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Determining the Effect of Video Information on the Dental Anxiety Levels of the Endodontic Patients: A Randomised Clinical Trial

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ABSTRACT

Objective: The present study assessed the effectiveness of pretreatment education in the form of Visual Video Information (VVI) on the anxiety levels of patients during endodontic treatment steps.

Methods: Patients ($n = 120$) having single-rooted teeth with a single root canal diagnosed with asymptomatic irreversible pulpitis and/or pre-prosthetic root canal treatment were included in this study. After completing anxiety scales and a sociodemographic/dental habits survey, the patients were randomly divided into two groups. Just before the endodontic treatment, VVI was given to the video group patients, while the control group patients received routine information verbally. In both groups, a galvanic skin response (GSR) device was placed on the patients' wrists to record the stress levels during the endodontic treatment process. Anxiety scales and a feedback-satisfaction survey were administered to all patients after the treatment process. Then, statistical analysis was performed ($\alpha = 0.05$).

Results: This study performed 60 endodontic treatments on 60 patients (30 females and 30 males). Sociodemographic characteristics and dental treatment habits of the patients significantly affected dental anxiety scale scores ($p < 0.05$). VVI resulted in a significant decrease in the mean scores of anxiety before and after the treatment, but this decrease was not significant between the groups ($p > 0.05$). Similarly, VVI did not impact the GSR readings between the groups during treatment ($p > 0.05$).

Conclusions: The educational VVI is effective for reducing anxiety in patients undergoing endodontic treatment. In addition, the electrodermal activity method is a promising alternative for objectively assessing anxiety levels.

1 | Introduction

Dental anxiety and fear can cause patients to delay or even cancel their dental appointments [1]. When anxious patients avoid dental treatments, it reduces the clinician's control over the treatment and results in more time-consuming procedures [2]. Previous painful and traumatic dental treatment experiences are the most important etiological factor for dental anxiety [3]. Dental anxiety is associated with personality characteristics, such as age, gender, presence of other psychological disorders, social factors, such as parents' approach to dental treatment and socioeconomic status, and dental factors, such as fear of pain, lack of control and unpredictability [4].

Endodontic treatments are one of the dental procedures that cause dental anxiety [5]. The sight of injectors and sharp-edged

hand instruments, noise and vibrations during cavity preparation, and cut dentin odours can increase the anxiety levels of patients during endodontic treatments and other invasive procedures [6]. Additionally, patients may be concerned about pain anticipation, situations that may cause a gag reflex, fear of choking due to varying saliva and swallowing management and cost and aesthetic expectations [7].

Patients who receive positive written information about endodontic treatment may feel more at ease toward the treatment [8]. Given information contributes to patients' rational decision-making regarding the best treatment option by increasing their level of knowledge [9] and decreases the fear and anxiety by increasing the patients' sense of control and predictability [4, 10]. In routine practice in dentistry, written information content (e.g., brochures, informed consent forms) or verbal information is used to raise awareness among patients. However, patients may have difficulty reading educational materials written by endodontists due to scientific writing styles [11]. In this regard, endodontic specialists should direct patients to alternative high-quality sources of information to prevent patients from using sources whose competence and reliability are unknown [12]. Compared to other information methods, video-based information has the advantages of being more entertaining due to its audio-visual content, shortening chair-time, ease of storage and reuse of data and being understood by patients with limited reading ability [13].

Thus, this clinical study has three main objectives: (1) to determine the effect of pretreatment video information on patients' anxiety levels using anxiety scales; (2) to evaluate the effect of pretreatment video information on the stress level occurring in patients during endodontic treatment steps, using electrodermal activity; (3) to investigate the relationship between patients' pretreatment anxiety levels and sociodemographic characteristics thought to play a role in the aetiology of anxiety. The null hypotheses tested in this study were: (1) Video information would not change the patients' skin conductance levels during endodontic treatment and anxiety scale scores after endodontic treatment; (2) sociodemographic characteristics and dental treatment habits of the patients would not affect pretreatment dental anxiety levels.

2 | Materials and Methods

This research protocol was submitted and approved by the Clinical Research Ethics Committee of Aydin Adnan Menderes University, Aydin, Turkey (Protocol ADUDHF 2019/071) and was also registered in the www.ClinicalTrials.gov database (NCT/04892394). Written informed consent was obtained from all participants after agreeing to participate in the trial.

2.1 | Subjects

The minimum estimated sample size was calculated using G* Power 3.1.9.2 software (Heinrich Heine, Düsseldorf University, Düsseldorf, Germany) based on previous research data [14]. For an α-type error of 0.05 and a β power of 0.95, this leads to a sample size of at least 46 (23 per group). A total of 120 patients (60 teeth per group) were enrolled in this study, considering the potential signal data dropout rate and to increase the statistical power of this study. Therefore, 120 patients referred to Aydin Adnan Menderes University Faculty of Dentistry Department of Endodontics from March to September in 2020 for endodontic treatment participated in this study.

Inclusion criteria included: (i) adult patients aged 18–65 years, who were included in ASA I and II according to ASA classification and had no eyesight or hearing impairment and had no mental or psychiatric disorder; (ii) patients presenting with single-rooted teeth with a single root canal diagnosed with asymptomatic irreversible pulpitis or single-rooted vital teeth with a single root canal requiring root canal treatment due to prosthetic reasons. Exclusion criteria included: (i) patients who refused to participate in this study; (ii) those who had medically compromised patients and those who had dermatological disease. This paragraph summarises the criteria, but all inclusion and exclusion criteria are listed in Table 1.

2.2 | Treatment Procedures

To prevent bias, all treatments were performed by the same clinician (Ş.A.), who had 5 years of clinical experience. While the patients were in the waiting room, they were asked to complete the patient identification form and anxiety scales—the Modified Dental Anxiety Scale (MDAS), Spielberger State–Trait Anxiety Inventory (STAI-S, STAI-T) and the Visual Analogue Scale (VAS)—under the supervision of the clinician.

Participants were randomly assigned using online software (http://www.random.org) to one of the two study groups: video group (detailed video information) or control group (basic verbal information). The patients were informed while sitting on the treatment chair in a quiet room, accompanied by the clinician. After the briefing, a galvanic skin response (GSR) device (Shimmer3 GSR+, Shimmer Sensing, Dublin, Ireland) was placed on the patients' wrists and fingers to determine their stress levels during treatment. Root canal treatment was divided into separate stages as anaesthesia, cavity preparation, rubber dam placement, determination of root canal length, root canal shaping, root canal filling and analysed per protocols. For each stage of root canal treatment, the start and end points were marked in the software used and the process of the procedure was recorded. Root canal treatments of all patients were completed in a single visit of <1 h. After the treatment, the procedure was finalised by administering the feedback-satisfaction form and anxiety scales (MDAS, STAI-S, VAS) to all patients.

2.3 | Measurement of Anxiety and Stress

Levels of dental anxiety were measured before the educational information and after endodontic treatment using the Turkish version of the MDAS. The MDAS comprises five questions, including all four items of Corah's Dental Anxiety Scale (DAS), as well as allowing the assessment of the level of anxiety associated with the injection process [15]. Each response is rated on a 5-point Likert scale ranging from 5 (no anxiety) to 25 (highest anxiety level). İlgüy et al. [16] confirmed the validity and reliability

TABLE 1 | Inclusion/exclusion criteria of the participants.

Inclusion criteria	Exclusion criteria
1. Patients between 18 and 65 years of ages	1. Patients who refuse to participate this study
2. Patients with healthy (ASA 1) and mild systemic disease (ASA 2) according to ASA classification	2. Patients have existing pain caused by another tooth
3. Patients with no mental disorders in their medical history	3. Patients with dermatological disease in the medical histories
4. Patients who do not have a psychiatric disorder that they have started, and who do not use psychotherapeutic drugs	4. Medically compromised patients (with immunosuppressive/systemic diseases, patients on medications)
5. Literate and not visually impaired patients	5. The presence of spontaneous pain, swelling, or fistula in the relevant tooth
6. Patients presenting with single-rooted teeth with a single root canal diagnosed with asymptomatic irreversible pulpitis or single-rooted vital teeth with a single root canal requiring root canal treatment due to prosthetic reasons	6. Teeth whose working length cannot be reached due to calcification and step formation in the root canal
	7. The presence of foreign material in the root canal that prevents entry (broken instrument, post)
	8. The presence of advanced periodontal disease (probing depth > 4 mm) or root fracture in the relevant tooth
	9. Patients using pain medication on the same day before treatment (within 24 h)

of the Turkish version of this modified scale at a cutoff point of 19.

State anxiety (STAI-S) levels were measured both before educational information and after endodontic treatment, while trait anxiety (STAI-T) levels were measured only before educational information because they did not change over time. Each of the two STAI sub-scales consists of 20 questions [17]. STAI-S evaluates the patient's momentary mood, and STAI-T assesses the patient's general mood regardless of the situation. STAI scales with scores between 1 and 4 for each item can have a total score from 20 to 80. STAI scales are not specific to dental anxiety and are used in many psychological research studies. In this study, as in a previous study [18], the STAI scores were classified as no or low anxiety (20–37), moderate anxiety (38–44) and high anxiety (45–80).

The horizontal-line VAS for anxiety ranges from 0 mm (no anxiety) to 100 mm (most severe anxiety), with patients evaluated as calm (0–50), anxious (51–75) and phobic (76–100) according to their scores [3]. The VAS scale was applied to patients before the educational information and after endodontic treatment.

The secretion that occurs in the eccrine sweat glands due to sudomotor activation alters the conductivity of the skin. GSR provides an objective measure for evaluating dental anxiety by measuring electrodermal activity. GSR sensors consist of two Ag/AgCl electrodes that contact 1 cm^2 of the skin. At the beginning of the endodontic treatment in this study, the GSR device (Shimmer GSR+, Shimmer Sensing) was attached to the patient's preferred wrist, and the measuring tapes of the device were placed on the patient's proximal phalanges of the index and middle fingers. One-visit endodontic treatment was divided into seven steps [anaesthesia, cavity preparation, rubber dam placement, root canal length determination, root canal shaping, root canal filling, coronal restoration and finishing]. At the end of the treatment, the GSR data from each step were transmitted via a wireless connection to the computer software program (Neurolize, Istanbul, Turkey).

2.4 | Information Video

While sitting on the treatment chair, video group patients viewed a pre-recorded video clip on a tablet computer (iPad Mini 2; Apple Inc., San Francisco, CA, USA). In the first part of the video, the clinician informs about the root canal treatment procedure and its long-term success (65 s). In the next scene, the endodontic treatment steps are explained with spot information voiced by the clinician on a female patient (246 s). The information was provided in a clear way that the patient could understand, avoiding medical terms. During the video information, the operator accompanied the patient and answered the questions at the end of the screening.

2.5 | Statistical Analysis

Data were analysed statistically using the IBM SPSS Version 25 package program (IBM Corp., Armonk, NY, USA). Descriptive statistics were given as percentage, mean ± standard deviation

and minimum and maximum values. The Shapiro–Wilk test, the Skewness-Kurtosis values and histogram graphs revealed that the data were in accordance with normal distribution ($p > 0.05$). The Levene test was performed to determine whether the variances of the data were homogeneous ($p > 0.05$). Mauchly's W test of sphericity was used to assess the assumption of sphericity in a repeated-measures analysis of variance (ANOVA). It was observed that the data complied with the sphericity assumption ($p > 0.05$). One-way ANOVA was used for intergroup comparisons of parameters showing normal distribution, and Tukey's HSD test was used to identify the group that caused the difference. The independent sample t-test was used to compare parameters with normal distribution between two groups. For the comparison of repetitive data with normal distribution, the paired samples t-test was used. Pearson correlation analysis was used to examine the relationships between parameters. The two-way repeated-measures ANOVA test was used to examine the difference between the parameters included in the study and the time-dependent changes in this difference. Since multiple anxiety scales and repeated measures were used in this study, post hoc Bonferroni correction was used in statistical analyses to reduce family-based error rates and for pairwise comparisons. There is no missing data in the data set. For all tests, the Type I error level was set at 0.05.

3 | Results

We initially included 120 patients; however, two patients subsequently refused to participate. One patient disallowed the rubber dam placement due to excessive gag reflex, and different treatment (pulp capping/filling) procedures were planned for seven teeth without pulp exposure. The data of 50 patients could not be stored completely because of the disconnection of the GSR device during the treatment. In total, this study performed 60 endodontic treatments on 60 patients (30 females and 30 males) (Figure 1). The treatment duration was 45.30 ± 8.98 min in the video group and 47.27 ± 8.06 min in the control group (t(58); 0.892, $p = 0.376$, $p > 0.05$).

3.1 | Subjective Assessment of Dental Anxiety

No significant differences were found between the pretreatment mean scores for MDAS, STAI-S, STAI-T and VAS of the video and control groups [(tMDAS(58) = −0.029; $p = 0.977$, $p > 0.05$), (tSTAI-S(58) = −0.409; $p = 0.684$, $p > 0.05$), (tSTAI-T(58) = −0.252; $p = 0.802$, $p > 0.05$), (tVAS(58) = −1.138; $p = 0.260$, $p > 0.05$)]. There was a significant correlation between the mean MDAS, STAI-S and VAS scores but not between the STAI-T anxiety scale and other anxiety scales [pretreatment: (rMDAS/STAI-S(60) = 0.658, $p = 0.000$, $p < 0.05$), (rMDAS/VAS(60) = 0.798, $p = 0.000$, $p < 0.05$), (rST AI-S/VAS(60) = 0.539, $p = 0.000$, $p < 0.05$), posttreatment: (rMDAS/STAI-S(60) = 0.434, $p = 0.001$, $p < 0.05$), (rMDAS/VAS(60) = 0.258, $p = 0.046$, $p < 0.05$), (r STAI-S/VAS(60) = 0.426, $p = 0.001$, $p < 0.05$)] (Table 2). When the pretreatment anxiety values in this study were evaluated according to the cutoff points of the respective scales used in previous studies [3, 16, 18], 6.7% ($n = 4$) of the patients presented high dental anxiety based on the MDAS scores (16); 66.7% ($n = 40$) of the patients showed low anxiety, 15.0% ($n = 9$) moderate anxiety and 18.3% ($n = 11$) high anxiety on the STAI-S scale for state anxiety; 43.3% ($n = 26$) of the patients showed low anxiety, 30.0% ($n = 18$) moderate anxiety and 26.7% ($n = 16$) high anxiety [18] on the STAI-T scale for trait anxiety; and 90.0% of the patients were found to be calm ($n = 54$), 1.7% ($n = 1$) were found to be anxious, and 8.3% ($n = 5$) were found to be phobic on the VAS [3].

The sociodemographic variables and clinical details of the patients that are thought to play a role in the aetiology of dental anxiety are summarised in Table 3. Each anxiety scale was analysed based on the characteristics of all patients. Significantly higher mean MDAS, STAI-S and VAS scores were found in women compared to men [(tMDAS(58) = 2.770; $p = 0.008$, $p < 0.05$), (tSTAI-S(58) = 2.650; $p = 0.010$, $p < 0.05$), (tVAS(57.911) = 3.119; $p = 0.003$, $p < 0.05$)] and for those living with family members with dental phobia compared to those who did not live with a family member with dental phobia [(tMDAS(20.990) = 2.722; $p = 0.013$, $p < 0.05$), (tSTAI-S(58) = 2.565; $p = 0.013$, $p < 0.05$), (tVAS(58) = 5.477; $p = 0.000$, $p < 0.05$)]. Mean VAS scores were significantly higher among young compared to older patients (FVAS(2, 57) = 5.028; $p = 0.010$, $p < 0.05$), and the mean STAI-T scores of primary school graduates were significantly higher than those of university graduates (FSTAI-T(4, 55) = 3.054; $p = 0.024$, $p < 0.05$). The mean MDAS and VAS scores were significantly higher in those living in the district than those living in the city [(FMDAS(2, 57) = 3.807; $p = 0.028$, $p < 0.05$), (FVAS(2, 57) = 4.378; $p = 0.017$, $p < 0.05$)]. There was no significant difference between the income distribution of the patients and the mean scores of the anxiety scales [(FMDAS(3, 56) =2.168; $p = 0.102$, $p > 0.05$), (FSTAI-S(3, 56) = 0.987; $p = 0.405$, $p > 0.05$), (FSTAI-T(3, 56) = 1.147; $p = 0.338$, $p > 0.05$), (FVAS(3, 56) = 1.432; $p = 0.243$, $p > 0.05$)].

Our results demonstrated that the posttreatment anxiety mean scores (MDAS, STAI-S, VAS) in both groups were significantly lower when compared with the pretreatment anxiety mean scores [(video group; (tMDAS(29) = 3.509, $p = 0.001$, $p < 0.05$)), (tSTAI-S(29) = 3.384, $p = 0.002$, $p < 0.05$), (tVAS(29) = 2.755, $p = 0.010$, $p < 0.05$) and control group; (tMDAS(29) = 4.338, $p = 0.000$, $p < 0.05$), (tSTAI-S(29) = 3.467, $p = 0.002$, $p < 0.05$), (tVAS(29) = 2.734, $p = 0.011$, $p < 0.05$)] (Table 4). The two-way repeated-measures ANOVA test determined that this decrease was not significant between the groups (group vs. time interaction) [(FMDAS(1, 58) = 0.140; $p = 0.710$, $p > 0.05$), (FSTAI-S(1, 58) = 0.152; $p = 0.698$, $p > 0.05$), (FVAS(1, 58) = 0.192; $p = 0.663$, $p > 0.05$)] (Table 5).

3.2 | Objective Measurement of Stress Levels During Treatment

GSR readings, which we used to evaluate patients' stress levels during endodontic treatment, were measured in seven treatment steps in both groups. The results revealed no significant difference between the video and control groups at any step ($p > 0.05$). Furthermore, the GSR curve showed a downward trend throughout the treatment in both groups (Figure 2).

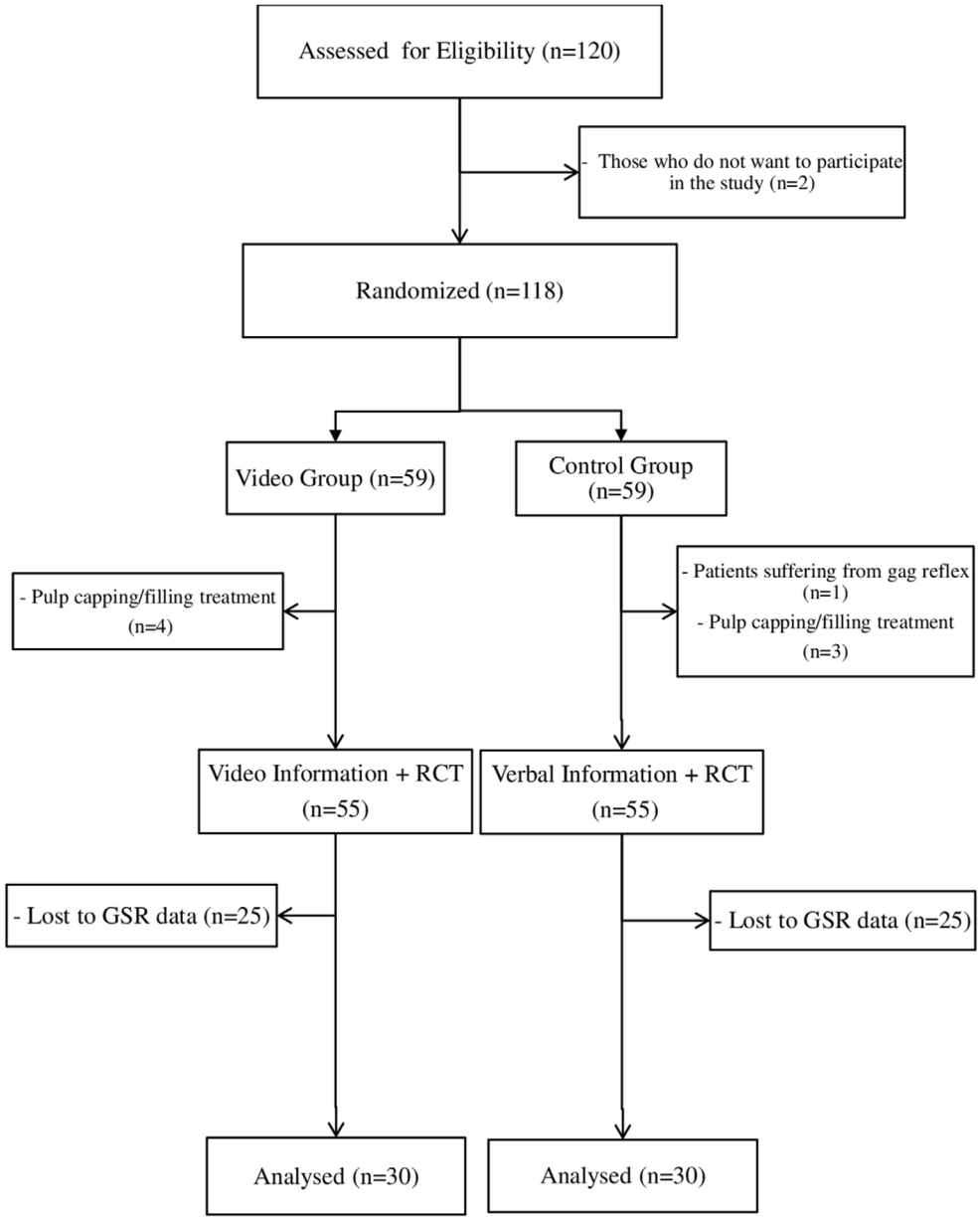

FIGURE 1 | Flowchart of the participants in the study.

When the relationship between the GSR readings of all patients at the seven different treatment steps was evaluated, GSR readings in the coronal restoration and finishing (final) step were significantly lower among all steps, except for the root canal length determination step [(coronal restoration and finishing/anaesthesia MD = −0.330, standard error (SE) = 0.097, $p = 0.026$, $p < 0.05$), (coronal restoration and finishing/cavity preparation MD = −0.314, SE = 0.83, $p = 0.009$, $p < 0.05$), (coronal restoration and finishing/rubber dam placement MD = −0.314, SE = 0.081, $p = 0.007$, $p < 0.05$), (coronal restoration and finishing/determination of root canal length MD = −0.230, SE = 0.074, $p = 0.061$, $p > 0.05$), (coronal restoration and finishing/root canal shaping MD = −0.215, SE = 0.061, $p = 0.020$, $p < 0.05$), (coronal restoration and finishing/root canal filling MD = −0.159, SE = 0.040, $p = 0.005$, $p < 0.05$)] (Table 6).

3.3 | Feedback—Satisfaction

According to the feedback-satisfaction form answered by all patients after the treatment, 83.33% ($n = 50$) of all patients responded that the GSR device worn on the wrist during treatment did not worry them, leaving 16.67% ($n = 10$) for whom it did. "How did the video information you watched affect your anxiety?" was directed to video group patients', for whom it increased in 13.3% ($n = 4$), decreased in 30.0% ($n = 9$), and did not change in 56.7% ($n = 17$). The entire video group of patients stated that the information provided in the informative video was sufficient. To the question "Would you like the information to be given before treatment next time to be like this?" 76.7% ($n = 23$) of the patients answered yes, and 23.3% ($n = 7$) answered no (Table 7).

TABLE 2 | Evaluation of the correlations of anxiety scales.

			Before treatment			After treatment	
			STAI-S	**VAS**	**STAI-T**	**STAI-S**	**VAS**
Before treatment	MDAS	*r*	0.658	0.798	0.089		
		p	**0.000***	**0.000***	0.498		
	STAI-S	*r*		0.539	0.136		
		p		**0.000***	0.302		
	VAS	*r*			0.039		
		p			0.776		
After treatment	MDAS	*r*				0.434	0.258
		p				**0.001***	**0.046***
	STAI-S	*r*					0.426
		p					**0.001***
	VAS	*r*					
		p					

Note: Bold values indicate that they show a significant difference according to the statistical test. Pearson Correlation Test $*p < 0.05$.

4 | Discussion

Dental anxiety studies conducted with more than one clinician may cause patients to develop a different emotional approach to each clinician and create limitations to the study [7]; therefore, in the present study, patients were informed before treatment, and endodontic treatment was administered by the same clinician (Ş.A.). Facco et al. [19] found that systemic diseases were effective on dental anxiety, underlying the importance of assessing dental anxiety in ASA-PS class P2 and P3 patients. Therefore, patients who were evaluated as ASA-PS class P1 and P2, who were not diagnosed with a defined anxiety disorder, and who did not use psychotherapeutic drugs were included in this study. It is known that pain is highly correlated with dental anxiety [20], so vital pulp teeth completed in one visit without pretreatment pain were included to prevent bias.

Dental anxiety can be evaluated by subjective measures, such as anxiety questionnaires and a semi-structured interview, or objective measures, like blood pressure [21], heart rate [22], finger temperature [23] and electrodermal activity [24] measurements associated with the activity of the patient's sympathetic nervous system. Dental anxiety questionnaires are the most commonly used measurement tools; although, all have the disadvantage of not being able to describe the nature of anxiety fully. Schuurs and Hoogstraten [25] suggested using more than one scale in dental anxiety research. In the current study, the MDAS, one of the most commonly used dental anxiety scales, was used to evaluate dental anxiety, and STAI forms were used to evaluate patients' state and trait anxiety. Trait anxiety did not change over time, so the STAI-T form was administered only before the treatment. In addition to these scales, the VAS, a single-item anxiety scale in which patients are not restricted by scenarios (clinical environment or the patient's condition while filling out the form), was used.

Although anxiety scales are the most commonly used methods for determining dental anxiety, they are evaluated based on the responses of the participants. Therefore, it is thought that participants may consciously or unconsciously deny their anxiety, and the reliability of the scales is generally questionable [25]. In addition to anxiety scales, dental anxiety can also be evaluated by measuring physiological changes (electrodermal activity, heart rate, blood pressure change, etc.) that occur in the organism due to sympathetic nervous system activation [2]. In the electrodermal activity measurement method, electrical changes caused by a small amount of fluid secreted from epidermal sweat glands are utilised. Furthermore, electrodermal activity (GSR) measurements were used as an indicator of stress levels originating from dental anxiety during the treatment process. GSR measurements are an objective value, and as such, they do not depend on patient responses and do not necessarily have the good reliability of anxiety scales [2]. Benjamins et al. [26], in their study examining the relationship between anxiety scales and electrodermal activity in dental anxiety, found that skin conductance levels produced different and reproducible responses both at the beginning and because of stimuli causing anxiety. Caprara et al. [27], similar to this result, found a significant relationship between electrodermal activity and dental anxiety. Morse [28] concluded that electrodermal activity and heart rate assessments were successful in reflecting stress levels related to dental treatments. Storm et al. [29] suggested the use of the electrodermal activity method to monitor stress levels during treatment (especially anaesthesia administration) in patients undergoing medical surgical procedures. In the light of all this information, in this study in which the impact of video information was evaluated, it was preferred to use the electrodermal activity measurement method during the treatment stages. Several studies have shown that electrodermal activity is successful in reflecting the change in the stress level [14, 29, 30] but there are few studies in which the level of dental anxiety is determined

TABLE 3 | Evaluation of anxiety scale scores and sociodemographic variables of the patients.

		Pre-MDAS	Pre–STAI-S	Pre–STAI-T	Pre-VAS
Age[a]	18–34	0.183	0.055	0.175	**0.010***
	35–49				
	50–65				
Gender[b]	Female	**0.008***	**0.010***	0.052	**0.003***
	Male				
Education level[a]	Literate	0.505	0.319	**0.024***	0.720
	Primary school				
	Secondary school				
	High school				
	Master degree and above				
Address[a]	Villages	**0.028***	0.137	0.069	**0.017***
	Districts				
	Big Cities				
Health assurance[a]	None	0.974	0.674	0.388	0.854
	Government Sponsored Private				
Employment status[b]	Yes	0.906	0.846	0.967	0.741
	No				
Monthly income[a]	< 1000 TL	0.102	0.405	0.338	0.243
	1000–2500 TL				
	2501–5000 TL				
	> 5000 TL				
Living with family members with dental phobia[a]	Absence	**0.013***	**0.013***	0.883	**0.000***
	Presence				
Traumatic dental treatment experience[b]	Yes	0.412	0.651	0.514	0.459
	No				
Endodontic treatment presence[a]	1–2 Times	0.186	0.345	0.947	0.325
	3–4 Times				
	No				
Last dental clinic visit[a]	0–6 months ago	0.417	0.092	0.710	0.640
	7–12 months ago				
	13–24 months ago				
	> 24 months				
Companion presence[b]	Yes	0.307	0.336	0.291	0.369
	No				
Watching root canal treatment video[b]	Yes	0.301	0.771	0.231	0.506
	No				

Note: Bold values indicate that they show a significant difference according to the statistical test.
[a]One-way ANOVA test.
[b]Indepedent samples *t*-test *$p < 0.05$.

TABLE 4 | Comparison of the pretreatment and posttreatment anxiety scale scores of the groups.

	Before treatment (mean score ± SD)	After treatment (mean score ± SD)	*p*
Video group			
MDAS	8.90 ± 4.75	6.83 ± 2.72	**0.001***
STAI – S	34.30 ± 11.24	28.40 ± 7.88	**0.002***
VAS	20.00 ± 24.64	7.67 ± 14.96	**0.010***
Control group			
MDAS	8.93 ± 4.14	6.57 ± 2.10	**0.000***
STAI – S	35.47 ± 10.88	28.53 ± 8.52	**0.002***
VAS	27.83 ± 28.55	12.33 ± 22.19	**0.011***

Note: Bold values indicate that they show a significant difference according to the statistical test. Paired samples *t*-test $*p < 0.05$.

by using this measurement method in endodontic treatments [24, 31]. Therefore, this study is pioneering in evaluating the effect of VVI on the anxiety level in patients undergoing endodontic treatment by virtue of its combination of subjective (anxiety scales) and objective measurements (electrodermal activity).

Dental anxiety tends to be higher in young patients than in older patients [16, 32, 33], although some studies show no significant difference [21]. It is thought that this situation may be because individuals go through different mental and emotional periods, the sociocultural life changes, and dental anxiety becomes less prioritised because of the emergence of other health problems [34, 35]. In our study, the patients in the "18–34 age group" had significantly higher anxiety than the patients in the "50–65 age group" according to mean VAS scores only, with no significant difference between the age groups according to the other scales (MDAS, STAI-S, STAI-T). This lack of significance in the relationship between age and dental anxiety is consistent with other studies conducted in Turkey, and the difference in sample size may be related to the small number of patients with high anxiety levels.

TABLE 5 | Comparison of pretreatment and posttreatment anxiety scale scores between groups.

MDAS	Video group	0.710
	Control group	
STAI-S	Video group	0.698
	Control group	
VAS	Video group	0.663
	Control group	

Note: Repeated-measures ANOVA test $p < 0.05$.

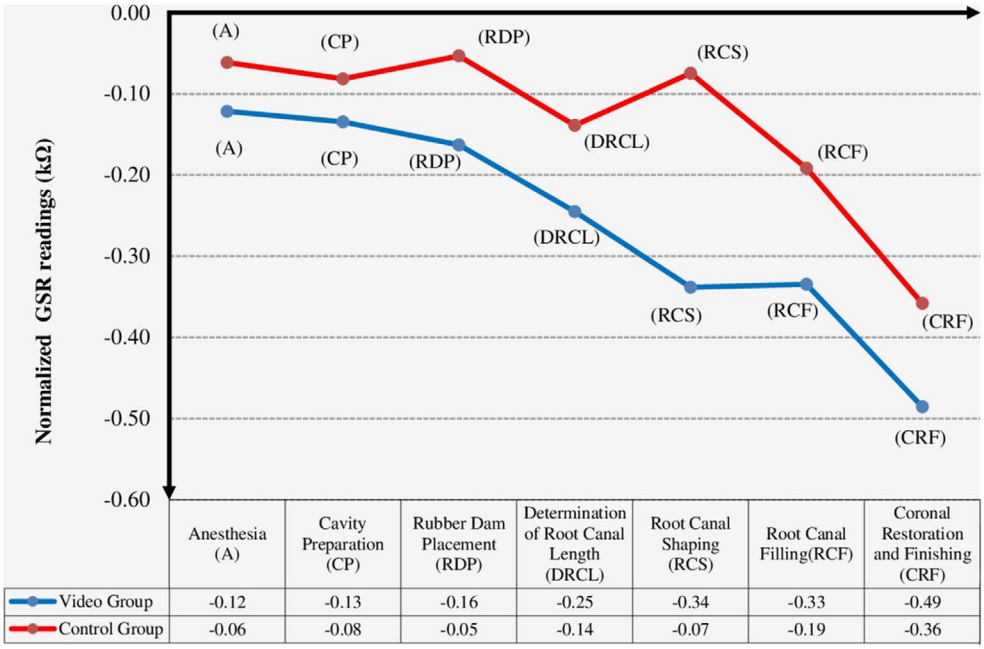

FIGURE 2 | Comparison graph of GSR readings of endodontic treatment steps between groups.

TABLE 6 | Evaluation of the relationship between the 'Coronal Restoration-Finishing' step and other steps.

		Mean difference	Standard error	*p*
Coronal restoration and finishing	Anaesthesia	−0.330	0.097	**0.026***
	Cavity preparation	−0.314	0.83	**0.009***
	Rubber dam placement	−0.314	0.081	**0.007***
	Determination of root canal length	−0.230	0.074	0.061
	Root canal shaping	−0.215	0.061	**0.020***
	Root canal filling	−0.159	0.040	**0.005***

Note: Bold values indicate that they show a significant difference according to the statistical test. Post hoc Bonferroni test *$p < 0.05$.

TABLE 7 | Results of satisfaction and feedback form by groups.

		Video group		Control group		Total	
		n	%	*n*	%	*n*	%
Did you worry about the GSR device worn on your wrist?	Yes	5	16.7	5	16.7	10	16.7
	No	25	83.3	25	83.3	50	83.3
How did the video you watched affected your anxiety?	Increased	4	13.3			4	13.3
	Decreased	9	30			9	30
	No differed	17	56.7			17	56.7
Was the information provided in the video you watched sufficient?	Yes	30	100			30	100
	No	0	0			0	0
Would you like the information to be given before treatment next time to be like this?	Yes	23	76.7			23	76.7
	No	7	23.3			7	23.3

Most studies conducted in Turkish society and worldwide have concluded that women have higher dental anxiety than men [16, 36]. This situation was explained by the difference in general anxiety level between the genders; women have a lower pain threshold and less tolerance to stimuli that cause fear and anxiety [37] and express their emotions more comfortably, while men tend to express fear as anger and impatience [38]. Muğlalı and Kömerik [39] suggested that men may not want to express their anxiety due to cultural prejudices, such as being more resilient and fearless in Turkish society. Similar to the literature, the current study concluded that the MDAS, STAI-S and VAS averages were higher in women than in men.

According to the MDAS and VAS scores applied before treatment, our study findings indicated a significantly higher dental anxiety in patients living in the city than in the district. This result contradicts those of Marakoğlu et al. [40] and Ragnarsson [41] but parallels the results of Stouthard and Hoogstraten [42]. Almost all of the patients in the present study resided near Aydın city. The reason our results differ from some reports [40, 41] may be that Aydin city has a more dominant population of rural origin compared to other metropolitan cities, metropolitan life does not differ from surrounding districts, and the sample size is different from other studies.

One of the most important indicators of high dental anxiety is that patients show avoidance behaviour and visit dental clinics only when urgent treatment is required. Past traumatic experiences in endodontic treatments are the most common cause of dental anxiety [43]. In the present study, it was found that the presence of traumatic dental treatment, the difference in the last dentist visit date and previous endodontic treatment experience did not cause a significant difference in the mean MDAS scores of the patients. This result may be due to the low number of patients receiving traumatic treatment in the study ($n = 6$, 10%) and the low anxiety of all patients, as indicated by the low anxiety questionnaire scores. Furthermore, it is known that the behaviour of avoiding dental treatments in Turkey is due to the difficulty of accessing dental treatment services, besides dental anxiety.

Dental anxiety is learned from the social environment (e.g., relatives, friends, or social media) and by directly witnessing the negative attitudes of relatives with dental phobic members in the family [4, 43, 44]. In our study, the mean MDAS, STAI-S and VAS scores of patients with dental phobic family members were significantly higher compared to those not living with family members with dental phobia. In light of these collective findings, the null hypothesis that patients' sociodemographic

characteristics and dental treatment habits will not affect pretreatment dental anxiety levels was rejected.

The pretreatment anxiety scale scores of all patients in our study were significantly reduced after endodontic treatment, regardless of the groups. Concurrently, the GSR readings' curve showed a decreasing trend throughout the endodontic treatment. These findings were similar to several previous studies that show blood pressure [7], heart rate [23], electrodermal activity [24], cortisol levels [45] and anxiety scale scores [46] decrease in patients after endodontic treatment.

No significant difference was found when the anxiety score means of the video and control groups were compared over time. Moreover, all GSR readings of the root canal treatment steps were comparable between the groups. At this point, the null hypothesis that VVI would not cause changes in the patients' anxiety scale score means and GSR readings during treatment was confirmed. Previous studies showed that VVI before treatment significantly increased [47], decreased [18] or did not change [48] the anxiety levels of patients. This inconsistency is thought to be due to the low sample size, different treatment procedures, the various multimedia forms and the lack of standard anxiety measurement tools.

In studies investigating the specific conditions that cause the most anxiety in endodontic treatments, anaesthesia application and the use of drills were at the top of the lists [21, 24, 36]. In the statistical evaluations performed on all patients in the current study, the GSR reading in the coronal restoration and finishing step was significantly lower than all other GSR readings, except for that in the root canal length step. Perhaps it was because of the feeling of relief that the patients felt close to the end of the treatment, the decrease in the expectation of pain and the unpredictability of the treatment.

This study has some limitations. Analysis of the GSR readings of 50 patients undergoing endodontic treatment could not be performed due to the lead plaques in the X-ray room, and 10 patients dropped out of the study. Therefore, this study was completed on 60 patients of the 120 patients included. Our research is a clinical study, and the data collection phase was completed within the scope of the measures taken by our faculty in response to the COVID-19 epidemic. In addition, our study was performed by randomising only patients at the university hospital; therefore, our results did not reflect the sociodemographic characteristics of the patients who applied to multiple different centres. In order to reflect the clinical conditions, the control group patients received routine information verbally in the study. However, the lack of an extra group such as a sham video with general content may be considered a lack of balanced control intervention. This is one of the limitations of the study and should be supported by future studies. Although controlled randomisation was performed in the selection of patients, our study was performed by a single experienced physician. The lack of blinding may have led to performance and detection biases.

In previous studies [49, 50], environmental variables such as temperature, humidity and emotional stress were found to affect the measurements on GSR devices. Since it was not possible to standardise the patients' emotional stress level and environmental variables such as temperature and humidity in this study design, and considering the data preprocessing and artefact removal procedures, we believe that it is not possible to achieve complete standardisation in the measurements made with GSR, and this is one of the important limitations of our study. The STAI-T, representing trait anxiety, was measured only at baseline, which is methodologically appropriate, but the potential effect over time due to exposure to the intervention should not be ignored as a limitation of this study. Furthermore, our patients were not consulted by an expert psychologist/psychiatrist to define the complex aetiology of anxiety and to evaluate its psychopathological features, and the description of psychological and mental health exclusion lacks specificity (e.g., DSM-5-based scales), so this is one of the limitations of this study. We also recommend that future studies about this issue use standardised diagnostic criteria or screening tools specificity (e.g., DSM-5 based scales) to define psychological conditions more rigorously.

5 | Conclusion

We conclude that providing VVI to patients did not cause a significant difference in anxiety scores and GSR readings during endodontic treatment compared to the patients who received routine information verbally. However, approximately 76.7% of the patients are satisfied with the type of information, and all of them find it sufficient. Based on this high satisfaction rate, VVI, which stands out because of its visual advantages, can be recommended to patients as an alternative to written or verbal information types. It was noteworthy to find similar results between the anxiety scales and electrodermal activity methods used as anxiety assessment methods in our study. It suggests that electrodermal activity is a useful method for the verification of anxiety scales. Due to the limited number of clinical studies evaluating endodontic treatment and dental anxiety in the literature, it will be beneficial to support our findings with prospective clinical studies with relatively larger sample sizes using culturally adapted anxiety measurement methods.

Author Contributions

Corresponding author Associate Professor Hicran Dönmez Özkan, DDS, PhD was the principal investigator of the study. She organised the study, worked with the department of statistics and wrote the manuscript. Expert in Endodontics Şule Anatürk, DDS performed patient care, recorded data and wrote the manuscript. Expert in Endodontics İlkim Pınar Saral, DDS assisted in developing ideas, plotting figures, and writing of the manuscript. Assistant Professor Tuna Çakar, PhD assisted in the use of Shimmer GSR and explained the readings of this device.

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Ethics Statement

The study was approved by our university's Clinical Research Ethics Committee (Protocol ADUDHF 2019/071). All participants were first informed about the study design and clinical treatment procedures with risks and signed a written informed consent form.

Consent

Informed consent (including for publication) was obtained from all individual participants included in the study.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The datasets used and/or analysed during the current investigation are available from the corresponding author upon reasonable request.

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