Indonesian Journal on Health Science and Medicine
Vol 2 No 2 (2025): October
ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo
https://doi.org/10.21070/ijhsm.v2i1.206

Distraction Using Virtual Reality Reduces Pain and Anxiety After PCI

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Abstract. Background: Cardiovascular diseases remain the leading cause of death globally, with percutaneous coronary intervention (PCI) being a common treatment modality. However, post-PCI patients frequently experience significant pain and anxiety. Specific Background: Conventional pain management strategies are often pharmacological and may involve adverse effects, prompting exploration of non-invasive alternatives like virtual reality (VR). Knowledge Gap: Although VR has been explored in various medical contexts, its efficacy in post-PCI recovery remains under-researched. Aims: This randomized clinical trial aimed to evaluate the effect of VR-based distraction on pain and anxiety levels in post-PCI patients. Results: A total of 144 patients were divided equally into intervention and control groups. The VR group, exposed to 3D natural scenes with soothing music, showed significantly lower mean pain (29.60 vs. 57.97) and anxiety scores (2.90 vs. 5.15) than the control group ($p < 0.001$ for both). Novelty: This study provides robust clinical evidence that immersive VR distraction can be an effective adjunct to standard post-PCI care. Implications: Integrating VR into post-PCI protocols may enhance patient comfort, reduce reliance on medication, and improve recovery experiences without added clinical risk.

Highlights:
1. Virtual reality effectively reduces pain and anxiety levels after PCI.
2. There was a significant difference between the intervention and control groups.
3. This distraction technique is non-invasive and easy to apply clinically.

Keywords: Virtual Reality, Anxiety, Pain, Percutaneous Coronary Intervention, Distraction Technique

Published : 04-08-2025

Indonesian Journal on Health Science and Medicine
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ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo
https://doi.org/10.21070/ijhsm.v2i1.206

Introduction

Internationally, cardiovascular disease is the primary cause of death, with ischemic heart disease accounting for almost half of these deaths. (1) Worldwide, Cardiovascular disease (CVSs) constitute the primary cause of mortality, cardiovascular disease caused around 18.6 million deaths in 2019, and by 2030, they are predicted to cause more than 22.2 million fatalities.(2) In Iran, Iraq and around the world, cardiovascular diseases (CVD) are the main cause of death. Typically, patients with CVDs are prescribed various drugs.(3,4) According to the world health organization, CVD is a major factor in fatalities attributable to cardiovascular disease and leading cause of morbidity and mortality globally.(5)

One appropriate technique for diagnosis CHD is percutaneous coronary intervention. Additionally, it is a gold standard technology for determining the best course of treatment. (6) In Korea, heart disease ranks second in terms of cause of death after cancer. In 2018, the mortality rate from coronary artery disease wich include myocardial infarction and angina, was 28.3 per 100,000 people. Over 65,00 PCI procedures are carried out annually at roughly 140 institutions in Korea. (7) In the holy city of Karbala, the Karbala Center for Cardiac Disease and Surgery conducted 2976 percutaneous coronary intervention in the year (2023). (8)

Acommon therapeutic approach for treating coronary artery disease is percutaneous intervention, or PCI, this is especially true for patient who arrive with acute coronary syndromes. Although PCI is successful in improving patient outcomes and resting coronary blood flow, major physical and psychological side effects, most notably anxiety, are frequently experienced. (9)

A number of things can cause pain both during and after PCI, such as catheter insertion, injectimg contrast material, and manipulating the coronary arteries. (10) Pain and anxiety not only affect patients comfort in the moment, but it may also have long term effects on healing and complianc with podt procedural car.(11) Muller et al., stated that the failing to manage anxiety and pain can result in longer hospital stays and a higher of complications following surgery.(12)

The wide rang of technologies have been used in education, rehabilitation, diagnosis, prediction, and treatment of disease over the past ten years, including the virtual reality, artificial intelligence, the internet of things, wearable smart sensors, mobile health, telemedicine, 3D printing, digital games, and others. In a number of medical circumstances, including the rehabilitation period following PCI, virtual reality has demonstrated potential in lowering procedure pain and discomfort, patient who used virtual reality (VR) during uncomfortable operation experienced far less discomfort than who received nomal care.(13,14)

Virtual reality (VR) treatment present an additional option for treating patients pain, virtual reality therapy has become increasingly popular. A variety of biological, emotional, social, cultural, and psychological factors influence how pain is experienced. Although they have well know adverse effects, pharmacological therapy and invasive techniques like nerve blocks are the main alternatives for analgesia. As part of a multimodal analgesia approach, non pharmacological therapy may be incorporated to minimize these problems by lowering

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the dosage and requirment for drugs. Using the virtual reality to administer or enhance psychological treatment for pain is kind of non pharmacological therapy.[15,16]
The virtual reality a modern uder interface with multisensorial (vision, hearing, touch, smell, and taste) interaction and ral time simulation.[17] Now that VR can be used to adjust mood, surroundings, and attention, less attention will be given to pain.[18]

Objective of the study

1- To assess the anxiety and pain level in patients after percutaneous coronary intervention.
2- To determine the effect of distraction technique using the virtual reality on anxiety and pain level in patients after percutaneous coronary intervention.

Methodology:

The studey design: Randomized controlled trial (RCT).
Setting: This study was conducted at Karbala Center for Cardiac Disease and Surgery and AL-Iman AL-Hassan AL-Mujtaba Teaching Tospital in Karbala City, Iraq. The period of study was conducted from september 13 th, 2024 to january 23 th, 2025.
Ethical consideration: The trial protocol recevied approved for registration in the iranian registry of clinical trials (IRCT) on november 18th, 2024. The trial identificatin number IRCT20241114063711N1 and membership number 63711 and trial ID 80184.
Sample and sampling procedure: The minimum sample size was used to calculate the sample size by free sample size calculator with considering a 0.05,error margin and confidence level 95%. one hundred and forty four participants were found to be sample size, these patients were split equally between the intervention (vertual reality) and control group. The patients who met the inclusion criteria without hearing or vision impairment, patient with verbal communication skills and intellectual capacity, male and females who are at least eighteen years old and patient with PCI, were informed the study aims and completed the consent form.
Experimental group: For the VR group as shown in **[figure 1]** the VR glassess were applied after percutaneous coronary intervention (PCI) completed at the coronary care unit (CCU), the virtual reality goggles are worn for fifteen minutes. After that, a variety of 3D videos are shown, including a natural video with relaxing music. The used VR glasses is KUSSTOM SMART ITEMS VR headset made in china and P9 plus max headset. After that the participant pain severity and anxiety level was evaluated by using the visual analogue scale (VAS) for pain and (VAS-A) for anxiety.[19]
Data collection tools: Part one: socio demographic and clinical data questioner
This part includes ten questions it is age, sex, marital status, educatinal level, occupation, smoking status, weight and height, body mass index, chronic diseases, and medications use.
Part two: Visual Analogue Scale (VAS)
The second part include the visual analogue scale (VAS) is one of the scale that used to evaluate the pain severity, it is consist of horizontal line that is 100 mm in long and has the phras (no pain) at one of the end and (sever pain) at the opposite end, participants marked pain severity at the line. Ther are four level of pain severity none (0-4 mm), mild (5-44

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mm), moderate (45-74 mm), and sever (75-100 mm).

Part three: Visual Analogue Scale for Anxiety(VAS-A)

The third part it consists of a 10-centimeter horizontal line with the words "not at all anxious" and "very anxious" at the left and right extremes, respectively. Anxiety levels are categorized as no anxiety (0), mild anxiety (1-3), moderate anxiety (4-6) and severe anxiety (7-10).

Testing the validity and reliability

The visual analogue scale (VAS) and visual analogue scale for anxiety(VAS-A) is commonly used measurment tool both nationally and internationally studes, scientific evidence has shown that both scale is reliable and valid scale for individuals who are 18 years old and above with free use the VAS. [20,21,22]

Figure1: Using virtual reality for distracting patients after percutaneous coronary intervention.

The results:

In this study, According to [**Table 1**] showed the distribution of 144 patients after PCI socio-demographic (Control = 72, and Intervention = 72), the age most from 60 to 69 years with mean 60.53 years in the control group, while in the intervention group the age most from 50 to 59 years with mean 57.38 years. Regarding sex, most (54.2%) patients were females in the control group, while in the intervention group most (56.9%) patients were males, and the majority were married in both groups respectively. According to the educational level, most of patients were not read and write in both groups. Regarding the

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occupation, the most were Gainer in both groups.

Table 1: The participants' socio-demographic variables (N=144)

Demographic data	Subgroup	Control		Intervention	
		f.	%	f.	%
Age group	41 - 49 years	8	11.1	12	16.7
	50 - 59 years	21	29.2	30	41.7
	60 - 69 years	36	50.0	28	38.9
	≥ 70 years	7	9.7	2	2.8
	Total	72	100.0	72	100.0
	Mean ± SD 60.53 ± 7.530 Min- Max 41 - 77 years			Mean ± SD 57.38 ± 6.514 Min- Max 45 - 72 years	
Sex	Male	33	45.8	41	56.9
	Female	39	54.2	31	43.1
	Total	72	100.0	72	100.0
Marital Status	Single	6	8.3	3	4.2
	Married	58	80.6	58	80.6

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	Widower	8	11.1	11	15.3
	Total	72	100.0	72	100.0
Educational level	Not Read and Write	40	55.6	34	47.2
	Read and Write	22	30.6	26	36.1
	Primary School	0	0	4	5.6
	Middle School	0	0	1	1.4
	Secondary School	2	2.8	0	0
	Institute	0	0	1	1.4
	College or Above	8	11.1	6	8.3
	Total	72	100.0	72	100.0
Occupation	Employee	10	13.9	21	29.2
	Retired	11	15.3	5	6.9
	Gainer	51	70.8	46	63.9
	Total	72	10	72	10

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			0.0		0.0

f= frequencies, %=Percentages, M = Mean of score

[Table 2] Assess and compare level of pain for control and intervention (distraction technique by using the virtual reality) groups in patient after PCI.

Table 2: Comparing the level of pain between both groups in patient after PCI (N=144)

Level of pain	Range	Control		Intervention		Mann-Whitney U		
		f.	%	f.	%	M.D	Z	p.value
No pain	**0-4**	0	0	0	0	28.375	-8.132-	.0000[a]
Mild	**5-44**	12	16.7	58	80.6			
Moderate	**45-74**	43	59.7	10	13.9			
Severe	**75-1000**	17	23.6	4	5.6			
	Total	**72**	**1000.0**	**72**	**1000.0**			

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	Min–Max	25	79	10	78			
	Mean ± SD	**57.97**	14.956	**29.60**	16.243			

Z = Standardized value, M. D = mean difference, P=probability value

The result in **[Table 2]** shown the level of pain for control and VR groups in patients after PCI and there were highly significant statistical differences in level of pain between control and intervention groups at P<0.001. The mild pain level percentage in intervention group was 80.6% and the mild pain level in the control group 16.7%, the moderate pain level in the intervention group 13.9% and for the control group 59.7% , finally the sever pain level in the intervention group was 5.6% and for the control group was 23.6% .

[Table 3] Assess and compare level of anxiety level for control and intervention groups in patient after PCI.

Table 3: Comparing the level of pain between both groups in patient after PCI (N=144)

Level of anxiety	**Range**	**Control Group**		**Intervention Group**		**Mann-Whitney U**		
		f.	%	f.	%	M.D	Z	p.value
No anxiety	**0**	0	0	0	0	2.250	-8.4800-	**.000**
Mild	**1-3**	8	11.1	61	84.7			

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Moderate	**4-6**	52	72.2	8	11.1			
Severe	**7-10**	12	16.7	3	4.2			
	Total	72	100.0	72	100.0			
	Min–Max	3	7	2	7			
	Mean ± SD	**5.15**	1.252	**2.90**	1.177			

Z = Standardized value, M. D = mean difference, P=probability value

The results in **[Table 3]** show the level of anxiety in patients after PCI for both the control and virtual reality intervention groups. There were highly significant statistical differences in anxiety levels between the two groups, with a p-value < 0.001. In the intervention group, 84.7% of patients experienced mild anxiety, compared to only 11.1% in the control group. Moderate anxiety was reported in 11.1% of the intervention group and 72.2% of the control group. Severe anxiety was observed in 4.2% of the intervention group, while 16.7% of the control group experienced severe anxiety. These findings suggest that the VR intervention had a substantial effect in reducing anxiety among post-PCI patients.

Discussion

The study finding inducate that the most patients age 50.0% from 60 to 69 years for control group and 41.7% from 50 to 59 years in the intervention group, these results consistent with Keshvari et al., were Mean ± SD age of them in the intervention and control groups was 50.95±4.120 and 52.08±4.002 years, respectively. In current study most the PCI patient in intervention group male 56.9% and 45.8% in control group, these findings

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supported by Keshvari et al., the predominant gender of participants was male 71.25%, with a Mean ± SD age of 50.95 ± 4.120 years in the intervention group and 52.08 ± 4.002 years in the control group.[25] Additionally, some studies have found that out of 64 individuals, 43.7% were female and 56.3% were male, with an overall mean age of 56.2±0.89 years.[26] Regard the marital status the majority of the percutaneous coronary intervention with married status 80.6%. Regarding the body mass index the 43.1% in control group and 47.2% in VR group with being overweight and 26.4% being obesity class I as supported by the study that was conducted by da Cruz et al., with title acute hemodynamic effects of virtual reality–based therapy in patients of cardiovascular rehabilitation, reported that the majority of them were males and smokers, and about half of them had obesity of class I as agree with study finding.[27]

Regarding the clinical data of study participants, similar to our findings, recent studies by Mu et al., continue to highlight the significant association between overweight, obesity, and hypertension, supporting the findings observed in our study.[28] Additionally, data from the National Health and Nutrition Examination Survey (NHANES) during August 2021 to August 2023 indicated that the prevalence of obesity among adults was 40.3%. The same report highlighted that 47.7% of adults had hypertension, with higher rates observed in men 50.8% compared to women 44.6%. These recent findings align with our study's results, where overweight prevalence was observed in both the control 43.1% and VR 47.2% groups, and hypertension was the most commonly reported chronic disease, affecting 45.8% of participants in the control group and 52.8% in the intervention group. The consistent association between elevated BMI and hypertension across these studies underscores the critical importance of addressing weight management in strategies aimed at preventing and controlling hypertension.[29,30]

Regarding the pain level in the group study and control group was statstical significant with 58 patients (80.6%) mild pain level and 12 patients with same level of pain in the control group with Mean ± SD 57.97 and Mean ± SD 29.60 in the VR groups. Virtual reality may evoke more positive emotions than conventional distraction methods. This could help patients cope with venipuncture in a non-stressful manner.[31]

Regarding the anxiety level in the intervention and control groups, there was a statistically significant difference between the two groups. In the VR group, 61 patients (84.7%) experienced mild anxiety compared to only 8 patients (11.1%) in the control group. The mean anxiety score was 2.90 ± 1.18 in the intervention group and 5.15 ± 1.25 in the control group. These results indicate that virtual reality was effective in reducing anxiety levels after PCI. Virtual reality may evoke more positive emotions and a sense of presence, which can help patients manage anxiety in a less stressful and more engaging way during post-procedural care.

Recent studies have explored the use of virtual reality (VR) as a non-pharmacological intervention to manage pain in patients undergoing cardiac procedures, including percutaneous coronary intervention (PCI). These investigations provide insights that align with the findings presented in table three, which indicate significant differences in pain levels between control and VR groups post PCI. Previous studies have demonstrated benefits of VR related therapies in improving pain associated with cardiac rehabilitation and various surgical procedures. This suggests potential applicability of VR interventions in the

ISSN 3063-8186. Published by Universitas Muhammadiyah Sidoarjo
https://doi.org/10.21070/ijhsm.v2i1.206

context of PCI. This aligns with your findings, where the intervention group experienced a higher percentage of mild pain levels 80.6%, while the control group reported higher percentages of severe 23.6% and moderate 59.7% pain levels.[32,33]
Virtual reality is a viable alternative therapy for pain management in both juveniles and adults, with a heightened potential for juveniles. VR can effectively alleviate acute pain, that agree with research results.[34] Decrease in pain and anxiety score from baseline to test 1 was much more pronounced in the VR condition compared to the control ($p < 0.001$). These studies underscore the potential of VR as an effective tool for pain management in patients undergoing PCI, supporting the significant statistical differences observed in resent results between control and intervention groups.[35]

Conclusion

Virtual reality technology can effectively manage the anxiety and pain severity after percutaneous coronary intervention (PCI) operations. However, more research is required to ensure the safe implementation of this technology in many medical specialties.

Limitations

Virtual reality often have high costs, limited resoulution, and performance disparities between different systems, which can impact experimental results. In addition, some patients expressed woreeies thet such modern technology would damage cardiac performance and some participant may need time to become familiar with VR systems. When conducting additional studay on use the VR in people with certain somaic disorders, this is acrucial topic to take into account

Acknowledgement

We would like to express our sincere appreciation to the nursing professors at the University of Kerbala and to everyone who contributed to this project. as well as the library staff in the college of nursing university of karbala and all patients who participant in the study.

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