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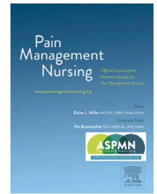
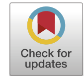


Original Article

# Effects of Virtual Reality on Pain, Anxiety, Patient Satisfaction in Coronary Angiography: A Randomized Trial



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ABSTRACT

*Background:* Since patients are conscious during the coronary angiography procedure, they may experience pain and anxiety regarding possible complications and an uncertain outcome.
*Aim:* This study was conducted to determine the effects of virtual reality application on pain severity, anxiety level, and patient satisfaction in patients who undergo coronary angiography.
*Method:* This randomized controlled study was conducted with a total of 70 patients, including 35 patients in the intervention and 35 patients in the control group. Apart from their routine treatment, virtual reality glasses application was used in the intervention group patients during the procedure. The patients in the control group were given only routine treatment. Data were collected by using “Descriptive Information Form”, “Visual Analogue Scale (VAS)”, Anxiety Assessment Scale (AAS), “Physiological Symptoms of Anxiety Follow-up Form”, and “Virtual Reality Glass Application Satisfaction Form”.
*Results:* Mean post-intervention scores of VAS, AAS, heart rate, diastolic and systolic blood pressure, respiratory rate of the intervention group decreased significantly compared with the control group, while $O_2$ saturation value was found to increase significantly.
*Conclusions:* In this study, it was found that virtual reality application was effective in reducing pain and anxiety, increasing patient satisfaction, and normative regulation of vital signs in patients who undergo coronary angiography.
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Coronary Artery Disease (CAD) is one of the cardiovascular diseases that affect individuals globally. It is among the leading causes of death among developed and developing countries (Malakar et al., 2019). With the developing technology in CAD, non-invasive and invasive interventions support diagnosis. Coronary angiography (CAG) is the most preferred and applied method among invasive methods (Heo et al., 2014). CAG is the process of making coronary arteries visible by administering radiopaque material through femoral, brachial, radial, and axillary arteries during cardiac catheterization (Demir & Arslantaş, 2016). Patients who undergo coronary angiography may experience anxiety due to the invasiveness of the procedure, the possibility of a life-threatening new diagnosis, and the risk of complications related to the procedure (Bal & Gun, 2023; Gallagher et al., 2010). Coronary angiography can be performed in the brachial artery, radial artery and femoral artery. However, it is often performed in the femoral artery in the inguinal region (Bhat et al., 2017; Manda & Baradhi, 2022). Unlike other regions, patients may experience pain in the groin, back and legs due to reasons such as the procedure's not allowing position change due to the operation site being the femoral artery, presence of pressure dressing at the intervention site, and having to lie still for 3-6 hours after the procedure (Fereidouni et al., 2019; Shoulders-Odom, 2008).

The increase in blood pressure in patients who undergo coronary angiography may cause an increase in intravascular pressure, which leads to an increase in the risk of developing complications (bleeding, hematoma, ecchymosis, etc.) at the intervention site (Merriweather & Sulzbach-Hoke, 2012; Shoulders-Odom, 2008). For this reason, it is very important to reduce pain, stress, and anxiety in patients who undergo CAG in order to maintain the hemodynamic balance and to prevent/reduce post-procedural complications (Aboalizm et al., 2016; Carroll et al., 2017; Demir &

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Arslantaş, 2016). In addition to pharmacologic approaches, non-pharmacologic approaches such as progressive relaxation exercises, massage, therapeutic touch, daydreaming and distraction are widely used in nursing care in reducing the pain, stress, and anxiety of patients (Aboalizm et al., 2016; Carroll et al., 2017; Demir & Arslantaş, 2016). Virtual reality application is one of the distraction techniques and is frequently used in the management of pain and anxiety (Gupta et al., 2018; Smith et al., 2020). Virtual reality (VR) is a real or fictional environment created with special hardware and software, giving individuals the perception of reality and creating the feeling of being in the event (Fuchs et al., 2011). It is commonly defined as the merging of abstract ideas with the digital world created by technology (Fuchs et al., 2011). These environments created in computer environment are presented to individuals through VR glasses. The purpose of using VR glasses is to enable patients to feel themselves in a three-dimensional environment by experiencing the feeling that they are in the displayed image (Wiederhold et al., 2014) . During the VR glasses application, the relaxing effect of music can also be provided by using natural sounds or relaxing music specific to the content watched (İnal & Canbulat, 2015; Wiederhold et al., 2014). In this technique, patients focus their attention on the environment they see, and the brains processing of signals related to pain and anxiety slows down (Hoffman et al., 2011; Indovina et al., 2018; Özkan & Polat, 2020). As a result, it shows its effect by mitigating the perception of pain and anxiety through distraction (Hoffman et al., 2011; Indovina et al., 2018; Özkan & Polat, 2020). VR glasses have great utility in nursing practice (alleviating pain, anxiety and fear and providing comfort and convenience) they are easy to apply, are inexpensive, and have mild or few side effects (headache, dizziness, eyestrain, nausea, vomiting) (İnal & Canbulat, 2015; Indovina et al., 2018; Ramaseri Chandra et al., 2022)

Although there are studies in the literature reporting decreased pain level and increased comfort level with VR glasses used in virtual reality (Nilsson et al., 2009; Scapin et al., 2018), a very limited number of studies have been found that specifically examine the effect of virtual reality on anxiety in coronary angiography patients (Keshvari et al., 2021). In the light of this information, this study was carried out to determine the effects of virtual reality application on pain severity, anxiety level, and patient satisfaction in patients who will undergo coronary angiography.

## Research Hypotheses

- $\mathbf{H_0}$: Virtual reality application has no statistically significant effect on pain severity, anxiety level, and patient satisfaction in patients who undergo coronary angiography.
- $\mathbf{H_1}$: Virtual reality application has statistically significant effects on pain severity, anxiety level, and patient satisfaction in patients who undergo coronary angiography.

## Methods

### *Design*

This study was conducted as a randomized controlled experimental study.

### *Participants and Setting*

Research population consisted of patients who were admitted to the Angiography Unit of Fırat University Hospital for angiography between July 4 and November 29, 2022. The sample group consisted of patients who met the inclusion criteria (being aged ≥18 years, being able to communicate adequately, not having received local anesthesia [local anesthesia is not used in facility]) and exclusion criteria (having any psychiatric problems, having received emergency coronary angiography, having myocardial infarction symptoms, unconscious, having undergone surgery within the last 6 weeks [The average recovery time after surgery is 6 weeks]. The time was shortened to control the feeling of pain and discomfort due to the surgery, having received analgesic during or before the procedure, having migraine, vertigo, headache, etc., being sensitive to light, having vision problems) and who accepted to participate in the study between these dates. Priori power analysis in the G-Power 3.1.9.4 program was used to determine the sample size in the study. In Priori power analysis, the effect size was found to be 0.80 based on anxiety and vital signs from studies conducted on the topic (Carl et al., 2019; Menekli et al., 2022). In line with this result, when the effect size was 0.80, significance level was 0.05 (Faul et al., 2014) and power was 0.95 (Çapık, 2014) in our study, the minimum number of patients to be included in the study was determined to be 34 for the intervention group, 34 for the control group, with a total of 68 patients. In the study, 80 patients were reached between these dates. Since 10 of the patients did not meet the research criteria, 35 patients were included in the intervention group and 35 patients in the control group, and the study was completed with a total of 70 patients (Fig. 1).

### *Randomization*

Considering the patients who met the inclusion criteria, the number of individuals in the intervention and control groups was equal (1:1), and the patients were divided into groups according to whether the barcode number was odd or even. Intervention and control groups were selected through lot method. The patients whose last digit of the barcode number was even were determined as the intervention group, while those with an odd number were determined as the control group (Fig. 1). The study adhered to the CONSORT guidelines.

### *Measurements*

The data were collected by the researcher by using "Descriptive Information Form", "Visual Analogue Scale (VAS)", Anxiety Assessment Scale (AAS), "Physiological Symptoms of Anxiety Follow-up Form", and "Virtual Reality Glass Application Satisfaction Form".

#### *Descriptive information form*

This form prepared by the researchers includes 13 questions on age, sex, marital status, educational status, occupation, employment status, income status, status of living alone, smoking status, alcohol use, presence of another chronic disease, previous coronary angiography, reason for coronary angiography.

#### *Visual Analogue Scale (VAS)*

This scale, developed by Price et al. (1983), is used to measure subjective experiences (Price et al., 1983). VAS, which is commonly used in adult populations, has been used to assess the intensity of unidimensional pain and has been found to be reliable and valid. It is used to measure the pain perceived subjectively by the individual. It has been reported to have higher sensitivity than other methods in the assessment of pain severity. It is thought to be the most appropriate scale for determining acute pain severity because it gives quick results and is easy to understand. It is a 0- to 10-centimeter ruler-shaped scale which is used to determine the intensity of pain quantitatively, with no pain at one end and most severe pain at the other. This marked line is used as numerical data in determining the level of pain perception. 0 represents no

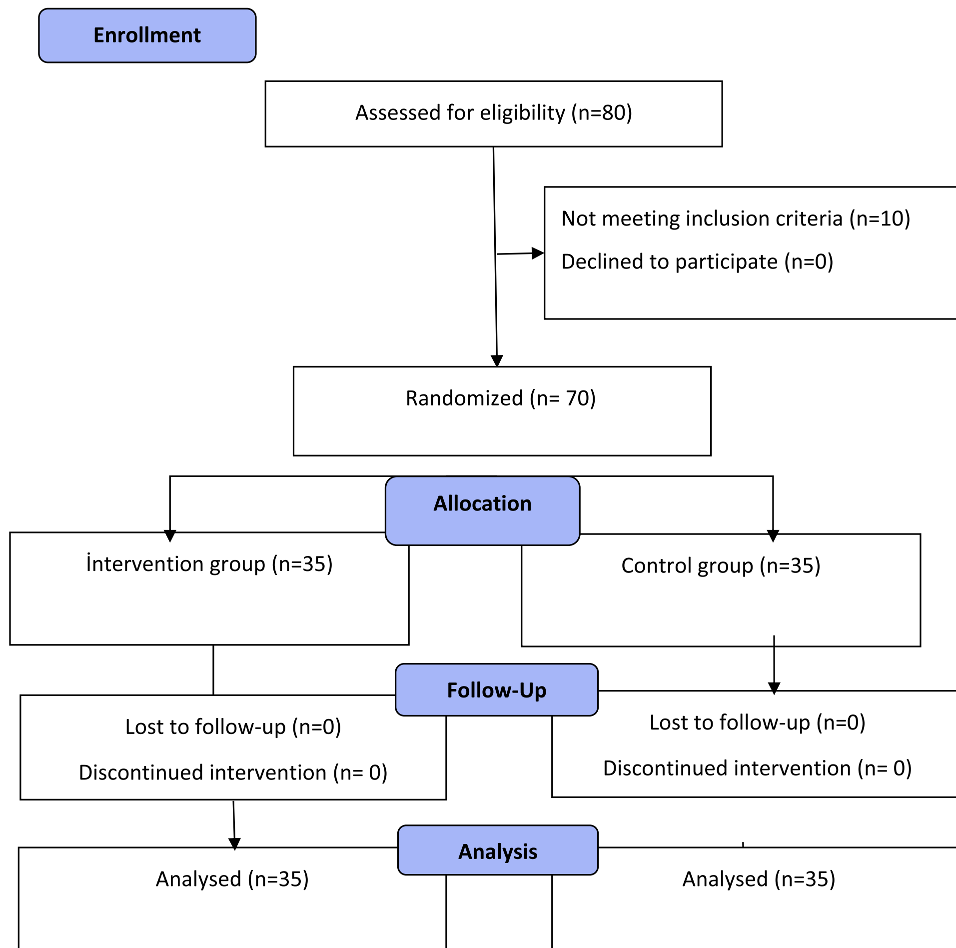


**Fig. 1.** CONSORT 2010 flow diagram.

pain, while 10 represents the highest severity of pain (Aslan, 2002). Cronbach alpha reliability coefficient was found to be 0.91 in this study.

*Anxiety Assessment Scale (AAS)*

AAS is used to assess unidimensional anxiety. The scale consists of a 10-centimeter horizontal line (0-no anxiety, 10-too much anxiety). Values range between 0 and 10; and as the score increases, the level of anxiety increases. The patients were asked to show their anxiety levels before and after the procedure on a 10-centimeter long horizontal line (Sahin & Basak, 2020). Cronbach alpha reliability coefficient was found to be 0.86 in this study.

*Physiological Symptoms of Anxiety Follow-up Form*

This form was created by the researcher to record blood pressure, heart rate, respiratory rate, and peripheral oxygen saturation (SpO2) value.

*Virtual Reality Glass Application Satisfaction Form*

This form includes 3 questions prepared in line with the relevant literature (Dutucu, 2019) in order to determine satisfaction with the video watched via virtual reality glasses. The first question of this form questions whether the patients are satisfied with the virtual reality glasses application. In this question, the patients were asked to show their satisfaction level on a 10-centimeter long horizontal line. It has a value of 0 (Not at all satisfied) at the beginning of the line and 10 (Very satisfied) at the end. In the second question of the form, it was asked whether the patients would want to use virtual reality glasses if the procedure were repeated. The third question of the form is “Would you recommend the virtual reality glasses to other patients who will perform the procedure?” Questions 2 and 3 are responded as yes, no, and undecided. Those who responded no to Question 3 were asked their reasons. Cronbach alpha reliability coefficient was found to be 0.89 in this study.

*Intervention*

The first measurement was obtained by applying the Patient Information Form, VAS, AAS, Physiological Symptoms of Anxiety Follow-up Form to the randomly assigned intervention and control group patients approximately one hour before the coronary angiography procedure. In the control group, no intervention was performed during the coronary angiography procedure and routine treatments (fluid support, rhythm control, allergic reaction follow-up) were carried out. Previously applied questionnaires (VAS, AAS, Physiological Symptoms of Anxiety Follow-up Form) were re-administered to the control group patients approximately 10-15 minutes after the procedure. Starting from minute 1 before the start of the procedure, the patients in the intervention group watched with an android mobile phone placed in the Cardboard Super Flex Binoculars Glasses, the licensed product “Secret Garden” with the music background, by using virtual reality application (30-45 minutes). Approximately 10-15 minutes after the completion of the coronary angiography procedure, the second measurements were obtained by applying the VAS, AAS, Physiolog-

**Table 1**
Descriptive Characteristics of the Patients (n = 70)

| Variables | | Groups | | | | Test value and significance |
|---|---|---|---|---|---|---|
| | | Control | | Intervention | | |
| | | n | % | n | (%) | |
| Sex | Female | 17 | 48.6 | 19 | 54.3 | $\chi^2 = .229$ |
| | Male | 18 | 51.4 | 16 | 45.7 | $p = .632$ |
| Marital status | Married | 32 | 91.4 | 32 | 91.4 | $p = .663$ |
| | Single | 3 | 8.6 | 3 | 8.6 | |
| Place of residence | City | 25 | 71.4 | 27 | 77.1 | $\chi^2 = .477$ |
| | Town | 6 | 17.1 | 4 | 11.4 | $p = .788$ |
| | Village | 4 | 11.4 | 4 | 11.4 | |
| Educational status | Illiterate | 8 | 22.9 | 6 | 17.1 | |
| | Literate | 3 | 8.6 | 8 | 22.9 | |
| | Primary education | 15 | 42.9 | 13 | 37.1 | $\chi^2 = 2.901$ |
| | Secondary education | 5 | 14.3 | 5 | 14.3 | p = .715 |
| | High school | 3 | 8.6 | 2 | 5.7 | |
| | Undergraduate and higher | 1 | 2.9 | 1 | 2.9 | |
| Profession | Housewife | 17 | 48.6 | 16 | 45.7 | |
| | Tradesperson | 4 | 11.4 | - | - | $\chi^2 = 7.272$ |
| | Worker | 1 | 2.9 | - | - | $p = .122$ |
| | Retired | 8 | 22.9 | 15 | 42.9 | |
| | Officer | 5 | 14.3 | 4 | 11.4 | |
| Working status | Employed | 6 | 17.1 | 3 | 8.6 | * $p = .239$ |
| | Unemployed | 29 | 82.9 | 32 | 91.4 | |
| Income status | Income=expense | 29 | 82.9 | 32 | 91.4 | * $p = .239$ |
| | Income<expense | 6 | 17.1 | 3 | 8.6 | |
| Smoking status | Yes | 8 | 22.9 | 11 | 31.4 | $\chi^2 = .650$ |
| | No | 27 | 77.1 | 24 | 68.6 | $p = .420$ |
| Alcohol use status | Yes | - | - | - | - | |
| | No | 35 | 100 | 35 | 100 | |
| Presence of another disease | Yes | 22 | 62.9 | 27 | 77.1 | $\chi^2 = 1.701$ |
| | No | 13 | 37.1 | 8 | 22.9 | $p = .192$ |
| Previous angiography | Yes | 14 | 40 | 18 | 51.4 | $\chi^2 = .921$ |
| | No | 21 | 60 | 17 | 48.6 | $p = .337$ |
| Reason for angiography | Chest pain | 33 | 94.3 | 34 | 97.1 | $\chi^2 = .348$ |
| | Numbness in the left arm | 2 | 5.7 | 1 | 2.9 | $p = .555$ |
| Cath site | Femoral | 35 | 100 | 35 | 100 | - |
| Continuous variables | | X ± SD | | X ± SD | | |
| Age | | 65.20 ± 13.57 | | 70.00 ± 9.82 | | T = 3.934 $p = .051$ |

* There is no $\chi^2$ value because Fisher's exact $\chi^2$ test was used; X = mean; SD = standard deviation.

ical Symptoms of Anxiety Follow-up Form, and the Virtual Reality Glass Application Satisfaction Form.

*Data Assessment*

The data obtained in the research were analyzed by using the SPSS (Statistical Package for Social Sciences) 22.0 program. Whether the scales showed normal distribution was examined. Skewness and Kurtosis values were found to be between +2 and -2 values. In addition, histogram graphs were also examined and it was determined that the measurements showed a normal distribution. Frequency and percentage analyses were used to determine the descriptive characteristics of the experimental and control groups. A $\chi^2$ analysis was performed to examine the difference between the sociodemographic characteristics of the experimental and control groups. According to the assumptions of the $\chi^2$ analysis, Pearson $\chi^2$value and Fisher's exact test were used. Mean scores and standard deviation values were used in the introduction of the scales. Independent Groups *t* test was used to compare the mean scores between the groups, while "Dependent Groups T-Test" was used to compare the intra-group pretest and posttest mean scores. Regression analysis was performed to measure the relationship between quantitative variables. Effect sizes for *t* test in independent groups according to Cohen's effect size table were as ≥20: Small; ≥50: Medium; ≥80 Large (Cohen, 1988).

*Ethical Considerations*

Approval from Fırat University Non-Interventional Research Ethics Committee (10.02.2022 dated, 2022/02-45 issued), and an official permission letter from the hospital where the application was conducted were taken in order to carry out the research. After the patients included in the study were informed about the study, their verbal and written consents were obtained. Since individual rights should be protected in the research, the Helsinki Declaration of Human Rights was adhered to during the study period. Verbal permission was obtained from the authors for the measurement instruments. Clinical trial registration was done (ClinicalTrials.gov.: NCT05459246)

## Results

As can be seen in Table 1, the control and intervention group were found to be similar in terms of descriptive characteristics.

When the intragroup comparison of the intervention and control groups was examined in the study, a significant difference was found in the post-application VAS (4.42 ± 1.63) and Anxiety (4.25 ± 1.80) mean scores of the intervention group when compared with the pre-application VAS (7.28 ± .82) and Anxiety (7.62 ± 0.77) mean scores ($p < .05$). No significant difference was found in the post-application VAS (7.40 ± 1.00) and Anxiety (7.14 ± 0.91) mean scores of the control group when compared with

**Table 2**
Comparison of Intragroup and Intergroup Mean Pain and Anxiety Scores of the Patients

| | | Groups | | |
|---|---|---|---|---|
| | | Intervention X ± SD | Control X ± SD | Intergroup $t^a/p$ |
| Pain | Pre-intervention | 7.28 ± .82 | 7.48 ± .95 | $t$ = –.940<br>$p$ = .351 |
| | Post-intervention | 4.42 ± 1.63 | 7.40 ± 1.00 | $t$ = -9.169<br>***p* < .001** |
| Intragroup $t^b/p$ | | $t$ = –9.560<br>***p* < .001** | $t$ = –.488<br>$p$ = .629 | |
| Anxiety | Pre-intervention | 7.62 ± 0.77 | 7.20 ± 1.25 | $t$ = 1.721<br>$p$ = .090 |
| | Post-intervention | 4.25 ± 1.80 | 7.14 ± 0.91 | $t$ = –8.444<br>***p* < .001** |
| Intragroup $t^b/p$ | | $t$ = 9.894<br>***p* < .001** | $t$ = .243<br>$p$ = .810 | |

$t^a$ = independent groups $t$ test; $t^b$ = dependent groups $t$ test;
Bold values indicate statistical significance ($p < .05$).

the pre-application VAS (7.48 ± .95) and Anxiety (7.20 ± 1.25) mean scores. When the differences between the groups were examined, while no significant difference was found between mean pre-intervention VAS and anxiety scores ($p > .05$), a significant difference was found in post-intervention mean scores ($p < .05$) (Table 2).

When the intragroup comparisons of the intervention and control groups were examined in the study, a significant difference was found in the post-intervention diastolic blood pressure, systolic blood pressure, heart rate, respiratory rate, and SpO2 mean scores of the intervention group ($p < .05$). No significant difference was found in the post-intervention diastolic blood pressure, systolic blood pressure, heart rate, respiratory rate, and SpO2 mean scores of the control group ($p > .05$). When the differences between groups were examined, significant difference was found between pre-intervention and post-intervention diastolic blood pressure, systolic blood pressure, heart rate, respiratory rate, and SpO2 mean scores ($p < .05$) (Table 3).

Table 4 shows the satisfaction levels of patients in the intervention group regarding the application of virtual reality glasses. It was found that 85.7% of the patients answered the question "Would you want to use virtual reality glasses again in case of another application" as "yes", while 82.9% answered the question "Would you recommend virtual reality glasses to other patients who will undergo angiography" as "yes", and it was found that all of the patients who answered as "no" gave this answer because they thought virtual reality glasses were disturbing (discomfort was reported due to the brightness of the image in the video projected on the VR glasses). Mean virtual reality glasses satisfaction scores of the patients was found as 7.22 ± 1.51 (Min-Max = 3-10).

When Table 5 is examined, it can be seen that the simple linear regression analysis performed to determine the effect of virtual reality application on pain, anxiety, diastolic blood pressure, systolic blood pressure, heart rate, respiratory rate, and $O_2$ saturation was found to be statistically significant ($p < .05$). It can be seen that virtual reality application has a negative effect on patients' pain, anxiety, diastolic blood pressure, systolic blood pressure, heart rate, and respiratory rate values, while it has a positive and significant effect on $O_2$ saturation value (Table 4, $p < .05$).

## Discussion

Interventional procedures are an integral part of the diagnosis and treatment program in various diseases. Such procedures are often accompanied by anxiety or fear. Psychological factors can affect the sensation of pain negatively in various ways (Crombez et al., 2012). Stress, anxiety, and fear do not only increase pain but also trigger it (Asmundson et al., 2012). Since patients are conscious during the coronary angiography procedure, they may experience pain and anxiety regarding possible complications and an uncertain outcome (Bal & Gun, 2023; Gallagher et al., 2010). This study was conducted to examine the effects of virtual reality application on pain severity, anxiety level, physiological symptoms of anxiety (heart rate, diastolic and systolic blood pressure, respiratory rate, saturation-vital findings), and patient satisfaction in patients who undergo coronary angiography. In this study, the groups were homogeneous in terms of sociodemographic and disease-related characteristics. Therefore, the results of the study were not affected by sociodemographic and disease-related characteristics that could lead to an increase or decrease in pain severity, anxiety level, and vital signs of the patients. On the other hand, no statistically significant difference was found between the mean scores of VAS, anxiety, and vital signs. This also ensures homogeneity of the groups in baseline measurement (Menekli et al., 2022).

In this study, when the mean scores between the groups were compared, it was found that VR glasses had a statistically significant effect on reducing the severity of pain. Unlike most analgesia, which use disruption of the C-fiber pathway that delivers nociceptive stimuli to the central nervous system, VR influences pain perception through attention, concentration, and emotional change (Pourmand et al., 2018). Through VR, patients focus on the stimulus they watch, dive into the virtual world, and distract their attention, providing pain management (Mosso-Vázquez et al., 2014). In VR, pain management is explained by three mechanisms. These mechanisms are distraction (distracting patients from painful stimuli while immersed in a virtual environment, e.g., relaxing environment), shifting focus (a series of VR applications that give the user greater empowerment, e.g., multi-object tracking), and skill enhancement (regulating patients' responses to painful stimuli, e.g., interactive games) (Ahmadpour et al., 2019). Although the researchers did not find any studies on the effect of VR on angiography-induced pain, there are similar studies in other fields on the effectiveness of VR and the various audio-visual interventions that are the main mechanism of VR. In this context, there are studies similar to the findings of the present study. In reviews evaluating the effect of VR use on acute or chronic pain management, it has been reported that VR use is effective in the treatment of various types of acute pain (Ahmadpour et al., 2019; Pourmand et al., 2018; Wong et al., 2022). In studies where VR was applied during transrectal prostate biopsy (Genç et al., 2022) and port catheter insertion (Menekli et al., 2022), a lower level of

**Table 3**
Distribution and Comparison of Intragroup and Intergroup Values of the Patients Regarding Physiological Symptoms of Anxiety

| | | Groups | | Intergroup $t^a/p$ |
|---|---|---|---|---|
| | | Intervention X ± SD | Control X ± SD | |
| Diastolic Blood Pressure (mmHg) | Pre-intervention | 91.65 ± 6.01 | 91.42 ± 5.84 | $t = .161$ $p = .872$ |
| | Post-intervention | 79.60 ± 8.40 | 90.28 ± 4.47 | $t = -6.636$ ***p* < .001** |
| Intragroup $t^b/p$ | | $t = 6.161$ **p=.000** | $t = 1.415$ p=.166 | |
| Systolic Blood Pressure (mmHg) | Pre-intervention | 140.85 ± 8.54 | 140.74 ± 6.60 | $t = .063$ $p = .950$ |
| | Post-intervention | 128.08 ± 10.40 | 139.60 ± 5.76 | $t = -5.726$ ***p* < .001** |
| Intragroup $t^b/p$ | | $t = 7.020$ ***p* < .001** | $t = .990$ $p = .329$ | |
| Heart rate (per minutes) | Pre-intervention | 90.28 ± 3.93 | 88.91 ± 4.83 | $t = 1.302$ $p = .197$ |
| | Post-intervention | 82.51 ± 4.69 | 88.20 ± 4.41 | $t = -3.492$ ***p* = .001** |
| Intragroup $t^b/p$ | | $t = 8.876$ ***p* < .001** | $t = .480$ $p = .634$ | |
| Respiratory rate (per minute) | Pre-intervention | 18.11 ± 1.13 | 18.25 ± 1.14 | $t = -.525$ $p = .602$ |
| | Post-intervention | 16.17 ± 0.82 | 18.65 ± 1.23 | $t = --9.911$ ***p* < .001** |
| Intragroup $t^b/p$ | | $t = 7.797$ ***p* < .001** | $t = -1.775$ $p = .085$ | |
| $SpO_2$(%) | Pre-intervention | 95.65 ± 0.99 | 95.85 ± .91 | $t = -.875$ p=.385 |
| | Post-intervention | 96.91 ± .81 | 95.91 ± 1.06 | $t = 4.399$ ***p* < .001** |
| Intragroup $t^b$/p | | $t = -6.347$ ***p* < .001** | $t = .373$ $p = .711$ | |

$t^a$ = independent groups $t$ test; $t^b$ = dependent groups $t$ test;
Bold values indicate statistical significance ($p < .05$).
$SpO_2$ = peripheral oxygen saturation.

**Table 4**
Distribution of Satisfaction With the Application of Virtual Reality Glasses in Intervention Group Patients

| Variables | | n | % |
|---|---|---|---|
| The state of wanting to use virtual reality glasses again in case of another application | Yes | 30 | 85.7 |
| | Undecided | 5 | 14.3 |
| The state of recommending virtual reality glasses to other patients who will undergo angiography | Yes | 29 | 82.9 |
| | No | 3 | 8.6 |
| | Undecided | 3 | 8.6 |
| The reason for not recommending if your answer is “no” (n:3) | The virtual reality glasses were disturbing | 3 | 100 |
| Mean satisfaction with virtual reality glasses scores of patients | 7.22 ± 1.51 (Min-Max = 3-10) | | |

pain intensity and a statistically significant difference between the groups (intervention and control) were found (Genç et al., 2022; Menekli et al., 2022). In another study conducted on individuals with capsaicin-induced pain, Hughes et al. (2019) suggested that VR is a non-pharmacologic form of pain management that alters the perception of acute pain by reducing activity in pain-related brain regions (Hughes et al., 2019). VR has the potential of being an important tool in reducing pain in patients who undergo interventional procedures in a variety of medical settings (Czech et al., 2021). VR is a viable alternative therapy for pain management for both teenagers and adults. VR can also relieve acute pain effectively (Huang et al., 2022). In our study, patient pain was associated with the incision wound and was considered as acute pain. Our findings are consistent with VR studies reported in the literature.

In this study, when the mean scores between the groups were compared, it was found that VR glasses had a statistically significant effect on reducing the level of anxiety. In cases when patients experience anxiety, the anxiolytic effect of VR is used to relieve this feeling. VR calms individuals down by changing their understanding of time in the negative environment they are in, by providing an environment where they feel good (Seabrook et al., 2020; Smith et al., 2020). VR activates individuals' senses and follows a sensory and motivating path away from its prosexic function in the central nervous system. VR distracts individuals and reduces individuals' levels of being affected by the environment. For example, it prevents individuals from feeling anxious when in a foreign environment while in the hospital (Găină et al., 2022). In studies examining the effect of VR distraction on reducing anxiety of patients before coronary angiography, it has been reported that the appli-

**Table 5**
Regression Analysis Results of the Effects of Virtual Reality Application on Pain, Anxiety and Physiological Symptoms of Anxiety in Patients who undergo Angiography

| | Model | Variables | B | S.Error | $\beta$ | *t* | *p* |
|---|---|---|---|---|---|---|---|
| Pain | 1 | Constant | 7.400 | .229 | | 32.293 | **.000** |
| | | Virtual reality-intervention | −2.971 | .324 | −.744 | -9.169 | **.000** |
| | $R = .744$ $R^2 = .553$ $F_{(1,68)} = 84.075$ $p < .001$ | | | | | | |
| Anxiety | 1 | Constant | 7.143 | .242 | | 29.560 | **.000** |
| | | Virtual reality-intervention | −2.886 | .342 | −.715 | −8.444 | **.000** |
| | $R = 0.715$ $R^2 = 0.512$ $F_{(1,68)} = 71.306.$ $p < .001$ | | | | | | |
| Diastolic blood pressure | 1 | Constant | 90.286 | 1.139 | | 79.249 | **.000** |
| | | Virtual reality-intervention | −10.686 | 1.610 | −.627 | −6.636 | **.000** |
| | $R = .627$ $R^2 = .393$ $F_{(1,68)} = 44.037,$ $p < .001$ | | | | | | |
| Systolic blood pressure | 1 | Constant | 139.600 | 1.422 | | 98.186 | **.000** |
| | | Virtual reality-Intervention | 1.429 | .537 | −.570 | −5.726 | **.000** |
| | $R = .570$ $R^2 = .325$ $F_{(1,68)} = 32.792$ $p < .001$ | | | | | | |
| Heart rate | 1 | Constant | 88.200 | 1.151 | | 76.613 | **.000** |
| | | Virtual reality-intervention | −5.686 | 1.628 | -.390 | −3.492 | **.010** |
| | $R = .390$ $R^2 = .152$ $F_{(1,68)} = 12.196,$ $p = .001$ | | | | | | |
| Respiratory rate | 1 | Constant | 18.657 | .177 | | 105.200 | **.000** |
| | | Virtual reality-intervention | −2.486 | .251 | −.769 | −9.911 | **.000** |
| | $R = .769$ $R^2 = .591$ $F_{(1,68)} = 98.224,$ $p < .001$ | | | | | | |
| $O_2$ Saturation | 1 | Constant | 95.914 | .161 | | 596.739 | **.000** |
| | | Virtual reality-intervention | 1.000 | .227 | .471 | 4.399 | **.000** |
| | $R = .471$ $R^2 = .222$ $F_{(1,68)} = 19.354,$ $p < .001$ | | | | | | |

Bold values indicate statistical significance ($p < .05$).
S.Error = standard error.

cation can effectively reduce perioperative anxiety (Keshvari et al., 2021; Pouryousef et al., 2020) and its signs (Keshvari et al., 2021). With regard to the importance of anxiety and its effect on angiographic results, it is recommended that nurses use these methods to reduce the anxiety of patients before coronary angiography (Pouryousef et al., 2020). In a study conducted by using VR technology with informed consent and a process of explanation, the VR group showed a significantly greater reduction in anxiety from baseline to postprocedure when compared with the control group (Morgan et al., 2021). In studies conducted with different patient (cesarean section and oncology patients undergoing port catheter implantation) groups, VR glasses were found to reduce the level of anxiety (Almedhesh et al., 2022; Menekli et al., 2022). Systematic reviews have reported that VR technology has a similar positive effect in reducing anxiety in medical procedures (Ioannou et al., 2020; Smith et al., 2020).

In this study, when the mean scores between the groups were compared, it was found that VR glasses had a statistically significant effect on decreasing the mean systolic and diastolic blood pressure, heart rate, respiratory rate, and increasing the O2 saturation value. There is a relationship between pain, anxiety, and vital signs (Dayoub & Jena, 2015). When pain and anxiety are triggered, corticotropin-releasing hormone activates the locus coeruleus in the brainstem to release noradrenaline to rapidly activate sympathetic fibers. Sympathetic nervous system then responds immediately by releasing adrenomedullary catecholamines. Sympathetic activation is reflected in increased heart rate, blood pressure, and respiration (Bushnell et al., 2013; Caes et al., 2017). In this study, it is thought that the decrease in pain and anxiety in the intervention group led to a decrease in mean systolic and diastolic blood pressure, heart rate, respiratory rate, and an increase in O2 saturation value. In a study by Menekli et al (2022), it was reported that the use of VR had an effect on decreasing mean systolic and diastolic blood pressure, heart rate, respiratory rate, and increasing O2 saturation value of the patients in the intervention group compared with the control group (Menekli et al., 2022). Different studies conducted have reported that VR application causes positive decreases and increases (O2 saturation) on vital signs compared with pre-intervention (Genç et al., 2022; Sahin & Basak, 2020; Smith et al., 2020). This shows that VR has positive effects on vital signs, which we consider as physiological symptoms of anxiety.

Because it is important to collect data on patient satisfaction to evaluate and improve the quality of medical care (Almedhesh et al., 2022), patient satisfaction was evaluated in

this study. The present study found that the patients in the experimental group had a high level of satisfaction with the VR glasses. In different studies evaluating the effect of VR use on patient satisfaction, it was reported that patients were highly satisfied with the VR application (Almedhesh et al., 2022). In a study conducted on VR, Bahat et al. (2015) found that patients had a high level of satisfaction (Bahat et al., 2015). In their meta-analysis, Zhang et al. (2023) found that the application of VR glasses in interventional procedure increased patient satisfaction (Zhang et al., 2023). In another study, it was reported that VR application did not affect patient experiences negatively. It has been stated that the use of non-pharmacologic tools such as VR can be effective in improving subjective measures of patient experience (Glennon et al., 2018). In the brain, the limbic system and amygdala play a role in mediating anxiety, and this is often experienced by patients before a medical procedure. While mild anxiety is essential for survival, increased levels of anxiety in a clinical setting can lead to worsened pain perceptions, decreased pain thresholds, and less cooperative patients. Therefore, it is necessary to reduce anxiety levels and increase patient satisfaction to manage pain in patients (Smith et al., 2020). Increasing patient satisfaction will ensure that the health institution provides quality service (Sahin & Basak, 2020). In this study, it is thought that the decrease in pain and anxiety in the intervention group led to an increase in patient satisfaction. In line with the results obtained from the study, it is thought that the use of distracting methods such as VR glasses to control pain and anxiety during the coronary angiography procedure will be effective in increasing patient satisfaction and therefore the quality of patient care in institutions.

### *Limitations*

The study was conducted in a single center and the number of patients is limited. Therefore, the results of the study cannot be generalized to all patients. The study was planned in the mother tongue of the country; the patients who could not speak that language were excluded from the study. Patient preferences were not considered in the program watched with VR glasses. Researchers and patients were not blinded; only the data analyst was blinded.

## Conclusion

In this study, it was found that VR application was effective in reducing pain, anxiety, and physiology symptoms of anxiety and increasing patient satisfaction in patients who underwent coronary angiography. It is recommended to use VR glasses in coronary angiography units, to apply them to patients in the management of pain and anxiety by nurses, and to conduct studies with VR in different areas with larger sample groups.

### *Clinical Implications*

VR can be used in many different clinical scenarios. However, the timeframe in which it will be used may vary depending on the needs of the patient and the purpose of treatment. VR glasses can encourage more patient involvement in treatment processes. VR games and simulations can further motivate patients, especially in medical procedures that cause pain and anxiety. When selecting VR glasses, a model suitable for the requirements of the clinical application in which it will be used should be chosen. In particular, those with a lightweight and ergonomic design that patients can wear comfortably and for long periods of time should be preferred. However, there are also some factors to consider when using VR glasses in hospitals and clinics, such as sterilization of devices, safety precautions and ethical responsibilities. Careful consideration of these factors supports the effective use of VR in healthcare.

## Declaration of Competing Interest

The authors have no conflicts of interest to disclose.

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Clinical trial registration was done (ClinicalTrials.gov.: NCT05459246). The CONSORT checklist for randomized controlled trials was used in this study.

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