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Relieving Anxiety Through Virtual Reality Prior to Endoscopic Procedures

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Purpose: Endoscopic procedures can cause anxiety, which can lead to more uncomfortable, difficult, and incomplete procedures, in addition to greater use of sedative medication. Here, we investigate whether exposing patients to virtual reality (VR) prior to endoscopic procedures can reduce their anxiety levels.
Materials and Methods: Forty patients at Gangnam Severance Hospital were enrolled and divided into the VR group and the control group. Patients in the VR group were exposed to VR prior to their procedure to alleviate anxiety. The primary data outcomes were State-Trait Anxiety Inventory (STAI), pain score, satisfaction with sedation, and satisfaction with the procedure.
Results: The mean STAI-state and STAI-trait did not differ significantly between the control group and the VR group. While defining a high anxiety STAI score as ≥45 in an STAI-state, the proportion of patients with high anxiety at baseline was 35% and increased to 50% prior to the procedure in the control group. However, in the VR group, the proportion of patients with high anxiety at baseline was 60% and decreased to 50% prior to the procedure. The proportion changes of patients with high anxiety in the STAI-state exhibited a significant difference between the control and VR groups (p=0.007). Furthermore, patients' satisfaction with sedation was significantly greater in the VR group compared to the control group (p=0.017).
Conclusion: VR exposure may relieve patients' anxiety levels prior to endoscopic procedures, but further well-designed placebo-controlled studies are needed. VR, an inexpensive, easily available, and non-invasive method, also improved the satisfaction with sedation of endoscopic procedures.

Key Words: Virtual reality, endoscopy, procedure, anxiety, sedation

INTRODUCTION

Esophagogastroduodenoscopy (EGD) and colonoscopy are the most common diagnostic and therapeutic procedures for gastrointestinal disease. Procedures such as endoscopic mucosal resection (EMR) or endoscopic submucosa dissection (ESD), which have been increasingly performed in recent years, can make patients anxious, vulnerable, and embarrassed.[1,2] Such discomfort can complicate the procedures and increase medication use and risk of sedative-related complications.[3,4] Therefore, various non-invasive approaches, such as listening to music, have been used to reduce patient anxiety before endoscopic procedures. In a recent randomized controlled study, listening to music and looking at a silent natural image were both effective in the stability of physical and psychological conditions, including autonomic nervous function, prior to EGD.[5] However, most previous studies were concerned with lowering the sedative doses and improving the tolerance for pain and anxiety.[3,6]

Virtual reality (VR), the technology consisting of a visual system, an audio system, and an integrated setup, has emerged as a promising tool for the management of pain and anxiety in various clinical settings.[7] By stimulating multiple human senses, VR systems can provide users with an immersive experience and a feeling of presence in the virtual world.[8] VR exposure can markedly reduce anxiety and persistent pain intensity, accelerated wound healing, and enhanced neurorehabilitation outcomes in patients with burns and complex regional pain syn-

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drome.[9] However, few studies have analyzed the effect of VR exposure on patient anxiety before invasive endoscopic procedures, even though many studies have suggested that VR exposure has anxiolytic effects and reduces stress.[10]

There are several methods to assess the anxiety of patients undergoing endoscopic procedures, including the Hospital Anxiety and Depression Scale, the Visual Analog Scale (VAS), and the Spielberger's State-Trait Anxiety Inventory (STAI).[11] In this study, we hypothesized that exposing patients to VR before endoscopic procedures could reduce their anxiety levels, using the Korean version of STAI.[12] In addition, we investigated whether VR reduces pain and improves patient's satisfaction with the procedure or sedation compared to the standard care.

MATERIALS AND METHODS

Patients

This study was designed as a pilot study to evaluate how VR exposure before endoscopic procedures affected patient anxiety. Based on the rule of thumb for pilot studies, we attempted to set a sample size of at least 12 subjects per group.[13] Finally, a total of 40 patients were included and randomly assigned into two groups: the control group and the VR group. A single physician performed the randomization process using a computer-generated randomization table. Between January 2020 and April 2022, patients who were scheduled for ESD of gastric lesions and EMR or ESD of colonic lesions at Gangnam Severance Hospital in Seoul, Korea, were enrolled. Inclusion criteria were as follows: 1) age 19 to 70 years; 2) absence of any history of overt or borderline psychiatric disorders; 3) ability to read and understand the patient information sheet; 4) abstinence from psychoactive medications; and 5) agreement to participate in the study. Following the evaluation of the above-mentioned criteria, all of the participants provided informed consent and were assigned to either the VR (intervention) group or the control (non-VR) group. This study was approved by the ethics committee of Gangnam Severance Hospital, Yonsei University College of Medicine (IRB number: 3-2018-0070).

Study design

One day before the procedure, all 40 patients were asked to answer the Korean version of the STAI to assess their baseline anxiety levels. On the procedure day, the patients in the VR group were exposed to VR through VR devices prior to the procedures. One researcher guided the patients and monitored them for any events during the VR exposure. Just before the procedure in the endoscopic room, all patients were asked to answer the STAI again to assess their anxiety levels. Patients completed a series of questions about pain, satisfaction with the procedure, and satisfaction with sedation (Fig. 1).

VR exposure

The VR was generated using the Samsung Gear VR (Consumer Edition, SM-R322, combined with a Galaxy S7; Samsung, Seoul, Korea). The current model is the size of ski goggles, weighs 318 grams, and is fitted on the head with elastic straps. The VR meditation program was used for this study, which consists of several short clips of 360-degree cameras in motion featuring gardens, beaches, and underwater scenes with sounds from nature (Cerevrum Inc., New York, NY, USA). Patients self-selected one of these clips, which varied in runtime from 3 to 5 minutes.

Spielberger's State-Trait Anxiety Inventory

The STAI is a widely used and validated survey within the scientific literature and the gold-standard for measuring anxiety levels.[14] The STAI consists of two questionnaires for self-evaluation.[15] The two parts are: the state portion, which measures immediate emotional state caused by concern or tension and may change over time; and the trait portion, an acquired per-

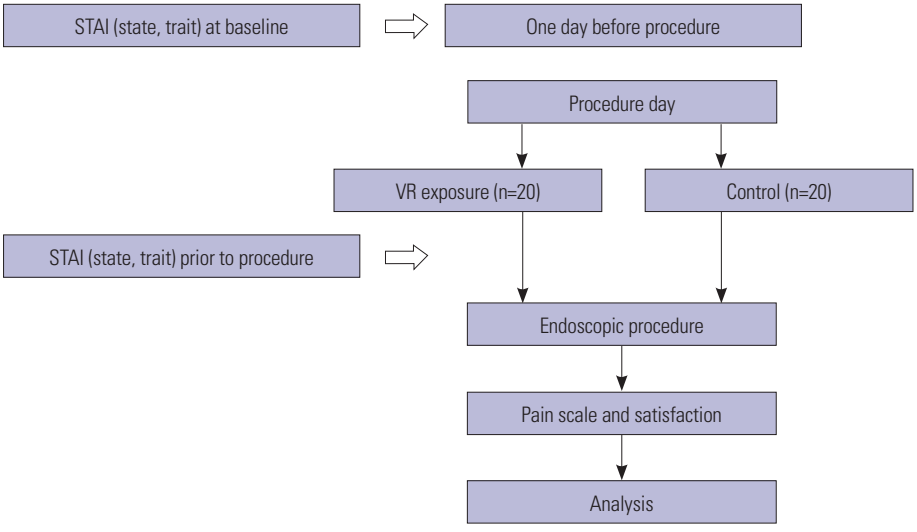

Fig. 1. Flow chart of the study design. STAI, State-Trait Anxiety Inventory; VR, virtual reality.

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sonality of feeling fearful in a safe situation. Scores range from 20 to 80, with higher scores indicating greater anxiety.[16] STAI scores are classified as 20–37: no or low anxiety, 38–44: moderate anxiety, and 45–80: high anxiety.[17,18]

Pain and satisfaction

After full recovery was confirmed, all patients completed a questionnaire about their overall satisfaction with the sedation and the procedure as well as pain. A VAS was used to assess pain. Satisfaction was assessed using a Likert scale (0–5).

Statistical analysis

The mean (±standard deviation) and median (interquartile range) of continuous variables in parametric and non-parametric distributions, respectively, are presented. Categorical variables are represented numerically (%). The independent Student's t test or the Mann-Whitney U test were used to compare continuous variables. The χ^2 test was used to compare categorical variables. SPSS software (version 25.0; IBM Corp., Armonk, NY, USA) was used for statistical analyses, and two-tailed p values<0.05 were considered statistically significant.

Table 1. Baseline Characteristics of All Patients

Variables	Control group (n=20)	VR group (n=20)	*p* value
Age, yr	56.65±8.62	59.65±6.92	0.378
Sex			
Male	13 (65.0)	15 (75.0)	0.255
Female	7 (35.0)	5 (25.0)	0.189
Existing conditions			
None	7 (35.0)	8 (40.0)	0.871
Diabetes mellitus	5 (25.0)	4 (20.0)	0.562
Hypertension	2 (10.0)	4 (20.0)	0.225
Thyroid disease	0	1 (5.0)	0.172
Gastric ulcer	1 (5.0)	0	0.347
Duodenal ulcer	0	0	0.859
Gastric cancer	3 (15.0)	1 (5.0)	0.101
Liver disease	0	2 (10.0)	0.185
Others	3 (15.0)	6 (30.0)	-
Therapeutic endoscopy history			0.316
Done	3 (15.0)	5 (25.0)	
Not done	17 (85.0)	15 (75.0)	
Type of endoscopy			0.617
Gastroscopy	13 (65.0)	15 (75.0)	
Colonoscopy	7 (35.0)	5 (25.0)	
ESD/EMR	2 (28.6)/5 (71.4)	2 (40.0)/3 (60.0)	0.586
Type of the lesion			0.246
Malignant*	10 (50.0)	13 (65.0)	
Duration of procedure, min	39.15±26.51	47.30±32.68	0.742
Dosage of sedative, mg			
Midazolam	3.00±1.31	2.75±1.03	0.891
Propofol	61.25±36.82	57.50±25.49	0.324

VR, virtual reality; ESD, ndoscopic submucosa dissection; EMR, endoscopic mucosal resection.
Data are presented as mean±standard deviation or n (%).
*Malignant lesions included any kind of carcinoma.

RESULTS

Baseline characteristics

The median age of all patients was 58.25 years, with a 70.0% (28 of 40) male predominance in both groups. There was no significant difference between the control group and the VR group in terms of age, sex, existing diseases, previous experience of endoscopic procedures, the type of endoscopy, the type of lesion, procedure time, and the dosage of sedatives (Table 1).

Anxiety levels

Table 2 compares the STAI scores of the control group and the VR group at baseline and prior to the procedure. The mean STAI-state and STAI-trait did not differ significantly between the two groups. Defining a high anxiety STAI score as ≥45, the number and proportion of high anxiety patients in each STAI-state and trait were calculated. In the STAI-state, the proportion of patients with high anxiety at baseline (one day before the procedure) was 35% and increased to 50% prior to the procedure in the control group. However, in the VR group, the proportion of patients with high anxiety at baseline was 60% and decreased to 50% prior to the procedure. The proportion changes of patients with high anxiety in the STAI-state exhibited a significant difference between the control group and VR group (p=0.007); however, those in STAI-trait showed no significant difference between the two groups (Table 3 and Fig. 2).

Pain and satisfaction

There was no difference in the pain score (VAS) and overall satisfaction with the procedure between the control group and the VR group. However, satisfaction with sedation was significantly greater in the VR group compared to the control group (Table 2).

Table 2. STAI, Satisfaction with the Procedure, Satisfaction with Sedation, and Pain Score at Baseline and Prior to the Procedure by Group

	Control group (n=20)	VR group (n=20)	*p* value
Baseline			
STAI (state anxiety)	42.85±5.184	44.60±7.549	0.398
STAI (trait anxiety)	41.95±5.472	42.80±5.578	0.629
Prior to procedure			
STAI (state anxiety)	43.00±5.648	45.45±8.003	0.270
STAI (trait anxiety)	42.40±5.205	42.45±5.772	0.977
Satisfaction with procedure	4.65±0.572	4.65±0.587	-
Satisfaction with sedation	4.45±0.605	4.85±0.366	0.017
Pain score (VAS)	1.55±1.191	1.55±1.468	-

VR, virtual reality; STAI, Spielberger's State-Trait Anxiety Inventory; VAS, Visual Analogue Scale.
Values are presented as mean±SD.

Table 3. Number of Patients with High Anxiety Scores at Baseline and Prior to the Procedure by Group

	Control group (n=20)		VR group (n=20)		*p* value
	Baseline	Prior to procedure	Baseline	Prior to procedure	
STAI (state anxiety)	7 (35.0)	10 (50.0)	12 (60.0)	10 (50.0)	0.007
STAI (trait anxiety)	7 (35.0)	5 (25.0)	8 (40.0)	9 (45.0)	0.188

STAI, Spielberger's State-Trait Anxiety Inventory; VR, virtual reality.
Values are presented as n (%).

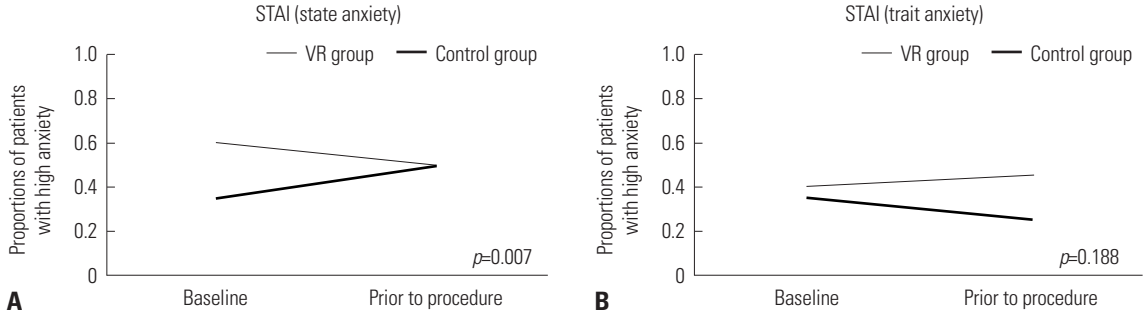

Fig. 2. Comparison of the proportion changes in patients with high anxiety (STAI score ≥45) between baseline and prior to the procedure by group. (A) STAI (state anxiety). (B) STAI (trait anxiety). STAI, State-Trait Anxiety Inventory; VR, virtual reality.

DISCUSSION

The aim of this study was to investigate the impact of VR exposure on patients scheduled to undergo endoscopic procedures. Although there have been numerous studies on auditory and visual effects using subjective evaluations such as anxiety and satisfaction during various endoscopic procedures, there have been few reports on the influence of VR exposure prior to endoscopic procedures. The current study found that VR exposure might reduce patients' anxiety levels before the endoscopic procedure and increase their satisfaction with sedation.

According to Spielberger's norms for anxiety scores, it was clear that patients scheduled for endoscopic procedures experience anxiety. However, some patients exhibited relief of STAI-state anxiety but not trait anxiety after VR exposure prior to the endoscopic procedure. Since state anxiety is a temporary emotional state caused by concern or tension while trait anxiety is a more general and long-standing condition, it is reasonable to believe that only state anxiety was reduced through VR exposure. Clinicians must use strategies to decrease patient anxiety prior to procedures. In this study, even 3 to 5 minutes of VR exposure prior to the endoscopic procedure reduced anxiety. Furthermore, patients who received VR exposure reported significantly greater level of satisfaction with sedation with this non-invasive intervention compared to those in the control group.

These findings are consistent with previous studies that used VR to decrease anxiety in surgical patients.[10,19,20] According to a recent study of Hendricks, et al.,[21] VR users experienced significant reductions in tension and strain, as well as significant enhancement in feelings of calmness between pre- and post-procedure.

However, recent studies on VR exposure during endoscopy failed to demonstrate the superiority of VR in reducing anxiety.[9,22] VR application decreased patient pain during the colonoscopy, but it had no effect on STAI-measured anxiety in these studies. Karaveli, et al.[22] suggested that the use of VR to alleviate pain could help eliminate complications and reduce costs related to the administration of anesthetic drug. These studies differ from ours in that they used VR during endoscopy rather than before the endoscopic procedures, as we did. In addition, the small sample size of these studies precluded robust statements on clinically relevant endpoints, such as reduction of anxiety and enhancement of patient satisfaction.

It is well-documented that increased anxiety prior to endoscopic procedures is associated with increased physiologic stress, worse outcomes (pain, mood deterioration, and mortality), and decreased patient satisfaction.[23,24] Improving the overall patient satisfaction promotes patient-physician relationships, as well as patient recovery and compliance. Sedative premedication, first used to reduce anxiety prior to endoscopic procedures, has recently been shown to result in no remarkable improvement in the overall satisfaction of patients.[25] Although sedatives have been shown to relieve patients' anxiety and pain during endoscopic procedures, it may increase the risk of complications, such as hypotension and respiratory depression.[5,26] As a result, the use of non-pharmacologic tools, such as VR, to reduce anxiety may have the dual effect of improving subjective patient experience measurements and reducing the impact of pharmacotherapy-related complications.[21] From this perspective, it is meaningful that patients who underwent VR exposure prior to endoscopic procedures reported significantly greater satisfaction with sedation compared to those in the control group in this study.

There are several limitations of this study that need to be

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addressed. First, the sample size was small, and the study subjects were heterogeneous of procedure type, type of lesion, duration, and technical difficulties. We were also unable to assess the impact of other factors on anxiety levels, such as sex, education, and socioeconomic status. Second, while we were performing this study for more than 2 years, VR technology continued to advance, and the videos we used became outdated. Better results could have been obtained if the research was conducted with new VR devices and applications. Third, although the goal was to make the patients comfortable with VR, it was possible that any intervention itself just prior to the procedure may have amplified the patients' anxiety levels. Finally, since there are few previous studies on VR exposure before endoscopic procedures, it is not known whether 3 to 5 minutes of exposure is sufficient time to relieve anxiety. Although this study showed that the proportion changes of patients with high anxiety in the STAI-state exhibited a significant difference between the control group and the VR group, it is not yet sufficient to definitively conclude that VR exposure reduces anxiety prior to endoscopic procedure. Similarly, caution is advised when deciding with confidence if VR affects satisfaction with sedation. Further well-designed, placebo-controlled studies are needed.

In conclusion, this study found that VR exposure may reduce patients' anxiety levels before endoscopic procedures, and no adverse effects or events were reported. VR, an easily available, non-invasive, and inexpensive method, also might improve patients' satisfaction with sedation during endoscopic procedures. Considering its manageability, low cost, minimal time required for implementation, and the wait time prior to endoscopic procedures, VR can be widely recommended. Subsequent studies are required to further verify these results.

AUTHOR CONTRIBUTIONS

Conceptualization: Hyojin Park. Data curation: all authors. Formal analysis: Yuna Kim and Hyojin Park. Investigation: Yuna Kim, Sung Hwan Yoo, and Hyojin Park. Methodology: Hyojin Park. Project administration: Hyojin Park. Resources: all authors. Supervision: Hyojin Park. Writing—original draft: Yuna Kim. Writing—review & editing: Sung Hwan Yoo, Jaeyoung Chun, Jie-Hyun Kim, Young Hoon Youn, and Hyojin Park. Approval of final manuscript: all authors.

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