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The Effect of Using Virtual Reality Glasses on Pain During Fistula Cannulation in Hemodialysis Patients: A Randomized Controlled Trial

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ABSTRACT

Objective: Fistula cannulation is performed very frequently for hemodialysis patients. Cannulation carried out repeatedly causes significant pain. In this study, it was aimed to determine the effect of watching videos with virtual reality glasses on reducing the pain during fistula cannulation in hemodialysis patients.

Methods: The study was carried out with a total of 47 patients. The patients in the intervention group were shown a video for about five minutes during the procedure using virtual reality glasses as the intervention. The control group patients went through only the standard cannulation procedure.

Results: There was no statistically significant difference between the first pain measurement scores of the intervention and control groups. There was a statistically significant difference in the mean pain score of the patients in the intervention group. Also, when the first and second pain measurements were compared within the groups, the second measurement scores were statistically significantly lower than the first in the intervention group.

Conclusion: The study results revealed that virtual reality can reduce the pain experienced during fistula cannulation in hemodialysis patients.

Keywords: Arteriovenous fistula, hemodialysis, pain, virtual reality

1. INTRODUCTION

Chronic kidney disease (CKD) is a common disease that affects all age groups, has high morbidity and mortality rates, reduces the quality of life, and can be prevented and/or its advanced stages can be slowed down with early diagnosis (1). CKD is defined as the chronic, progressive and irreversible deterioration of the kidneys due to the balance in the body's fluid-electrolyte and metabolic endocrine functions not being able to be adjusted with a decrease in glomerular filtration rate (GFR) (2).

Some symptoms become obvious in the body due to a decrease happening in kidney functions over time in patients who develop kidney disease. Renal Replacement Therapy (RRT) methods should be applied to the patient when conservative treatments are not sufficient, and the picture of uremia cannot be corrected. Hemodialysis (HD), peritoneal dialysis (PD) or kidney transplantation, among the RRT methods, is started according to the patient's condition (2,3).

Permanent vascular access that can be used for months or years is required for HD treatment to be sufficient for patients with End-Stage Renal Disease (ESRD) to survive and improve their quality of life. Therefore, arteriovenous fistula (AVF), graft or catheter should be always available to provide adequate blood flow in patients who would have the HD treatment (4,5). CKD patients with HD treatment go through 300-320 AVF cannulations per year on average. The diameter size of the fistula needles and their length, the puncturing process in the skin, the progress of the needles into the tissue during the procedure, the angle of insertion of the

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needles and the insertion techniques cause the patients to experience pain during the procedure (3,4,6-8).

Nurses are considered the primary healthcare providers for patients having hemodialysis treatment. Predicting the pain experienced during cannulation and planning appropriate interventions to reduce this pain are among the roles that nurses should fulfill (9). In patients receiving HD treatment, many non-pharmacological interventions are used by nurses to reduce the symptoms caused by the disease process and hemodialysis treatment. These non-pharmacological methods, included in independent nursing practices, have been preferred in nursing practices in recent years due to their safe and easy application and minimal side effects. Nurses use many non-pharmacological methods such as distraction, massage, hot and cold application, and aromatherapy to reduce the pain experienced during hemodialysis AVF cannulation (10).

Distraction, which is one of the non-pharmacological methods, is a method that enables patients to control and reduce the symptoms they experience by focusing their attention on a different point (11). Methods such as listening to music, drawing pictures, watching TV, solving puzzles, daydreaming, deep breathing and coughing exercises, sphygmomanometer blowing, active listening, touching, blowing up a balloon, distraction cards, and use of virtual reality glasses are used for this purpose. The use of virtual reality (VR) has been determined to be effective in reducing pain and anxiety (12-16).

The individuals concentrate their attention on the image they watch and feel like they are in another world thanks to these five-dimensional glasses by getting away from the environment they are in with the glasses connected to the device worn on their heads and the sounds coming from the headsets. The most basic feature distinguishing virtual reality glasses from similar applications is that it gives people the feeling of being real. The use of virtual reality glasses, which are easy to apply and use, have no side effects and can be effective in physical, psychological and social recovery, is an intervention that can be preferred in nursing practices (15). Karaman and Taşdemir (2021) reported, in their study with patients who underwent breast biopsy, that virtual reality intervention reduced the pain and anxiety of the participants (16). In the study conducted by Şen (2020) with hemodialysis patients, the use of virtual reality glasses during the cannulation procedure was noted to reduce the pain of the patients and increased patient satisfaction (15).

It was aimed in this study to determine the effect of using virtual reality glasses during fistula cannulation applied to hemodialysis patients on their pain experienced.

2. METHODS

2.1. Design

The study was carried out with patients in the hemodialysis unit of a hospital in Istanbul between September and November 2022. This was a single-centred parallel-design randomized controlled intervention trial with a pre-test and post-test. CONSORT were used in reporting the study. The study was registered as a Clinical Trial on January 23, 2023, with ClinicalTrials.gov ID: NCT05693584

2.2. Setting and Participants

The study population consisted of patients (n=82) in the hemodialysis unit of a private hospital and the sample included patients who met the inclusion criteria and agreed to participate in the study (n=47).

2.2.1. Inclusion Criteria

Patients who agreed to participate in the study, who were 18 years or older, had hemodialysis treatment administered via AVF, without vision, hearing and perception problems, were open to communication and could speak Turkish, without any signs of infection such as redness, swelling or open wound at the site of the intervention, had cannulation procedure performed with a 16 G AVF (Proximal) needle and a single needle insertion attempt was made, and those who had not taken any analgesics in the last three hours were included in the study.

2.2.2. Sample Size, Randomization and Blinding

The sample size of the study was calculated using the G*Power 3.1.9.7 program. The sample size calculation was performed for the t-test in independent groups, taking the study design with two groups (Intervention Group, Control Group) and two measurements (Pretest, Posttest) into account. The sample size was calculated as seven for each group by taking the with a 5% margin of error ($\alpha = 0.05$) and 95% power ($1-\beta = 0.95$), according to reference study (14,17).

Patients who met the inclusion criteria were randomized into two groups, the intervention group (n= 28) and the control group (n=28). After nine patients were excluded from the study since seven of them did not continue the study and two of them were not feeling well during the study, it was completed with a total of 47 patients, 23 in the intervention group and 24 in the control group. In the post hoc analysis, the power of the study was determined as 99% (17).

Computer-assisted simple randomization (https://www.randomizer.org/) was used to determine the groups. The data were collected by one of the researchers and the analysis and evaluations were performed by the other researcher. Thus, blinding was used during data collection and analysis.

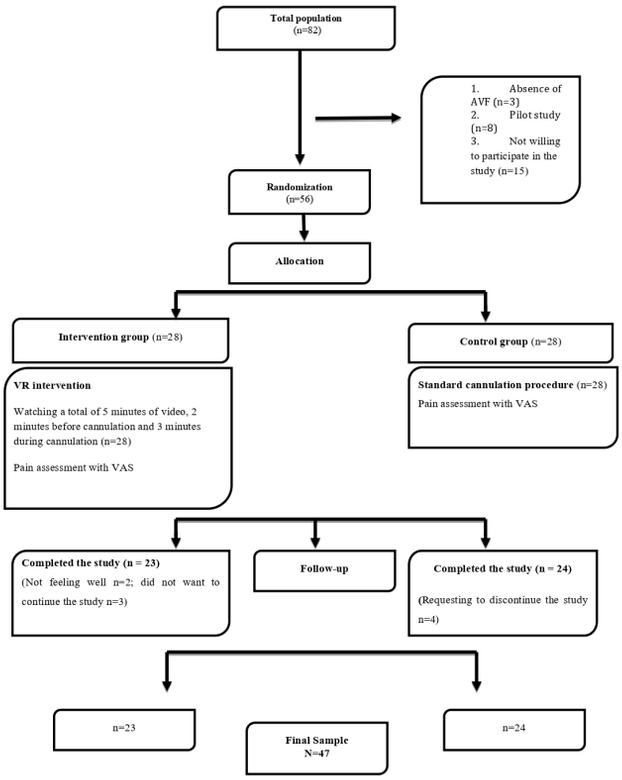

Figure 1. *Flow diagram of the study*

2.3. Instruments

The data collection was carried out with the Personal Information Form and Visual Analogue Scale (VAS).

• *Personal Information Form:* The form prepared by the researchers includes questions about participants' age, gender, educational status, employment status, disease, and hemodialysis.

• *Visual Analogue Scale (VAS):* One of the scales used for the assessment of pain is the VAS. This scale, developed by Price et al. (1983), is used for the measurement of subjective experiences (18). VAS is a scale evaluated by individuals marking their levels of pain on a horizontal or vertical line of 10 cm or 100 mm, with one end of the scale indicating that the patient is very good, meaning no pain (0 points), and the other end indicating that the patient is feeling very bad, meaning unbearable pain (10/100 points). It is used in various patient populations to assess the severity of acute pain, especially the efficacy of treatment/intervention. Its sensitivity has been reported to be higher than other methods in the assessment of pain severity (19).

Virtual reality glasses: Bobo VR Z4 brand virtual reality glasses with 5.7 inches with 1440x2560 pixel screen resolution and James Bullough Lansing (JBL) brand wireless headsets were used.

2.4. Interventions

*Standard Care:*There were a total of 40 hemodialysis machines and beds in the hemodialysis unit where the study was conducted, and a total of nine nurses and three doctors were working. Patients are admitted to hemodialysis sessions in four groups: morning and afternoon groups visiting on Monday-Wednesday-Friday, and morning and afternoon groups visiting on Tuesday-Thursday-Saturday. During the study, there were 82 patients in total, three of whom did not have AVF.

The patients were welcomed by the unit staff on the day of the session, then they were taken to their beds following their weight measurements, and cannulation was performed by the inpatient nurses after the hemodialysis machine and materials were prepared. A cannula size 16 was used for the AVF cannulation. Rope ladder technique is used for cannulation and all nurses use the same technique. The nurses in the dialysis unit had at least two years of experience in this field.

*Pilot study:*To test the understandability of the Personal Information Form and VAS and the applicability of the intervention, a pilot study was carried out with a total of eight patients, representing 10% of the individuals included in the sample, and these eight patients included in the pilot study were excluded from the study. As a result of the pilot study, the intervention and the materials used were determined to be suitable.

Intervention: One week before the intervention, the pain experienced by the patients during AVF cannulation was assessed with VAS (First measurement).

- *Intervention group:* First, the Personal Information Form was filled. Then, the patients were shown a video of nature, forest, and seaside images with relaxing background music, an average of five minutes, two minutes before the AVF cannulation procedure and three minutes during the procedure, using virtual reality glasses(https://www.youtube.com/watch?v=pXfUhkK_QRQ&t=8s). The cannulation procedure was performed by the inpatient nurse. Pain assessment was performed by researcher after intervention immediately **(**Second measurement). The researcher did not actively participate in the cannulation process. To prevent interaction among the participants during the virtual reality intervention, a curtain was placed between the patients in the intervention and control groups. The VR glasses and headsets used were cleaned with alcohol-based disinfectant wipes before use for each patient.
- *Control group:* First, the Personal Information Form was filled. No intervention was performed on the patients other than the routine practices of the unit. As in the intervention group, needle insertion into the fistula was performed by clinical nurse. Pain assessment was performed by the researcher after intervention immediately **(**Second measurement). The researcher did not actively participate in the cannulation process.

2.5. Data Analysis

In this study, the data were analyzed in the SPSS program. A normality test was done with skewness and kurtosis. While mean,

standard deviation and number-percentage distributions were used in the data analysis, the Independet Sample T-test, Mann-Whitney U test, and Chi-square test were used for repeated measurements. Cohen-d was used to determine the effect size.

2.6. Ethical Consent

The ethical approval from the Fenerbahçe University Ethics Committee (29.2022fbu,14.09.2022) and institutional permission were obtained from the relevant hospital management to be able to conduct the study. As per the Declaration of Helsinki's Privacy and Confidentiality Principle, all precautions were taken to manage the confidentiality of the personal information of the volunteers participating in the study. Informed consent was obtained from all participants.

3. RESULTS

When the distribution of the personal information of the patients in both groups was compared, the difference between the groups was determined not to be statistically significant and both groups were similar to each other in terms of variables (p>.05) (Table 1).

Table 1. *Distribution of the personal information of patients in the intervention and control groups*

Characteristics	Intervention		Control		Test Statistic	P Value
	X±SD		X±SD		t	P
Age	59.73 ± 11.48		60.54 ± 11.40		-0.240	.811
Duration of dialysis(year)	10.30±9.20		8.12±8.45		0.846	.402
	N	**%**	**N**	**%**	**X^2**	**P**
Gender						
Female	8	34.8	7	29.2	0.170	.680
Male	15	65.2	17	70.8		
Marital Status						
Unmarried	4	17.4	2	8.3	0.865	.416
Married	19	82.6	22	91.7		
Education						
Primary school	14	60.9	10	41.7	7.314	.120
Secondary school	3	13	1	4.2		
High school	2	8.7	10	41.7		
Associate degree	2	8.7	1	4.2		
Undergraduate	2	8.7	2	8.3		
Working status						
Yes	4	17.4	2	8.3	0.865	.416
No	19	82.6	22	91.7		
Status of having a hemodialysis patient in their family						
Yes	4	17.4	9	37.5	1.475	.225
No	19	82.6	15	62.5		
Vascular access site						
Right brachial	4	17.4	2	8.3	0.865	.416
Left brachial	19	82.6	22	91.7		

t: Independet Sample T – test
X^2: Fisher's Chi-Square

The pain experienced during the cannulation procedure by the patients included in the study was assessed one week before the intervention, and the mean pain score of the intervention group patients was 3.69±2.63 and it was 3.37±1.05 for the patients in the control group. There was no statistically significant difference between the groups (p>.05).

While the mean pain score assessed while watching a video with virtual reality glasses during the cannulation of the patients of the intervention group was 2.47±1.95, it was 3.58±1.14 for the patients in the control group who only had standard cannulation. The difference between the groups was determined to be statistically significant (p< .05) (Table 2).

Table 2. *Intragroup and intergroup comparisons of VAS mean scores*

	Intervention (n=23)	Control (n=24)	Test and Significance	
	X±SD	X±SD	t/Z	p
First measurement	3.69±2.63	3,37±1.05	– 0.489	.625
Second measurement	2.47±1.95	3.58±1.14	– 2.021	**.043***
	Z= – 2.416	Z= – 1.414		
	p=0.016*	p=0.157		

t: Independet Sample T-test
Z:Mann Withney U Test

Table 3. *Effect of virtual reality glasses on fistula cannulation pain intensity*

	Intervention d (n=23)	Control d (n=24)	First measurement	Second measurement
First measurement & Second measurement	0.53	-	-	-
Intervention & Control	-	-	-	0.69

d= Cohen's d effect size (Cohen's d effect size: Small 0.2; Medium 0.5; Large 0.8; Very large 1.3)

When the intra-group pre-test and post-test measurements were compared, the first measurement, which was the pre-test of the intervention group, was 3.69±2.63 and the second measurement, which was the measurement during the intervention, was 2.47±1.95, and there was a significant difference between the measurements. The second pain score measurement of the intervention group was significantly lower than the first one (p<.05). In the measurements of the control group, the mean pain score at the first measurement was 3.37±1.05 and it was 3.58±1.14 at the second one, and there was no statistically significant difference between the measurements (p>.05).

When the effect size was calculated according to the measurements with a significant change, it was d=0.53 according to the difference between the first and second measurements of the intervention group and it was d=0.69

according to the difference between the intervention and control groups in the second measurements. Considering Cohen's d effect size, watching videos with virtual reality was determined to have a medium effect on reducing pain (Cohen's d effect size: Small 0.2; Medium 0.5; Large 0.8; Very large 1.3) (18).

4. DISCUSSION

It was aimed in this study to determine the effect of using virtual reality glasses during fistula cannulation applied to hemodialysis patients on their pain experienced. The mean pain scores of the intervention and control groups during fistula cannulation before the intervention were 3.69±2.63 and 3.25±1.15, respectively in our study and these scores were similar to the pain scores found in the studies of Bagheri et al. (2014) and Sabitha et al.(2008) (8,20).

The main factors that virtual reality is assumed to contribute to reducing pain are related to the degree of virtual reality and the level of interaction with the virtual environment. A high level of interaction with the virtual world has been suggested to reduce pain by leading to a block in visual and auditory pain stimuli present in a clinical setting (21,22). Patients report less pain because their attention is temporarily distracted from the painful stimulus through virtual reality glasses (23). In our study, there was a significant decrease in the level of pain experienced by the intervention group patients, who watched a video with virtual reality glasses during fistula cannulation, compared to the control group. In their study in which they evaluated the effectiveness of using virtual reality glasses in reducing pain during fistula cannulation in hemodialysis patients, Nasirzadeh et al. (2019) concluded that virtual reality glasses had a positive effect on pain and reduced the felt pain (24). In their study conducted in 2017 on the effect of relaxing music chosen by the patient as a distraction method on pain experienced due to fistula cannulation in hemodialysis patients, Shabandokht-Zarmi et al. reported that the pain felt during the procedure was less in the intervention group patients (25). In a meta-analysis study examining the effectiveness of virtual reality goggles in relieving pain and anxiety in pediatric patients, it was concluded that virtual reality goggles are effective in managing pain by drawing pediatric patients into a virtual world (26). A recent systematic review and meta-analysis of randomized controlled trials using virtual reality to reduce the sensation of pain noted that virtual reality effectively reduces pain during medical procedures in both children and adults (26). The difference of this study from other studies is that it was conducted with adult hemodialysis patients.

Many studies conducted in different sample groups support that distraction with virtual reality glasses significantly reduces pain compared to standard care (21,27-29). However, some studies did not find a statistically significant difference between virtual reality distraction and standard care procedures (30-32). In our study, it was found that the use of VR glasses significantly reduced pain during fistula cannulation in hemodialysis patients pain compared to standard care.

4.1. Limitations

There are some limitations of our study. First, the study was conducted only in one hemodialysis unit, which may affect the generalizability of its results to other settings. Secondly, it was not possible to control the effect of participants' anxiety and stress levels on their pain intensity. Third, the fact that it was not possible that the fistula cannulation to be performed by the same nurse for all participants might have negatively affected the study results. Finally, during intervention, interaction may occur even if there are curtains between patient beds.

5. CONCLUSION

According to the results of this study, the intervention group patients, who watched a video with virtual reality glasses, were determined to feel less pain during fistula cannulation than the patients in the control group. Therefore, virtual reality may be an effective therapeutic option that can be used to reduce pain experienced due to fistula cannulation in hemodialysis patients. Since hemodialysis patients are regularly cannulated, they are constantly exposed to pain and different methods should be used to reduce pain. With this study, the use of virtual reality glasses can be used as a different method to reduce pain.

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