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The Effect of Virtual Reality Application on Pain and Anxiety During Chest Tube Removal Following Open Heart Surgery: Randomized Controlled Study

Açık Kalp Ameliyatı Olan Hastalarda Göğüs Tüpü Çıkarılması Sırasında Uygulanan Sanal Gerçekliğin Ağrı ve Anksiyete Üzerine Etkisi: Randomize Kontrollü Çalışma

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ABSTRACT Objective: Chest tube removal is a painful medical procedure following cardiac surgery. This study aimed to examine the effect of virtual reality (VR) application on pain and anxiety during chest tube removal in patients undergoing open-heart surgery. **Material and Methods:** In this parallel-group, randomized controlled study, a total of 40 participants were randomly assigned to intervention (n=20) and control (n=20) groups. 360-degree VR videos with nature and landscape scenes and relaxing background music were shown to the intervention group using VR glasses. Data were collected using a Patient Information Form, visual analog scale (VAS), Trait Anxiety Inventory, and Profile of Mood States Tension-Anxiety Subscale (POMS-TA). Descriptive statistics, independent samples t-test, chi-square tests, mixed design analysis of variance, and Bonferroni correction were used for data analysis. **Results:** VAS, POMS-TA Subscale, systolic and diastolic blood pressure, pulse, and respiratory scores measured immediately after chest tube removal (T1), 10 minutes later (T2), and one hour later (T3) were found to be lower in the intervention group compared to the control group ($p<0.05$). The number of patients using analgesics during and after chest tube removal was lower in the intervention group ($p<0.05$). **Conclusion:** VR application reduced pain and anxiety levels during chest tube removal and improved vital signs. Additionally, VR reduced the use of analgesics during and after the procedure. In this context, VR applications can be recommended as an effective attention diversion method during chest tube removal.

Keywords: Virtual reality; chest tube; pain; anxiety; nursing

ÖZET Amaç: Kalp ameliyatı sonrası göğüs tüpü çıkarılması, ağrılı tıbbi işlemlerden biridir. Bu çalışma, açık kalp ameliyatı geçiren hastalarda göğüs tüpü çıkarılması sırasında sanal gerçeklik (SG) uygulamasının ağrı ve anksiyete üzerindeki etkisini incelemek amacıyla yapılmıştır. **Gereç ve Yöntemler:** Bu paralel gruplu, randomize kontrollü çalışmada toplam 40 katılımcı rastgele olarak müdahale (n=20) ve kontrol (n=20) gruplarına atanmıştır. Müdahale grubuna SG gözlükleri kullanılarak doğa ve manzara sahneleri ve rahatlatıcı fon müziği içeren 360 derece VR videolar izletilmiştir. Veriler; Hasta Bilgi Formu, Görsel Kıyaslama Ölçeği (GKÖ), Sürekli Anksiyete Ölçeği ve Duygu Durum Profili Gerginlik & Anksiyete Alt Ölçeği (DDP-GAAÖ) kullanılarak toplanmıştır. Verilerin değerlendirilmesinde tanımlayıcı istatistikler, bağımsız örneklerde t-testi, ki-kare testleri, karma desen varyans analizi ve ve Bonferroni düzeltmesi kullanılmıştır. **Bulgular:** Göğüs tüpü çıkarılmasından hemen sonra (T1), 10 dk sonra (T2) ve 1 saat sonra (T3) ölçülen GKÖ, DDP-GAAÖ, sistolik ve diyastolik kan basıncı, nabız ve solunum skorları, müdahale grubunda kontrol grubuna göre daha düşük bulunmuştur ($p<0,05$). Göğüs tüpü çıkarılması sırasında ve sonrasında analjezik kullanan hastaların sayısı müdahale grubunda daha düşüktü ($p<0,05$). **Sonuç:** SG uygulaması, göğüs tüpü çıkarılması sırasında ağrı ve anksiyete düzeylerini azaltmış ve temel yaşamsal bulguları iyileştirmiştir. Ayrıca SG, işlem sırasında ve sonrasında analjezi kullanımını azaltmıştır. Bu bağlamda, SG uygulamaları göğüs tüpü çıkarılması sırasında etkili bir dikkat dağıtma yöntemi olarak önerilebilir.

Anahtar Kelimeler: Sanal gerçeklik; göğüs tüpü; ağrı; anksiyete; hemşirelik

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Chest tubes are often placed in individuals following cardiovascular surgery to drain air, blood, and other fluids in the pleural, pericardial, and mediastinal cavities; thus, the development of problems such as hemothorax and pneumothorax can be prevented and hemodynamic and cardiopulmonary functions can be preserved after the surgery.[1] However, besides their positive effects, chest tube applications are very painful and anxiety-causing applications and cause physiological and psychological problems.[2-4] Previous studies indicate that most patients experience pain that can reach severe levels, pain-related anxiety, and instability in vital signs during chest tube removal (CTR).[2,4-6] It is known that pain that can not be effectively managed slows down the healing process, reduces patient satisfaction and quality of life, and increases the length of hospital stay and the cost of care.[1,7] Therefore, effective pain management is critical to prevent undesirable outcomes.

Today, pharmacological and non-pharmacological methods are utilized for effective pain management during CTR.[2,3] Recently, virtual reality (VR) has become one of the non-pharmacological treatments, which are defined as cognitive behavioral interventions that are associated with a strengthened analgesic effect.[8,9] VR distracts attention away from the painful medical procedure to other senses (e.g., visual, auditory, and tactile stimuli) by making individuals feel as if they were in a different environment, this reduces the cognitive capacity required to transmit pain to the central nervous system and relieves pain and anxiety.[10,11] Besides, VR applications are attention diversion methods preferred in clinical applications because they are easy to apply, non-invasive, and inexpensive and have almost no side effects.[12,13] However, as far as we know, few studies in the literature showed the effects of VR during CTR.[9,14] In previous studies, it was stated that VR interventions improved pain, anxiety, and vital signs and increased patient satisfaction in many acute painful procedures, such as burn treatment, phlebotomy, sternotomy, multiple fracture treatment,breast biopsy.[8,15-18] In addition, recent systematic reviews and meta-analyses have revealed that VR-based interventions can reduce pain in patients undergoing painful procedures.[10,19] However, the use of VR technologies in the healthcare field is relatively new and, more studies are needed about the subject. And also as far as we know the effect of VR on basic vital signs during CTR has not been examined in the literature. In the current study, we hypothesized that VR applied during CTR in patients following open heart surgery would have a positive effect on pain (H1a) and anxiety (H1b). Therefore we aimed to examine the effect of VR applied during CTR on pain and anxiety in patients undergoing open heart surgery.

MATERIAL AND METHODS

DESIGN AND SAMPLE

This parallel-group randomized controlled trial was conducted in a training and research hospital's cardiovascular surgery intensive care unit in Türkiye (June 2022-July 2023). The population of the study consisted of adult patients who had undergone coronary artery bypass graft (CABG) surgery.

The G*Power 3.1.9.7 software was used to determine the sample size required to conduct the study. The effect size was found to be 0.86 based on anxiety and vital signs from studies conducted on the subject.[20,21] For this reason, 36 participants (18 controls, 18 intervention) with an effect size of 0.86, 80% power, and 5% margin of error; and 20 participants were assigned to each group considering possible losses.

PARTICIPANTS

The inclusion criteria were as follows: being aged ≥18 years, being literate, having undergone CABG surgery for the first time, having a bilateral chest tube, and giving verbal and written consent. The exclusion criteria were as follows: having a psychiatric problem, having a neurological disease (such as epilepsy, or dementia), having chronic pain, having vision and hearing problems, and having used VR glasses before. A total of 51 patients were enrolled in the study. Ten patients were excluded because they did not meet the research criteria and one patient refused to participate in the study

RANDOMIZATION

Patients who met the research criteria were randomly assigned to groups with equal assignment ratios (1:1),

creating blocks of six combinations of five on "www.randomizer.org", by a statistician who was not involved in this research. Accordingly, 20 patients in the intervention group and 20 patients in the control group were included in the study. After the participants' consent was obtained and the preliminary tests were performed, the practitioner-researcher learned about patients' groups by phone. In the statistical analysis and reporting phase of the study, the groups were named A and B, thus the researchers were blinded.

MEASUREMENTS

Patient Information Form: This form was created by the researchers to question the sociodemographic characteristics and medical status of the patients.

Visual Analogue Scale (VAS): This scale allows patients to score their pain levels between 0 and 10 (0: no pain, 10: unbearable pain). It has been reported to be more sensitive and reliable than other one-dimensional scales, with a sensitivity of 0.48 and a selectivity of 0.98.[22]

Trait Anxiety Inventory (TAI): This is the second part of the State-Trait Anxiety Inventory (STAI) that was developed by Spielberg et al. and whose Turkish validity and reliability study was conducted by Öner and Le Compte.[23] It is used to evaluate individuals' general anxiety levels. It has 20 questions and a four-point Likert-type scale. The scores obtained from the scale range from 20 to 80. High scores show high levels of anxiety. Cronbach's alpha reliability coefficient of the scale ranges from 0.82 to 0.87

Profile of Mood States Scale (POMS) Tension-Anxiety Subscale (POMS-TA): POMS was developed by Mcnair et al., and its validity and reliability study was conducted by Agargün et al.[24] It is a five-point Likert-type scale used to evaluate situational and short-term mood changes. The 9-item "Tension & Anxiety Subscale" of POMS was used in the study. The scores obtained from the scale range from 0 to 36. The higher the score is, the higher the anxiety level is. Cronbach's α value of the scale was found as 0.85.

VR Glasses: In the study, IOS-and Android-compatible VR glasses with 3D sound and 3D image features were used. With VR glasses, individuals watched 360-degree VR videos with nature and landscape scenes and relaxing background music, giving individuals a feeling of comfort and peace, and making them feel as if they were in nature. Six different VR videos were selected among the most viewed videos of the most known search engines and video platforms (Google, Yandex, and YouTube) by the researchers and they were recorded in the library of the smartphone used in the research so, during the research, patients could watch the videos they chose.

INTERVENTION AND DATA COLLECTION

In the study, all operations were performed by the same surgical and anesthesia team. When the drainage from the chest tube was less than 100 mL in the last 24 hours and no complications were observed in the patients, the tubes were removed by the same physician and nurse working in the intensive care unit, and the removal of the chest tubes took five minutes. Analgesics were administered to all patients upon physician request, as needed.

In both groups, data were collected in four stages: before the removal of the chest tube (T0), immediately after the removal of the chest tube (T1), 10 minutes after the removal (T2), and one hour after the removal (T3). The VR applications in the research were made by the practitioner-researcher. The data were collected by a specialist nurse who did not participate in the study. Before using the data collection forms, the nurse was given information about how to use them.

Firstly, pre-tests were performed on the patients included in the study by the specialist nurse*;* the patient information form was filled out for all patients, and their pain levels (VAS), state anxiety levels (TAI), general anxiety levels (POMS-TA), and vital signs (blood pressure, pulse, respiratory, body temperature, oxygen saturation) were measured and recorded. Then, the practitioner-researcher learned about patients' groups by phone.

INTERVENTION GROUP

The patients included in the intervention group, were placed in the semi-upright sitting position required

for the procedure by the practitioner-researcher and they were allowed to choose the video they wanted to watch among the videos recorded on the smart mobile phone. Then, the phone was connected to VR glasses and, patients were allowed to watch the video that they chose for a total of 10 minutes, five minutes before the procedure and five minutes during the procedure. Immediately after the CTR procedure was completed (T1) VR glasses were removed by the research and, the patient's pain level (VAS) and anxiety level (POMS-TA) felt during the CTR were measured and recorded by the nurse. Meanwhile, vital signs were measured and recorded. In T2 and T3, VAS and POMS-TA scales were applied again, and vital signs were measured and recorded. In T2, patients were asked to describe their pain during CTR, and their feelings. In T3, information about analgesics used for the patients was obtained from patient files.

CONTROL GROUP

No intervention was applied to the control group patients except for the routine procedure. All control group assessments were performed simultaneously and as frequently as those in the intervention group.

DATA ANALYSIS

The data were analyzed on the SPSS V26 software package (IBM Corp., Armonk, New York, USA). Descriptive statistics were utilized to assess participants' general characteristics. The normality assumption was evaluated using the Shapiro-Wilk test. To compare two-category variables with numerical data, the t-test was used for independent groups. Chi-square tests (Pearson chi-square/Fisher exact test) were used to compare the groups with categorical variables. The mixed-design analysis of variance (ANOVA) analysis was used to compare the measurements by groups. Bonferroni correction was applied for comparison of main effects in mixed design ANOVA analyses. A $p<0.05$ level was considered statistically significant.

ETHICAL CONSIDERATIONS

Prior to the study, necessary ethical approvals were obtained from the Yozgat Bozok University Clinical Research Board (no: 2017-KAEK-189_2022.06.23_04). The study was conducted in accordance with the Declaration of Helsinki. Written and verbal consent was obtained from all participants in advance.

RESULTS

In the study, the median age was 63.5 and 65 in the intervention (n=20) and control (n=20) groups, respectively. Both groups had a homogeneous distribution regarding all descriptive and clinical features ($p>0.05$) (Table 1). In the intervention group, VAS ($F=247.209$, $p<0.001$, $\eta^2=0.954$) and POMS-TA ($F=298.482$, $p<0.001$, $\eta^2=0.961$) scores decreased significantly over time. VAS and POMS-TA scores in T1, T2, and T3 were lower in the intervention group than in the control group ($p<0.05$) (Table 2). In the intervention group, systolic blood pressure ($F=7.281$, $p<0.001$, $\eta^2=0.378$), diastolic blood pressure ($F=2.998$, $p=0.043$, $\eta^2=0.200$), pulse ($F=15.755$, $p<0.001$, $\eta^2=0.568$), and respiratory ($F=6.563$, $p=0.001$, $\eta^2=0.354$) scores decreased significantly over time. Systolic and diastolic blood pressure, pulse, and respiratory scores in T1, T2, and T3 were lower in the intervention group than in the control group ($p<0.05$) (Table 3). The number of patients using analgesics during and after CTR was lower in the intervention group ($p<0.05$). More patients in the intervention group expressed positive emotions (joy-relaxation) during the CTR ($p<0.05$) (Table 4).

DISCUSSION

The results obtained from the study showed that VR reduced the level of pain and anxiety in patients who had open heart surgery. At the same time, it was determined that it reduced the amount of analgesics used during and after the procedure, provided a positive effect in basic vital signs.

Consistent with the H1a hypothesis of the current study, it was determined that the pain levels of the intervention group patients were lower than the levels of the control group during and after the CTR procedure. There are few studies on the evaluation of the effect of VR during CTR in the literature. Similar to the findings of the current study, in the Kızılcık Özkan et al.'s study, it was stated that patients exposed to VR application had lower levels of pain dur-

TABLE 1: Distribution of sociodemographic and some clinical characteristics of the participants by groups (n=40).

	Group		Test statistics	
	Intervention n=20	Control n=20	Test Value	p value
Gender				
Male	9 (45.0%)	11 (55.0%)	0.400†	0.527
Female	11 (55.0%)	9 (45.0%)		
Age				
$\bar{X}$±SD	64.3±3.99	65.15±3.91	-0.681‡	0.500
M (minimum-maximum)	63.5 (58-72)	65 (59-71)		
Educational status				
Primary education	11 (55.0%)	10 (50.0%)	0.100†	0.752
High school	9 (45.0%)	10 (50.0%)		
Body mass index				
$\bar{X}$±SD	2.4±0.68	2.25±0.72	0.679‡	0.501
M (minimum-maximum)	2.5 (1-3)	2 (1-3)		
Chronic disease				
Yes	14 (70.0%)	14 (70.0%)	0.001†	0.999
No	6 (30.0%)	6 (30.0%)		
Acute pain experience				
Yes	15 (75.0%)	17 (85.0%)	0.625†	0.429
No	5 (25.0%)	3 (15.0%)		
Disease knowledge				
Yes	2 (10.0%)	3 (15.0%)	0.229†	0.633
No	18 (90.0%)	17 (85.0%)		
Number of bypasses				
Single	8 (40.0%)	11 (55.0%)	0.902†	0.342
Dual	12 (60.0%)	9 (45.0%)		
Number of grafts				
1	8 (40.0%)	11 (55.0%)	0.902†	0.342
2	12 (60.0%)	9 (45.0%)		
Length of stay in intensive care				
2-3 days	14 (70.0%)	15 (75.0%)	0.125†	0.723
4-5 days	6 (30.0%)	5 (25.0%)		
Trait anxiety levels				
$\bar{X}$±SD	37.55±9.32	36.95±9.34	0.203‡	0.840
M (minimum-maximum)	34 (26-59)	34 (26-56)		

‡Independent sample t-test (t); †Chi-square test (χ^2); Summary statistics mean±standard and Median (minimum,-maximum) for numerical data. For categorical data, Number (Percentage) is given as value; SD: Standard deviation.

ing and after CTR.[9] In the Laghlam et al.'s study, two groups treated with VR and Kalinox (an inhaled equimolar mixture of N_2O and O_2 for pain relief) were compared during CTR and it was stated that VR was ineffective in managing pain and anxiety compared the Kalinox. However, the superiority of VR to Kalinox was evaluated in the study and, it is thought that the results of the mentioned study may be due to the sedative and/or amnesic effect of Kalinox; therefore, a complete comparison with our study findings could not be made.[14] On the other hand, few previous studies indicated that VR-based applications resulted in less pain, less anxiety, and better functional results after cardiac surgery compared to treatment with the traditional method.[25-27] Also, recent systematic reviews and meta-analyses including different acute and chronic painful procedures such as dressing change, port catheter application, injection, wound care, chronic neck pain indicated that VR was effective in reducing pain and anxiety levels, was tolera-

TABLE 2: Intra- and intergroup comparison of VAS and POMS-TA scores in the intervention and control groups (n=40).

	Group		Test statistics†		
	Intervention n=20	Control n=20	*F*	*p value*	η^2
VAS					
T0	6.40±0.94[a]	6.10±0.79[a]	**1.196**	**0.281**	**0.031**
T1	4.20±0.95[b]	6.45±0.60[a]	**79.658**	**<0.001**	**0.677**
T2	2.60±0.75[b]	6.20±0.95[a]	**175.886**	**<0.001**	**0.822**
T3	1.50±0.51[c]	2.10±0.64[b]	**10.688**	**0.002**	**0.220**
Test statistics$^{\varphi}$	***F=247.209 p<0.001 η^2=0.954***	***F=228.678 p<0.001 η^2=0.950***			
State anxiety					
T0	28.70±2.54[a]	29.50±2.42[a]	**1.043**	**0.314**	**0.027**
T1	17.50±3.24[b]	31.70±1.98[a]	**280.466**	**<0.001**	**0.881**
T2	13.30±3.39[b]	28.20±2.71[a]	**236.049**	**<0.001**	**0.861**
T3	9.40±0.82[c]	12.60±2.21[b]	**36.848**	**<0.001**	**0.492**
Test statistics$^{\phi}$	***F=298.482 p<0.001 η^2=0.961***	***F=287.302 p<0.001 η^2=0.960***			

T0: Before chest tube removal (baseline); T1: Immediately after chest tube removal; T2: 10 minutes after chest tube removal; T3: 1 hour after chest tube removal. Mixed Design analysis of variance (F). Effect size (η^2). $^{\phi}$Intra-group comparison; †Inter-group comparison. Descriptive statistics are given as mean±standard deviation. Sections marked in bold are statistically significant (p<0.05). a>b: Different letters within the same row indicate statistically significant differences (p<0.05); VAS: Visual Analog Scale; POMS-TA: Profile of Mood States Tension-Anxiety Subscale.

TABLE 3: Intra-and intergroup comparison of Vital Signs scores in the intervention and control groups (n=40).

	Group		Test statistics†		
	Intervention n=20	Control n=20	*F*	*p value*	*η2*
Systolic blood pressure					
T0	132.00±12.81[a]	125.50±15.38[ab]	2.108	0.155	0.053
T1	121.00±7.18[b]	132.00±11.05[a]	**13.933**	**0.001**	**0.268**
T2	120.00±7.25[b]	132.50±8.51[a]	**25.000**	**<0.001**	**0.397**
T3	117.00±8.65[c]	125.50±7.59[b]	**10.917**	**0.002**	**0.223**
Test statistics$^{\varphi}$	***F=7.281 p<0.001 η2=0.378***	***F=7.800 p<0.001 η2=0.394***			
Diastolic blood pressure					
T0	76.00±8.83[a]	73.50±7.45[a]	0.937	0.339	0.024
T1	70.50±7.59[b]	76.50±8.13[a]	**5.821**	**0.021**	**0.133**
T2	69.00±10.21[b]	77.00±8.01[a]	**7.600**	**0.009**	**0.167**
T3	68.00±7.68[b]	78.00±7.68[a]	**16.964**	**<0.001**	**0.309**
Test statistics$^{\varphi}$	***F=2.998 p=0.043 η2=0.200***	***F=0.933 p=0.435 η2=0.072***			
Pulse					
T0	85.40±5.77[b]	83.60±6.54[b]	0.852	0.362	0.022
T1	77.10±3.14[c]	87.70±5.00[a]	**64.497**	**<0.001**	**0.629**
T2	76.70±3.04[c]	88.10±5.00[a]	**82.660**	**<0.001**	**0.685**
T3	76.20±3.26[c]	85.90±5.37[ab]	**42.884**	**<0.001**	**0.530**
Test statistics$^{\varphi}$	***F=15.755 p<0.001 η2=0.568***	***F=5.253 p=0.004 η2=0.304***			
Respiration					
T0	23.30±2.27[b]	22.90±2.47[b]	0.284	0.597	0.007
T1	21.90±2.00[c]	24.90±2.10[a]	**21.429**	**<0.001**	**0.361**
T2	21.60±1.05[c]	23.20±1.51[ab]	**28.313**	**<0.001**	**0.427**
T3	20.90±1.21[c]	23.40±1.85[ab]	**14.383**	**0.001**	**0.275**
Test statistics$^{\varphi}$	***F=6.563 p=0.001 η2=0.354***	***F=7.258 p<0.001 η2=0.377***			
Body temperature					
T0	36.26±0.48[b]	36.33±0.49[b]	0.179	0.675	0.005
T1	36.50±0.48[b]	36.65±0.41[b]	1.050	0.312	0.027
T2	36.40±0.62[b]	36.39±0.66[b]	0.005	0.941	0.000
T3	36.64±0.48[b]	36.97±0.42[a]	2.519	0.124	0.127
Test statistics$^{\varphi}$	***F=2.298 p=0.094 η2=0.161***	***F=9.654 p<0.001 η2=0.446***			
Oxygen saturation					
T0	92.05±3.00[ab]	93.55±2.74[a]	2.724	0.107	0.067
T1	92.15±2.92[b]	90.45±3.43[b]	2.849	0.100	0.070
T2	92.70±2.68[b]	91.40±2.82[b]	2.238	0.143	0.056
T3	93.00±2.45[b]	92.40±1.93[b]	0.740	0.395	0.019
Test statistics$^{\varphi}$	***F=1.409 p=0.256 η2=0.105***	***F=17.521 p<0.001 η2=0.594***			

T0: Before chest tube removal (baseline); T1: Immediately after chest tube removal; T2: 10 minutes after chest tube removal; T3: 1 hour after chest tube removal. Mixed Design analysis of variance (F). Effect size (η^2). $^{\phi}$Intra-group comparison; †Inter-group comparison. Descriptive statistics are given as mean±standard deviation. Sections marked in bold are statistically significant (p<0.05). a>b: Different letters within the same row indicate statistically significant differences (p<0.05).

TABLE 4: The distribution of patients' analgesic intake before and after the chest tube removal procedure and their thoughts during the procedure by groups (n=40).

	Group		Test statistics	
	Intervention n=20	Control n=20	Test value	p value
Use of analgesia				
Pre-procedure use	2 (10.0)	4 (20.0)	**2.111**†	**0.042**
During and post-procedure use	1 (5.0)	8 (40.0)		
Description of pain felt during the removal of the chest tubes				
Very little	9 (45.0)	0 (0.0)		
Some	9 (45.0)	0 (0.0)		
Sharp	0 (0.0)	4 (20.0)	**34.000**†	**<0.001**
Sinking	2 (10.0)	6 (30.0)		
Throbbing	0 (0.0)	3 (15.0)		
Very much	0 (0.0)	7 (35.0)		
Description of emotions felt during the removal of the chest tubes				
Neutral expressions				
Feeling nothing	8 (40.0)	0 (0.0)		
Positive expressions				
Joy-relaxation	10 (50.0)	0 (0.0)	**34.000**†	**<0.001**
Negative expressions				
Pain	0 (0.0)	12 (60.0)		
Fear	0 (0.0)	5 (25.0)		
Excitement-panic	2 (10.0)	3 (15.0)		

†Chi-square test (χ^2); Summary statistics are given as Number (Percentage). Sections marked in bold are statistically significant (p<0.05).

ble by patients, and was suitable for clinical use as it had almost no side effects.[12,28-30] Furthermore, VR application was found to significantly reduce the level of pain during some acute painfull procedures suc as breast biopsy, and the Extracorporeal Shockwave Lithotripsy procedure.[18,31] In the current study, the fact that CTR is one of the procedures that cause acute pain suggests that the results are comparable. In this context, it can be said that our study results support the evidence in the literature.

At the same time, it was found that the during and post-procedure analgesia use was lower in the intervention group than in the control group. This finding suggests that VR can be an effective alternative or adjunctive method for pain management in CTR. While analgesics reduce the perception of pain by disrupting the transmission of neural nociceptive signals to the central nervous system, VR changes the perception of pain by changing emotional, behavioral, and psychological factors. A withdrawal from painful and anxious emotions and behaviors is observed, and this situation relaxes individuals.[32] It is thought that the use of analgesics decreased in the current study with these effects. There is no study in the literature that examines the effect of VR on the amount of analgesia used during and after CTR. However, several previous studies support the current study findings, showing that VR reduced the amount of analgesics used in painful procedures.[33,34] Considering the side effects of analgesics on patients and that the majority of the individuals following cardiac surgery consisted of the elderly, these results indicate that VR is promising in achieving effective results by reducing patients' pain and the amount of analgesic used.

CTR following cardiac surgery is a non-repeatable procedure, and individuals experience varying levels of anxiety because they do not know what to expect during the procedure. Therefore, effective anxiety management is considered to be very important during CTR, which is a painful procedure following cardiac surgery. Previous studies have shown that VR applications are effective in reducing anxiety levels in some acute painful procedures such as ster-

notomy, wound debridement, and post-operative dressing chance.[8,10,12,21,28] Similarly, consistent with the H1b hypothesis of the current study, it was determined that the anxiety levels during and after CTR were lower in the intervention group than in the control group and decreased over time. In this context, it could be thought that the findings of the current study are consistent with the literature.

In the current study, blood pressure (systolic and diastolic), pulse, and respiratory values decreased over time (T1, T2, T3) and showed improvement, in the intervention group. These results suggest that decreased pain and anxiety levels in individuals positively affect physiological parameters.[1] There were no results in the literature showing the effect of VR on vital signs during CTR, but, Mosso-Vázquez et al. in heart surgery, and Sahin and Basak in arthroplasty surgery stated that a VR-based application stabilized blood pressure, heart rate, and respiratory values in individuals following surgery.[25,35] On the contrary, few studies in the literature suggest that VR did not make a significant difference between groups on physiological parameters in painful procedures.[11] However, the use of VR technologies in the healthcare field is relatively new, and, more studies are needed on the subject.

LIMITATIONS

This research has some limitations. First, this is a single-center study with a relatively small sample size. This situation creates a limitation in terms of generalizability. Another limitation is that patients could not be blinded due to the nature of the study. Patients in intervention groups might have thought they would benefit from the VR application.

CONCLUSION

The findings of this study showed that VR applied during CTR in patients following open heart surgery reduced the level of pain and anxiety. It also decreased the amount of analgesic drugs used during and after the removal of the tube and improved the vital signs. All these results show that VR can be an effective attention diversion method for pain and anxiety management. At the same time, it is easy to apply, cheap, reliable, tolerated by patients, and a satisfactory application, all of which show its suitability for clinical use by nurses.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

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