \frac{2\sigma^2 (Z\beta + Z\alpha)^2}{d^2}$$

Where, σ is the pooled standard deviation (SD).

$$\sigma = \frac{\sqrt{(n_1 - 1)\sigma_1^2 + (n_2 - 1)\sigma_2^2}}{n_1 + n_2 - 2}$$

$Z\beta = 0.8146$ and $Z\alpha = 1.95$,

When the power of the study is 80% at 5% level of significance (95% confidence level).

$X1 = 3.35$

$X2 = 4.35$

d = difference between the mean post-test score.

$\sigma1 = 2.38$

$\sigma2 = 2.95$

$n = 35.45 = 36$.

A total sample size of 40 subjects in each group was recruited. Hence, the total number of subjects was (40 + 40 = 80).[14]

RESULTS

Frequency and Percentage Distribution of Baseline Characteristics
Table 1 depicts that more than half of the children were between 7 and 11 years and half of the children were diagnosed with Acute lymphocytic leukemia (ALL) in the intervention group and the control group, respectively. The duration of illness among half of the children was between 6 months and 1 year, with the majority of children having no aggressive spread in the intervention group and the control group, respectively.

Comparison of Pain Perception and Fear of Children Between Intervention and Control Groups
Our study shows that the obtained *P* value is lesser than the tabled *P* value (*P* < 0.05). Hence, based on the obtained pain scores *P* value (*P* = 0.002**) with a mean ± SD = 1.82 ± 0.18 of the intervention group, mean ± SD = 8.01 ± 3.21 of the control group, and obtained *P* value of fear scores (*P* = 0.001**) with a mean ± SD = 0.81 ± 0.71 of the intervention group, mean ± SD = 3.01 ± 1.42 of the control group, we can find that there is a significant difference in the mean ± SD between the pain perception and fear scores of children in the intervention group when compared to that of the control group [Table 2].

Comparison of Pain Perception and Fear of Mothers of Children Between Intervention and Control Groups
Our findings show that obtained *P* value is lesser than the tabled *P* value (*P* < 0.05). Hence based on the obtained pain scores *P* value (*P* = 0.003**) with mean ± SD = 1.81 ± 1.34 of the intervention group, mean ± SD = 7.04 ± 4.02 of the control group, and obtained *P* value of fear scores (*P* = 0.002**) with mean ± SD = 0.98 ± 0.81 of the intervention group, mean ± SD = 2.93 ± 1.32 of the control group, we can find that there is a significant difference in the mean ± SD between the pain perception and fear scores of mothers in the intervention group when compared to that of the control group [Table 3].

Correlation Between Pain Perception of Children and Pain Perception of Mothers in the Intervention Group
Data depicts that calculated *r*-value (r = 0.91, *P* = 0.001**) reveals that there was a statistically significant strong positive correlation between the pain perception of children and the pain perception of mothers in the intervention groups. Hence, we conclude that with an increase in the perception of pain by children, there will be an increase in the perception of pain by mothers and vice versa in the intervention group [Table 4].

Correlation Between Fear Scores of Children and Fear Scores of Mothers in the Intervention Group
Data depicts that calculated *r*-value (r = 0.84, *P* = 0.001**) reveals that there was a statistically significant strong positive correlation between the fear scores of children and the fear scores of mothers in the intervention groups. Hence, we

Table 1: Description of baseline variables of children both in intervention and control group						
Variables	Intervention group		Mean±SD	Control group		Mean±SD
	f	%		f	%	
Age in years			10.21±3.92			9.25±3.21
a). 7–10 years	22	55		27	67.5	
b). 11–14 years	15	37.5		11	27.5	
c). 15–18 years	3	7.5		2	5.0	
Gender						
a). Male	28	70		30	75	
b). Female	12	30		10	25	
Education						
a). Primary	20	50		21	52.5	
b). Higher primary	12	30		15	37.5	
c). High school	3	7.5		2	5.0	
d). Higher secondary	5	12.5		2	5.0	
Diagnosis						
a). Acute lymphocytic leukemia	20	50		23	57.5	
b). Hemangioma	3	7.5		4	10	
c). Neuroblastoma	4	10		3	7.5	
d). Medulloblastoma	3	7.5		2	5.0	
e). Ewings sarcoma	2	5.0		-	-	
f). Wilms tumor	2	5.0		1	2.5	
g). Acute Myeloid Leukemia	6	15		7	17.5	
Duration of illness						
a). 0–6 months	8	20		6	15	
b). 6 months-1 year	20	50		23	57.5	
c). 1–2 years	5	12.5		6	15	
d). 2–3 years	7	17.5		5	12.5	
Type of treatment						
a). Chemotherapy	40	100		40	100	
Need for cannulation						
a). Chemotherapy	40	100		40	100	
Phase of treatment						
a). Induction phase	4	10		1	2.5	
b). Consolidation phase	14	35		9	22.5	
c). Maintenance phase	22	55		30	75	
Aggressive spread						
a). Yes	5	12.5		8	20	
b). No	35	87.5		32	80	

SD=standard deviation, CI=confidence interval

conclude that with an increase in the fear scores by children, there will be an increase in the fear scores by mothers and vice versa in the intervention group [Figure 2].

DISCUSSION

Our study found that most children in the intervention group had lower pain scores on the W-BFPRS. There was a strong positive correlation between children's pain perception and fear and mothers' pain perception and fear scores in the intervention group.

This study set out to assess how much pain and fear young patients had during IV cannulations, as well as how well an immersive distraction tool called VR worked to ease their discomfort. Distraction works through an attention process.[15]

A distraction's ability to lessen perceived pain increases with how much attention it demands. There are a number of reasons why VR distraction lessens the perception of fear and pain. The use of VR as a distraction is predicated on the idea that pain has a large psychological component and that it triggers a strong, attentive reaction because of the possibility of tissue damage it may cause. This change in focus alters how pain is perceived, decreasing pain intensity. In addition, it was recently shown that experiencing pain in VR lessens the amount of brain activity associated with it and alters how people perceive incoming pain signals.[16]

There was a statistically significant difference in the amount of pain perceived by children in the intervention and control groups in this study [Table 2]. Most children in the

Table 2: Comparison of pain perception and fear of children between intervention and control groups. H$_{01}$: There will be no significant difference in pain perception and fear of children between the intervention and control groups. $n=40+40$

	Group	Maximum obtained score	Minimum obtained score	Mean±SD	CI (95%)		U	P
					Lower	Upper		
Pain	Intervention	4	0	1.82±0.18	0.82	2.16	18	<0.002**
	Control	10	2	8.01±3.21	0.61	1.41		
Fear	Intervention	1	0	0.81±0.71	0.46	0.91	22	<0.001**
	Control	4	0	3.01±1.42	2.20	3.82		

Maximum possible pain score: 10 *Significant ($P<0.05$), ** Highly Significant. Maximum possible fear score: 4. SD=standard deviation, CI=confidence interval

Table 3: Comparison of pain perception and fear of mothers of children between intervention and control groups. H$_{02}$: There will be no significant difference in pain perception and fear of mothers of children between the intervention and control groups. $n=40+40$

	Group	Maximum obtained score	Minimum obtained score	Mean±SD	CI (95%)		U	P
Pain	Intervention	4	0	1.81±1.34	1.06	2.56	29	<0.003**
	Control	10	0	7.04±4.02	5.02	8.92		
Fear	Intervention	2	0	0.98±0.81	0.61	1.47	30	<0.002**
	Control	4	0	2.93±1.32	2.21	3.82		

Maximum possible pain score: 10 *Significant ($P<0.05$) ** Highly Significant. Maximum possible fear score: 4. SD=standard deviation, CI=confidence interval

Table 4: Correlation between pain perception of children and pain perception of mothers in the intervention group. H$_{03}$: There will be no correlation between the pain perception of children and the pain perception of mothers in the intervention group. $n=40 + 40$

Variables	Mean±SD	CI (95%)		r	P
		Lower	Upper		
Child's pain perception	1.81±1.32	0.92	2.54	0.91	<0.001 **
Mother's pain perception	1.98±1.27	1.52	2.83		

*Significant ($P<0.05$) ** Highly Significant. SD=standard deviation, CI=confidence interval
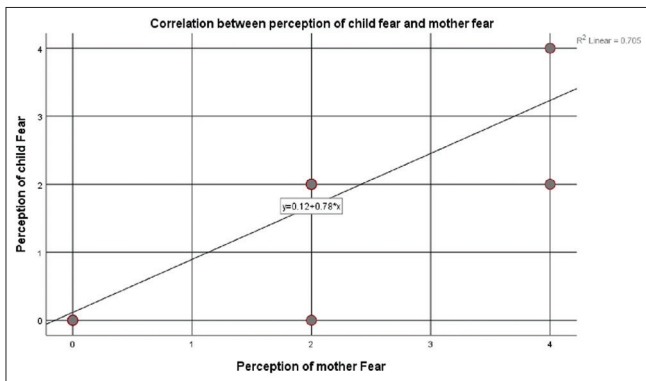
Figure 2: Scatter diagram showing correlation between fear scores of children and fear scores of mothers in the intervention group

intervention group had lower pain scores on the W-BFPRS. These findings are consistent with Puppala Niharika[17] demonstrates that the use of VR eyeglasses during dental treatment significantly reduces state anxiety scores ($P = 0.001$) and pain perception ($P = 0.001$). According to research by Birnie KA distraction, hypnosis, combined CBT, and breathing exercises are useful in reducing children's discomfort or anxiety—or both—associated with needles.[6] In contrast, Lindsay Jibb et al.[7] found that there was no difference in pain between the arms but that the active distraction arm had less anguish during the procedure. Samina Ali. et al. during pediatric intravenous insertion observed that humanoid robot-based distraction therapy had no effect on pain, but had a marginally positive effect on distress.[8] Playing diversion cards, listening to a cartoon soundtrack, or inflating balloons are just a few distraction strategies that have been proven to significantly reduce anxiety and pain perception.[12] In this study, there is a strong positive correlation between children's pain perception and mothers' pain perception in the intervention group ($r = 0.91$, $P < 0.05$) [Table 4], and there is a strong positive correlation between children's fear scores and mothers' fear scores in the intervention group ($r = 0.84$, $P < 0.05$) [Figure 1]. Likewise, Khadra[18] found a statistically significant positive correlation between procedural pain and anxiety (rs (5)=0.811, P=0.027).

Until now, the use of Immersive VR technology in pediatric oncology settings has been limited, with the technology typically serving as a distraction method during invasive medical procedures. This pilot study investigated the effect

of VR distraction on pain perception and fear in children with cancer undergoing IV cannulation.

The inclusion of cancer children from two settings was one of our study's strengths. To identify a broad group with a range of socioeconomic factors that can add to the strength of the study, both the intervention and control groups were recruited from both settings, allowing for the control of known and unknown confounding factors. One advantage of the study could be the instrument's prestudy calibration. The fact that the IV cannulation technique was carried out by a single nurse contributed to the study's reduction in variability. However, there were drawbacks to our study. The investigators who evaluated pain and fear were not blinded because the Wong–baker faces pain rating scale W-BFPRS and CFS require direct observation. Self-reported data were employed in the study, which increased the likelihood of people underreporting and overreporting, which is another drawback. Adding to this, another drawback of the study is that it only assessed VR distraction after the procedure. Consequently, additional randomized controlled clinical trials with a bigger sample size need to be carried out to evaluate VR distraction during other painful procedures. Future research may take into account the patient's enjoyment and contentment with the VR experience during invasive procedures.

CONCLUSION

Pain is the fifth vital sign and is being treated using a variety of psychological techniques, including distractions from VR environments and video game play. The findings of this study show that VR can be used to distract and reduce pain and fear in cancer children during IV cannulation.

Conflicts of interest
There are no conflicts of interest.

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