

Efficacy of Audiovisual Distraction in the Reduction of  
Dental Anxiety During Endodontic Treatment

University of Michigan Graduate Endodontics  
Vincent M DeNitto, DMD

Committee Members

G. Rex Holland, BSc, BDS, PhD (Chair)

Patricia Bauer, DDS, MS

Mathilde Peters, DMD, PhD

Joseph Himle, PhD

Thomas Braun, PhD

## **Introduction**

Anxiety is a common reason many patients give for not visiting a dentist. Anxiety can arise as a conditioned response to a previous painful or traumatic experience with a dentist or can result from negative beliefs and perceptions of dental situations rendering patients particularly sensitive to the reception and communication they receive from dental staff and to the outcome of dental treatment (1). During a dental visit, many patients will normally experience some type of tension or fear, with some patients experiencing moderate to severe anxiety. In the United States alone, it has been estimated that approximately 80% of the population has some anxiety about dental treatment and that 5 to 14% have an extreme degree of dental treatment anxiety (2). Several studies support the hypothesis that pain or fear of pain is a primary source of this anxiety, as well as being a major obstacle to seeking dental care (3). Anxious patients feel more pain during injections of local anesthesia and of longer duration than less anxious patients (4).

No current data exists regarding the prevalence of root canal treatment. However it is estimated that the majority of adults undergo one or more root canal treatments during their lifetime (8). Root canal treatment is a well-accepted and beneficial treatment for diseases of the dental pulp. Anxiety in patients undergoing root canal treatment, as in most patients undergoing invasive medical procedures, may be due to concerns about the physical discomfort caused by the procedure itself. A 1991 study by Wong and Lytle showed that root canal therapy and oral surgery were found to be the most anxiety provoking treatments (5). Thirty-five

percent of participants in the study stated that they had heard that root canal therapy was the most unpleasant dental procedure whereas 29% stated oral surgery treatment had the worst reputation. However, 53% of patients actually experiencing oral surgery treatment stated that an oral surgery procedure was the most unpleasant treatment whereas only 17% of patients experiencing root canal therapy stated the same.

Great advancements have been made in the treatment of dental anxiety, including the use of oral medications, nitrous oxide, and music distraction (8). Unfortunately, not all therapies are fully effective and not all patients respond equally to all therapies. This study will test a new treatment modality for the reduction of endodontic related dental anxiety. The aim of the study is to determine if an audiovisual device worn during endodontic therapy can reduce the pre-treatment anxiety felt by a patient. If successful, this finding could alter the way that endodontic associated anxiety is managed and may allow more people with high anxiety to finally visit a dentist in peace. We also decided to examine if there was any correlation between dental knowledge and changes in dental anxiety. If it is shown that patients with a greater dental knowledge tend to have a larger decrease in their dental anxiety, then a case may be made for providing patients with more information regarding their procedure before treatment. This can be accomplished by having patients watch an informative movie about the procedure or by utilizing modern technology such as the Apple iPad to help better educate them.

## **Literature Review/Rationale**

### **Causes of Dental Anxiety**

The reason for the development of dental-related anxiety is still yet to be determined. However, three main aspects have been suggested: (i) direct conditioning to aversive encounters in the dental office, (ii) vicarious learning, through role models, such as family, peers and society, and (iii) psychodynamic and personality aspects, i.e. specific traits that when present, increase the patient's proneness for apprehension in the dental setting (12).

A 1954 study by Shoben and Borland (11), sought to prove an etiology behind dental fear. Transcripts of interviews conducted with 15 self-reported fearful patients and 15 non-fearful patients were scored for presence or absence of 11 factors, 5 of which were broad personality dispositions. Fearful and non-fearful groups did not differ in the frequency of scored high anxiety, trouble with authority figures, emphasis on appearance, emphasis on orality, or dependency. In fact, the two patient groups differed in only 2 of the 11 factors: fearful patients more frequently reported a history of traumatic dental experiences (direct conditioning) and more frequently noted unfavorable attitudes toward dentistry among family members (vicarious learning).

### **Methods of Measuring Dental Anxiety**

There are a wide range of methodological approaches and techniques currently available to study behavior and attitudes relevant to health, illness and health care including, fear of dentists, dentistry and dental pain. This includes a variety of methodological approaches and techniques, especially through the use of

questionnaires and behavioral measures. Some of the many subjective methods used for measuring dental anxiety include the Corah dental anxiety scale (13) the Spielberger state-trait anxiety inventory (15), the visual analog scale (18,19), and the Kleinknecht dental fear survey (26).

Unlike subjective measures, which rely on patients to provide an answer, objective measures allow an investigator to collect data without the possibility of bias. Objective measures include blood pressure, pulse rate, pulse oximetry, finger temperature, and galvanic skin response.

### **Subjective Methods**

In 1969, Dr. Norman Corah developed a questionnaire to measure the relative anxiety of dental patients (13). Today, the Corah Dental Anxiety Scale (DAS) is one of the most widely used psychometric instruments for the measurement of dental fear. The scale contains four multiple-choice items dealing with the patient's subjective reactions about going to the dentist, waiting in the dentist's office for the procedure, and anticipation of drilling and scaling. Points are assigned for the patients' choices, with points ranging from one to five points. Total scores range from 4 to 20, with 13 and above regarded as dentally anxious. The DAS has undergone numerous tests to confirm its validity. In a 1978 study, Dr. Corah himself demonstrated the DAS to be a reliable, valid, and useful measure of dental anxiety (14). More recently, the ability of the DAS to distinguish between fearful and regular Norwegian dental patients was assessed (15). The results showed that 90% of the fearful patients and 85% of the regular patients were correctly assigned to the appropriate groups. It was thus concluded that when used on a Norwegian

population, the DAS is a valid instrument for distinguishing fearful patients among those regularly attending for dental treatment.

The Spielberger State-Trait Anxiety Inventory (STAI) distinguishes between anxiety as a general aspect of personality (trait anxiety) and anxiety as a response to a specific situation (state anxiety). The questionnaire contains 20 items for which the individual rates how they generally feel. The score ranges from 20 to 80.

According to a Brazilian validation study (16), subjects were considered to have high or low trait anxiety if their scores were greater than 49 or less than 33, respectively. A 2009 study by Fuentes and others (17), investigated a relationship between dental anxiety and trait anxiety. It was found that patients with high dental anxiety tended to present with high trait anxiety, but high trait anxiety seemed not to predispose to high dental anxiety. In the Norwegian study mentioned previously (15), distinguishing between fearful and regular Norwegian dental patients, the STAI was also evaluated. The results showed that 80% of the fearful patients and 79% of the regular patients were correctly assigned to the appropriate groups. The authors concluded that although not developed specifically for this purpose, the STAI might still be a valid measure used to distinguish between fearful and non-fearful patients.

A third way often used to measure dental anxiety is through the use of a Visual-Analog Scale. First described by Freyd almost ninety years ago (1923), the Visual-analog scale is a simple, self-administered measure for subjective phenomena. The Visual Analog Scale for Anxiety (VASA) is represented using a continuum with "not at all anxious" and "very anxious" at the left and right extremes respectively.

The following written instructions are included, "Please put a cross on the line shown below to indicate how you feel right now". A mark at the extreme left end would indicate that you are feeling not at all anxious. A mark at the extreme right end would indicate that you are feeling the most anxious you could ever imagine. A mark near the center would indicate that you feel moderately anxious. The VASA has been used in several studies to measure the degree of anxiety in both anxiety disorder patients and healthy control subjects (18,19). It has proven to be a valid method for the measurement of anxiety and is highly sensitive for change.

### **Objective methods**

Anxiety is often thought of as a direct causal relationship of high blood pressure but studies have not shown any long-term direct link between high blood pressure and anxiety (27). However, even though anxiety does not cause persistent high blood pressure, it can and often does cause temporary spikes in blood pressure. Although the high blood pressure is not persistent, these spikes do have the potential to severely damage a patient's vascular system (27).

An extremely accurate method used to measure dental anxiety is through the measurement of a galvanic skin response (20). As opposed to questionnaires, which rely on patients expected truthfulness, galvanic skin conductance is not reliant on a patient's veracity. Galvanic skin response takes advantage of the electrical changes induced by minute amounts of fluid from epidermal sweat glands released secondary to anxiety. Sweat on the skin provides a low-resistance pathway for electric current, which is then recorded. Several investigators have used psychophysiological measurements such as galvanic skin resistance (GSR), as used

in polygraph testing, to quantitate levels of anxiety in patients. The use of galvanic skin response has been validated as an accurate method in measuring dental anxiety. In a 2003 study by Caprara et al (20), galvanic skin conductance was used to objectively measure a patient's dental anxiety. The authors concluded that there was a statistically significant correlation found between skin conductance and dental anxiety in all cases.

### **Treatment Modalities for Dental Anxiety**

There have been a variety of approaches used in an attempt to relieve endodontic related anxiety or phobia. An often-used method involves the administration of an oral sedative to a patient prior to the appointment (9). The use of oral medication for management of anxiety is a convenient, inexpensive, and well-established technique for the management of mild anxiety. By far, the best class of drugs used for this purpose is the benzodiazepines. These drugs provide specific relief of anxiety without depressing cardiopulmonary function. They also have the fewest side effects when compared to other classes of sedatives (9).

Another method to relieve endodontic anxiety is the use of nitrous oxide. Nitrous oxide has been used for anesthesia in dentistry since December 1844, where Horace Wells made the first 12–15 dental operations with the gas in Hartford, CT (25). Its debut as a generally accepted method, however, came in 1863, when Gardner Quincy Colton introduced it more broadly at all the Colton Dental Association clinics, that he founded in New Haven and New York City (25). Although the exact mechanism of action is not fully understood, it is believed to be trifold and includes analgesia, anxiolysis, and anesthesia. As with oral sedatives, nitrous oxide is best



suited for patients with mild to moderate anxiety.

A third method that has been used to relieve endodontic anxiety is to provide patients about to undergo endodontic treatment with positive information relating to endodontic therapy. In a study by van Wijk & Hoogstraten(10), it was shown that fear of pain from endodontic treatment could be decreased significantly by providing positive information prior the treatment. The positive information given to the patient was about a previous study where people who experienced root canal treatment personally were 4 to 5 times more likely to describe the procedure as painless. This technique allows the patient to be more at ease before and during treatment, decrease avoidance behavior and make decisions regarding treatment choice, based on common sense rather than fearful expectations

Other therapies used in an attempt to relieve endodontic related anxiety include relaxation techniques and music distraction (6,7,8). Lai et al, showed that music distraction could decrease the procedure-related anxiety of patients undergoing endodontic treatment (8). However in a recent study by Lahmann et al, which looked at dental anxiety in general, relaxation exercises were shown to be more effective than music distraction in highly anxious patients (7). According to the study, one possible explanation for this phenomenon is that, to a certain extent, using relaxation exercises allows the patient to control his or her own perception of stress, thereby achieving reduced pain sensitivity. These factors do not apply to music distraction, which operates on a principle of overall distraction by masking fear-enhancing noises during treatment (7). Music distraction still proved to be beneficial in reducing state anxiety in comparison with no intervention, with its

greatest effect among subjects with moderate anxiety (7).

Recently a new approach has gained popularity to help relieve anxiety related to endodontics that incorporates a visual as well as an audio component (6).

Audiovisual distraction (A/V distraction) allows a patient to use two of their senses to help further their distraction potential. A recent study compared audio and audiovisual distraction techniques in managing anxious pediatric patients (6). In the study, children presenting for their first dental visits were separated into three groups: no treatment, listened to music through headphones, or watched television. The authors concluded that the audiovisual distraction technique was more effective in managing anxious pediatric patients as compared to the audio distraction technique and normal dental setup (no distraction techniques used).

Dental anxiety is an extremely common problem in the United States, affecting millions of Americans (28). More specifically, anxiety related to endodontic therapy can be especially debilitating (28). Treatment options such as nitrous oxide or benzodiazepine medications are tremendously effective for a large percentage of the population, but as a dental profession, we should always look to reduce our patients anxiety in a non-pharmacologic manner whenever possible. One option that has been shown to be a reliable alternative to pharmacologic methods is music distraction (8). Another non-pharmacologic alternative used in treating anxiety is through the use of an audiovisual distraction device. This method has been already been shown to be extremely effective in pediatric patients, but has yet to be tested in the treatment of endodontic-related dental anxiety. The objective of this study is to investigate 1. If endodontic related dental anxiety can be reduced by the use of an

audiovisual device worn by the patient during treatment and 2. If an increased dental knowledge has any influence on this reduction. We hypothesized that there would be a greater anxiety reduction in the audiovisual group versus the control group and that a higher dental knowledge would also lead to reduced anxiety levels.

## **II. Materials and Methods**

The study was designed as a prospective, randomized, single-blinded controlled trial and had the approval of the University of Michigan Institutional Review Board.

A total of 60 patients requiring endodontic therapy were recruited for this study. All work was completed in the Graduate Endodontic Clinic at the University of Michigan School of Dentistry. Patients had to be above the age of 18, free of any systemic health problems preventing them from undergoing endodontic treatment, and had self-reported anxiety about root canal treatment. Exclusion criteria were: patients already taking anti-anxiety or psychotropic medications, patients with any visual or auditory deficits, and patients who could not communicate efficiently due to illiteracy or language barriers (non-English speaking patients).

Patients referred to the Graduate Endodontic Clinic were contacted prior to scheduling their appointment and informed about a research project ongoing in the clinic concerning patients who are anxious about undergoing endodontic therapy. Treatment was explained in simple terms. If after this dialogue the patient agreed to participate in the study, they were enrolled. Patients were scheduled for full half-day blocks of time, to ensure adequate time to perform all required treatment and data collection.

New patients were instructed to arrive early to complete any necessary paperwork. After being seated, all patients underwent a thorough review of their medical history as well as an endodontic examination. This consisted of any radiographs required, as well as intra and extra oral examinations. Once the need

for endodontic therapy was confirmed, consent forms to perform a root canal and consent to participate in the research project were explained and then signed by the patient. Upon signing the research consent form, a copy of the form was given to the patient to take home. Patients were then anesthetized and while waiting for the anesthesia to take effect, the patient was asked to complete a questionnaire administered on an iPad (Apple; Cupertino, CA, USA) using Qualtrics online survey software ([www.qualtrics.com](http://www.qualtrics.com)).

The administered questionnaire consisted of three parts. The first was the Corah Dental Anxiety Scale (Appendix A) (13). The scale contains four multiple-choice items dealing with the patient's subjective reactions about going to the dentist, waiting in the dentist's office for the procedure, and anticipation of drilling and scaling. Points were assigned for the patients' choices, with points ranging from one to five points. Total scores ranged from 4 to 20 with 13 and above regarded as dentally anxious. The second portion of the questionnaire was the Dental Knowledge Questionnaire (Appendix B) (21). This questionnaire consists of 15 questions regarding general dental knowledge, with subscales of teeth and gums, root canal procedures, and fear of dental pain. The last part of the questionnaire given to the patient was Appendix C. This portion of the questionnaire was created by the investigator in an attempt to identify the influences of patients' anxiety. Patients were asked to consider various influences, such as family, friends/acquaintances, media and previous traumatic dental experiences, and score them independently on a scale from 0 to 10 (0 = no influence, 10 = highly influential).

Upon completion of the questionnaires, the tooth undergoing root canal therapy was tested to check its level of anesthesia. This was done through the use of a refrigerant spray (Hygenic Endolce, Coltene/Whaledent; Switzerland) placed on a cotton pellet. The pellet was then placed on the tooth and if a sharp sensation was not felt, the patient was determined to be adequately anesthetized. After rubber dam isolation, the video eyewear (Vuzix Wrap 310XL; Vuzix Corporation, Rochester, NY, USA) was placed on the patient and attached to the previously mentioned iPad. A wireless pulse oximeter (OxiPulse, Phoenix, AZ), which measured the patients blood oxygen saturation and pulse rate, was then placed on the patients' index finger, monitored, and recorded every fifteen minutes throughout the root canal procedure.

Before the root canal procedure began, the patient was assigned by a dental assistant, through the use of a randomization sheet, into either an intervention group, in which a relaxation movie (*Solemnity*, Cedar Lake DVD, Milwaukee, WI) was watched and listened to by the patient throughout the root canal procedure, or a control group, in which nothing was turned on and the video eyewear remained blank. The randomization sheet was created by one of the study team members (TB) and the primary investigator was blinded until after the data collection had been completed. This ensured the primary investigator remained unbiased throughout the data collection phase, as all patients appeared the same with the eyewear present.

Immediately before the start of the root canal, the patient was asked to assign a number to the level of anxiety they were feeling. The range of anxiety levels given

was from 0-10, with 0 being no anxiety and 10 being maximum anxiety. The patient then underwent the endodontic procedure scheduled. Every fifteen minutes the patient was asked to reassess their anxiety level and again assign it to a score from 0-10. Data was collected for a total of 90 minutes (six readings).

Upon completion of the endodontic treatment, the video eyewear and pulse oximeter were removed and the Modified Corah Dental Anxiety Scale was re-administered. The patient was instructed to answer the questionnaire as if they were going to have another root canal tomorrow and would have the same anxiety reducing intervention they had just received (video or nothing). The difference between the first scale and the second scale was analyzed.

A paired *t*-test was used to assess the significance of changes over time in each treatment group, while a two-sample *t*-test was used to directly compare differences between the audiovisual and the control groups. A Pearson's correlation was used to determine if there was any correlation between changes in anxiety and dental knowledge. P-values < .05 were considered significant.

### **III. Results:**

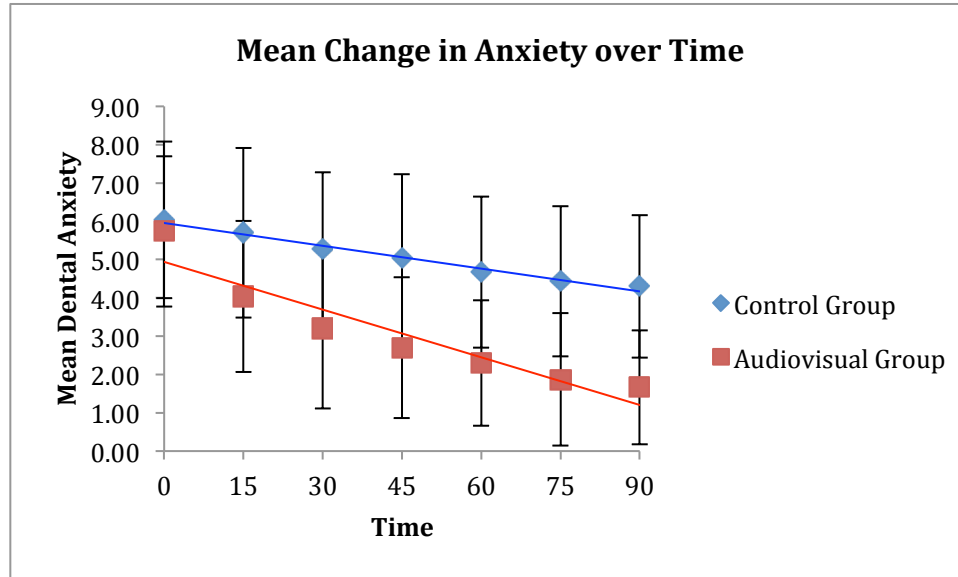
#### **Demographics**

We randomly assigned 60 subjects into one of two groups, audiovisual or control (Table 1). In the audiovisual group, 19 subjects were female and 11 were male, while in the control group, 17 subjects were female and 13 were male. When looked at by age, the audiovisual group had 8 subjects between 18 – 30 years old, 9 between 31 – 50, 9 between 51 – 70 and 4 above the age of 70. The control group had 5 subjects between 18 – 30, 11 between 31 – 50, 11 between age 51 – 70, and 3 above the age of 70. As for race, 26 of the audiovisual subjects were Caucasian, 3 were African-American, and 1 classified as “other”. The control group had 24 Caucasian subjects, 5 African-American subjects, and 1 classified as “other”.

#### **Mean Changes in Anxiety between Groups**

Graph 1 and Table 2 summarize the mean changes in anxiety between the two treatment groups over 90 minutes. The mean reported pre-operative anxiety score for the audiovisual group was 5.73 ( $\pm 1.96$ ) and the control group was 6.03 ( $\pm 2.04$ ). The difference between these scores was not significant ( $P > 0.05$ ). The mean reported post-operative anxiety score for the audiovisual group was 1.67 ( $\pm 1.49$ ), while the control group was 4.30 ( $\pm 1.86$ ). This difference was significant ( $P < 0.001$ ). The mean change from pre-operative to post-operative anxiety score for the audiovisual group was 4.07 ( $\pm 1.75$ ) and the control group was 1.73 ( $\pm 1.75$ ). This difference was significant ( $P < 0.001$ ).





**Graph 1.** Mean Change in Anxiety over Time (with standard deviations)

### Change in Dental Anxiety based on Gender

When mean change in dental anxiety was examined based on gender differences, female patients showed an apparent larger decrease in their dental anxiety than male patients (Table 3). Female patients in the audiovisual group showed a 4.32 ( $\pm 1.97$ ) point decrease from pre-operative to post-operative dental anxiety score. Male patients in the same group showed a 3.64 ( $\pm 1.64$ ) point decrease in their dental anxiety. This difference was not significant ( $P = 0.32$ ). Female patients in the control group showed a 2.24 ( $\pm 1.59$ ) point decrease in their dental anxiety from pre-operative to post-operative. Male patients in the same group showed only a 1.08 ( $\pm 1.86$ ) point decrease in their dental anxiety. This difference was also not significant ( $P = 0.073$ ).

### Mean Change in Pulse Oximetry and Pulse

The mean change in oxygen saturation from pre-operative to post-operative for patients in the audiovisual group was 0.24 ( $\pm 2.35$ ) (Table 4). The mean change in

the pulse oximetry for the control group was  $-0.30 (\pm 1.97)$ . When compared, no significant difference was found ( $P > 0.05$ )

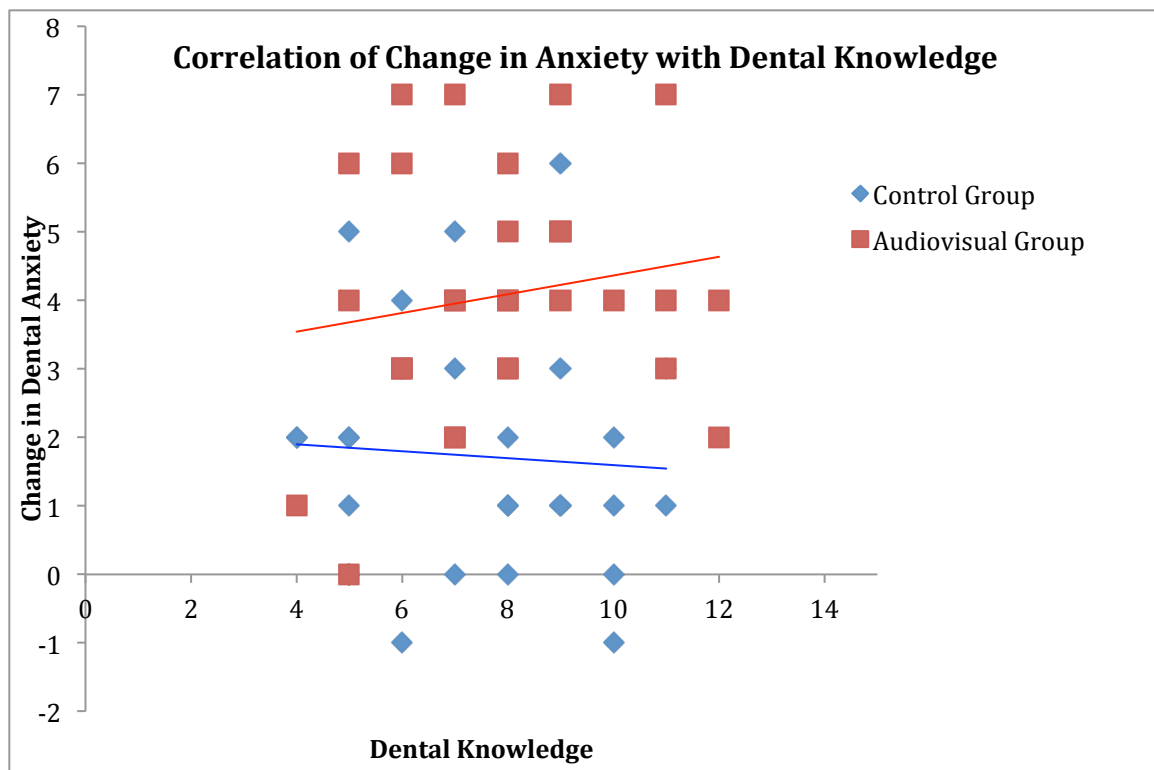
The mean change in pulse from pre-operative to post-operative for patients in the audiovisual group was  $2.66 (\pm 6.07)$ , while the control group exhibited a change of  $4.77 (\pm 6.40)$ . When compared, no significant difference was found ( $P > 0.05$ ).

### **Corah Dental Anxiety Scores**

Table 5 summarizes the mean total change from pre-operative to post-operative for the Corah Dental Anxiety scores. The mean pre-operative Corah Dental Anxiety score for the audiovisual group was  $12.5 (\pm 3.28)$  and the pre-operative Corah Dental Anxiety score for the control group was  $14.5 (\pm 2.73)$ . This difference was significant ( $P = 0.01$ ). The mean post-operative Corah Dental Anxiety score for the audiovisual group was  $8.5 (\pm 3.28)$ . The mean post-operative Corah Dental Anxiety score for the control group was  $11.5 (\pm 3.28)$ . The difference between the two post-operative scores was also considered different ( $P = 0.001$ ). The difference between the pre-operative and post-operative Corah Dental Anxiety scores for the audiovisual group was  $3.97 (\pm 2.84)$ . This difference was significant ( $P < 0.001$ ). The difference between the pre-operative and post-operative Corah Dental Anxiety scores for the control group was  $3.03 (\pm 3.12)$ . This difference was also considered significant ( $P < 0.001$ ). However, when these differences were compared ( $3.97$  vs.  $3.03$ ), no significance was found ( $P > 0.05$ ).

## Correlation between Change in Anxiety and Dental Knowledge

When change in dental anxiety was correlated with dental knowledge (Table 6), as scored from the Dental Knowledge Questionnaire, it was shown that there was an apparent positive correlation for patients in the audiovisual group, while for the control group there was an apparent negative to almost no correlation. This meant that patients in the audiovisual group with a higher dental IQ tended to have a greater decrease in their anxiety. The Pearson Correlation Coefficient for the audiovisual group was 0.16 ( $P = 0.39$ ) however this value was not significant. The Pearson Correlation Coefficient for the control group was -0.06 ( $P = 0.74$ ). This value is not significant. These results are summarized in Graph 2.



Graph 2. Correlation of Change in Anxiety with Dental Knowledge

## **Influences of Dental Anxiety**

The largest influence on dental anxiety was patients' previous traumatic dental experiences (Table 7). Subjects in the audiovisual group marked an average of 6.6 ( $\pm 2.19$ ) out of 10, while those in the control group marked an average of 6.4 ( $\pm 2.74$ ). The patients' family and friends/acquaintances were equally influential in causing patients anxiety. The audiovisual group had a mean familial influence of 3.5 ( $\pm 2.19$ ) and friends/acquaintances 3.4 ( $\pm 2.19$ ). The control group had a mean familial influence of 3.9 ( $\pm 3.28$ ), with friends/acquaintances at 4.0 ( $\pm 2.74$ ). The least influential factor in patients' anxiety was the media. The audiovisual group marked an average of 2.4 ( $\pm 2.19$ ) and the control group a 3.4 ( $\pm 2.19$ ).

#### **IV. Discussion:**

Personal video eyewear is a portable video entertainment system that has the potential of providing a relaxed environment during dental treatment. In contrast to traditional audiovisual programs that use a large television monitor above the patient's chair, this system includes a lightweight eyeglass system that has a built-in television monitor along with stereo earphones. Patients focus their attention on the relaxation video instead of anxiety-inducing dental equipment (syringe, drill, endodontic files, rubber dam) or noises. The music in the video coming through the earphones not only shields the drilling noise, but also, enhances the relaxation felt by the patient. It has been reported previously that such an audiovisual system is beneficial in the reduction of fear and pain for both adults and children undergoing dental prophylaxis and restorative procedures (22, 23).

Although similar studies have been performed, this is, to our knowledge, the first study that tests the use of video eyewear in the reduction dental anxiety on patients undergoing a root canal treatment. In 2008, Lai and colleagues (8) studied the effects of music on state anxiety in patients undergoing root canal therapy (state anxiety reflects a transitory emotional state or condition of the human organism that is characterized by subjective, consciously perceived feelings of tension and apprehension, and heightened autonomic nervous system activity (8)). Subjects in the music group listened to selected "sedative" music using headphones throughout the root canal treatment procedure, while patients in the control group wore headphones but without the music. The subjects' heart rate, blood pressure and finger temperature were measured prior to treatment and during treatment every

10 minutes until the end of the root canal treatment procedure. The results showed that the subjects in the music group had a significant increase in finger temperature and a decrease in anxiety score over time compared with the control group.

Prabhakar and colleagues conducted another similar study in 2007. In the study an audio only device was compared to an audiovisual device in reducing dental anxiety in pediatric patients. Sixty children were divided into 3 groups of twenty children apiece, with the first group acting as a control. The second group listened to music through the use of headphones while the third was shown an audiovisual presentation through a television throughout the entire visit. All children had their pulse and oxygen saturation measured throughout the procedure. The results showed that the audiovisual distraction technique was more effective in managing anxious pediatric dental patients as compared to the audio distraction technique and the normal dental setup (control). The results also indicated that there was a decrease in the oxygen saturation as the pulse rate increased, albeit not statistically significant.

In our study, audiovisual distraction did not have a favorable effect on pulse rate or pulse oximetry for the subjects undergoing root canal treatment. Patients in both groups tended to show pulse rates and oxygen saturation levels that did not vary significantly from pre-treatment to post-treatment. Thus, it is possible that personal video preference needs to be considered when selecting audiovisual intervention for subjects. However, doing so would have changed the focus of the trial to addressing what type of video is effective, rather than answering the more straightforward question of whether or not the use of a standardized audiovisual

device can assist in reduction of root canal treatment-related anxiety. The result however is not all that surprising, as a 2003 study by Bartfield et al (24) found that changes in heart rate did not correlate with pain and anxiety in patients undergoing IV placement.

There was also no significant difference in the mean reduction of dental anxiety when comparing the pre-treatment and post-treatment Corah Dental Anxiety scores ( $P > .05$ ). However, when comparing the pre-operative and post-operative scores given by the patient while undergoing the root canal therapy, the results showed that both groups had a decrease in anxiety over 90 minutes, with the audiovisual group having a significantly greater decrease than the control group ( $P < .001$ ). The most likely reason the self-reported anxiety scores significantly decreased over time, while the scores from the Corah Anxiety scale did not show a significant decrease from pre-operative to post-operative is because the self-reported anxiety scores are a real-time representation of what the patient is feeling at that very moment. This gives the most accurate score of dental anxiety. Patient's taking the Corah Dental Anxiety questionnaire must answer questions about how they would feel if they were placed into certain situations. Patients may tend to over or under value how they would feel because they were not actually in the moment. Patients may also forget what they had originally answered on the pre-operative Corah Dental Anxiety questionnaire and also over or under-score their post-operative questionnaire. Although our sample size was adequate, to completely eliminate this type of error, a larger sample size would be required.

Dental anxiety is a multidimensional complex phenomenon, and no one single

variable can exclusively account for its development (29). There are a number of factors that have consistently been linked with a greater incidence of dental anxiety, including: personality characteristics, fear of pain, past traumatic dental experiences, particularly in childhood (conditioning experiences), and the influence of dentally anxious family members or peers which elicit fear in a person (vicarious learning) (29). In our study the greatest factor influencing patients dental anxiety was found to be previous traumatic dental experiences with a mean rating of 6.47 ( $\pm 2.47$ ) out of 10. Family members and friends/acquaintances were equally influential in creating dental anxiety with scores of 3.72 ( $\pm 2.73$ ) and 3.68 ( $\pm 2.51$ ) out of ten, respectively. The least influential factor, as scored by the patients, was the media, receiving a 2.93 ( $\pm 2.20$ ) out of ten.

In our study, we attempted to find a correlation between dental knowledge and reductions in dental anxiety. To do this we used the Dental Knowledge Questionnaire (DKQ)(21). The mean number of correct answers for our total patient population was 7.55 ( $\pm 2.16$ ). The patients in the audiovisual group had slightly higher scores on the DKQ (7.83 vs. 7.27), however the difference was not significant ( $P > .05$ ). When compared to reduction in dental anxiety, an apparent positive trend was seen for the audiovisual group, indicating that patients with a higher dental knowledge who had the audiovisual intervention, tended to have a greater reduction in their dental anxiety. In contrast, the control group showed an apparent negative correlation, although neither of the correlations proved significant. Perhaps with a larger sample size, the difference between the two correlations would become significant.



## **Study Limitations**

It is important to note that the participants in this study self-reported their dental anxiety, with actual scores ranging from mild to severe. All patients were asked to complete a pre-treatment Corah Dental Anxiety Questionnaire, even though there was no specific score that was required to participate in the study. Had we only included patients who scored a 13 or above (indicating moderate anxiety), the study would have been further standardized.

Another issue that could be addressed in future studies is if patients should be allowed to choose the video they watch. Videos specifically designed for relaxation purposes should, in theory, work for everyone, but in reality don't. A few patients in the study commented after their treatment that they did not care for the video and would have liked the opportunity to choose the video they had watched. A follow-up study should be performed, allowing patients to choose from a selection of videos. Perhaps the results will be of greater magnitude, since the patient would choose a video they enjoyed watching, further adding to their relaxation and ultimately decrease in anxiety. The patient population would therefore have to be increased significantly to account for the extra variables.

Another caution with respect to the interpretation of this study is that blinding of the subjects was not practicable, which might potentially result in bias. Since patients knew which treatment group they were a part of, they may have rated their anxiety score with what they believed was correct (i.e. over-scoring anxiety reduction for patients in the audiovisual group or under-scoring anxiety reduction for patients in the control group) instead of what they actually felt.

## **V. Conclusions**

- Both the audiovisual and control groups showed a reduction in anxiety over 90 minutes with the audiovisual group showing a statistically greater reduction than the control group.
- There was an apparent positive correlation between dental knowledge and reduction in dental anxiety in the audiovisual group, while there was an apparent negative correlation in the control group. Neither statistic was statistically significant.
- Patients stated that previous traumatic dental experiences were the greatest influence in their dental anxiety. Familial influences, friends/acquaintances, and lastly the media followed this.
- Additional research involving larger groups is needed to confirm the results of this preliminary study.

## VI. Tables

Treatment Group	Gender		Age				Race		
	Male	Female	18-30	31-50	51-70	70+	Caucasian	African-American	“Other”
Audiovisual	11	19	8	9	9	4	26	3	1
Control	13	17	5	11	11	3	24	5	1

Table 1. Patient Demographics

Audiovisual Group				Control Group			
Time	Mean Anxiety Score	Standard Deviation	Change from Baseline	Time	Mean Anxiety Score	Standard Deviation	Change from Baseline
0	5.73	1.96	n/a	0	6.03	2.04	n/a
15	4.03	1.97	1.70	15	5.70	2.22	0.33
30	3.20	2.09	2.53	30	5.27	2.02	0.77
45	2.70	1.84	3.03	45	5.03	2.20	1.00
60	2.30	1.64	3.43	60	4.67	1.97	1.37
75	1.87	1.73	3.87	75	4.43	1.96	1.60
90	1.67	1.49	4.07	90	4.30	1.86	1.73

Table 2. Mean Change in Anxiety over 90 minutes

Treatment Group		Gender		p-value for difference
		Male	Female	
Audiovisual	Mean Change in Anxiety	3.64	4.32	0.324
	Standard Deviation	1.97	1.64	
Control	Mean Change in Anxiety	1.08	2.24	0.073
	Standard Deviation	1.86	1.59	

Table 3. Gender Differences in Change in Anxiety

Outcome		Treatment Group		p- value for difference
		Audiovisual	Control	
Change in Pulse Oximetry	Mean	0.24	-0.30	0.345
	Standard Deviation	2.35	1.97	
Change in Heart Rate	Mean	2.66	4.77	0.198
	Standard Deviation	6.07	6.40	

Table 4. Mean Change in Pulse Oximetry and Heart Rate

Outcome	Time point	Treatment Group			
		Audiovisual		Control	
		Mean Score	Standard Dev.	Mean Score	Standard Dev.
Corah Anxiety Question 1	Pre-treatment	3.4	0.55	3.9	0.55
	Post-treatment	2.5	1.09	3.1	1.09
Corah Anxiety Question 2	Pre-treatment	2.8	1.09	3.7	1.09
	Post-treatment	2.0	1.09	2.9	1.09
Corah Anxiety Question 3	Pre-treatment	3.4	1.09	3.8	1.09
	Post-treatment	2.1	1.09	3.1	1.09
Corah Anxiety Question 4	Pre-treatment	2.9	1.09	3.2	1.09
	Post-treatment	1.9	0.55	2.5	1.09
Corah Anxiety Total	Pre-treatment	12.5	3.28	14.5	2.74
	Post-treatment	8.5	3.28	11.5	3.28

Table 5. Corah Dental Anxiety Scores

Treatment Group	Pearson Correlation Coefficient	p-value
Audiovisual	0.16	0.39
Control	-0.06	0.74

Table 6. Correlation of Change in Anxiety with Dental Knowledge

Anxiety Influence Question #	Treatment Group			
	Audiovisual		Control	
	Mean	Standard Dev.	Mean	Standard Dev.
Q1	3.5	2.19	3.9	3.28
Q2	3.4	2.19	4.0	2.74
Q3	2.4	2.19	3.4	2.19
Q4	6.6	2.19	6.4	2.74

Table 7. Influences of Anxiety

## VII. Figures



Figure. 1. Subject undergoing Root Canal while wearing video eyewear



Figure 2. Video Eyewear

## VIII. Appendices

### Appendix A

#### Corah Dental Anxiety Scale

1. If you had to go to the dentist tomorrow, how would you feel about it?
  - a) I would look forward to it as a reasonably enjoyable experience.
  - b) I wouldn't care one way or the other.
  - c) I would be a little uneasy about it.
  - d) I would be afraid that it would be unpleasant and painful.
  - e) I would be very frightened of what the dentist might do.
  
2. When you are waiting in the dentist's office for your turn in the chair, how do you feel?
  - a) Relaxed.
  - b) A little uneasy.
  - c) Tense.
  - d) Anxious.
  - e) So anxious that I sometimes break out in a sweat or almost feel physically sick.
  
3. When you are in the dentist's chair waiting while he gets his drill ready to begin working on your teeth, how do you feel?
  - a) Relaxed.
  - b) A little uneasy.
  - c) Tense.
  - d) Anxious.
  - e) So anxious that I sometimes break out in a sweat or almost feel physically sick.
  
4. You are in the endodontist's chair to have your root canal. While you are waiting and the dentist is getting out the instruments, which he will use to perform the root canal, how do you feel?
  - a) Relaxed.
  - b) A little uneasy.
  - c) Tense.
  - d) Anxious.
  - e) So anxious that I sometimes break out in a sweat or almost feel physically sick.

\*\*\*Points are assigned for the subject's (S's) choices, with one point for an (a) choice to five points for an (e) choice. Total scores ranged from 4 to 20. (13 and above is regarded as dentally anxious)\*\*\*

## Appendix B

### Dental Knowledge Questionnaire

1. What is an ideal angle to hold your toothbrush when brushing your teeth?
  - a) About a 90 degree angle
  - b) About a 45 degree angle**
  - c) About a 25 degree angle
  - d) About a 65 degree angle
  
2. Root canal treatment is successful about what percent of the time?
  - a) 85%
  - b) 90%**
  - c) 95%
  - d) 98%
  
3. What is one reason that dentists refer patients for root canal treatment?
  - a) The root of a tooth has become diseased and needs to be replaced with an implant.
  - b) The root of the tooth has become decayed and needs to be removed and replaced with a filling.
  - c) There is inflamed tissue and/or an infection inside a tooth that needs treatment.**
  - d) A cavity inside a tooth needs to be treated.
  
4. What sensations are most people likely to experience when anesthetic is administered during root canal treatment?
  - a) Sharp or stabbing
  - b) Pinching or pressing**
  - c) Flashing or throbbing
  - d) Penetrating or piercing
  
5. How long does it usually take for the anesthesia used in root canal therapy to begin working?
  - a) Immediately
  - b) Within 10 minutes
  - c) Within 5 minutes**
  - d) Within 15 minutes

6. What is the final step in good tooth brushing technique?
- a) **Brush your tongue**
  - b) Brush the inside portions of your cheeks
  - c) Brush your gums
  - d) Brush your teeth again with fresh toothpaste
7. How long does it take to complete root canal treatment?
- a) 2-4 appointments
  - b) **1-3 appointments**
  - c) 3-5 appointments
  - d) Only 1 appointment
8. When you first start flossing every day, how long should you expect your gums to be sore?
- a) **For the first 5 days**
  - b) For the first 10 days
  - c) For the first 2 days
  - d) For the first 7 days
9. When is the most discomfort typically experienced during root canal treatment?
- a) **Before treatment even begins**
  - b) When the infected pulp is removed
  - c) During the administration of anesthesia
  - d) During drilling the infected tooth
10. What total length of dental floss should you first pull out when flossing?
- a) About 24 inches
  - b) About 10 inches
  - c) About 14 inches
  - d) **About 18 inches**
11. What is the material called deep inside teeth that contains blood vessels, nerves, and lymphatic vessels?
- a) Enamel
  - b) Dentin
  - c) Gingiva
  - d) **Pulp**



12. Where is numbness present once the anesthesia used for root canal therapy has been administered?

- a) Immediately surrounding the infected tooth
- b) Within the pulp of the infected tooth
- c) In the tissue surrounding the infected tooth
- d) In the tissue and teeth surrounding the infected tooth**

13. What sensations might you experience during root canal treatment?

- a) Scraping
- b) Pulling
- c) Probing
- d) Vibration**

14. How often should you replace your toothbrush?

- a) Every month
- b) Every 2 months
- c) Every 3-4 months**
- d) Every 5-6 months

15. What should you do if you experience post-operative discomfort in the 2 to 4 days after root canal treatment?

- a) Call your dentist after the 5<sup>th</sup> day
- b) Call your dentist after the 4<sup>th</sup> day
- c) Call your dentist immediately**
- d) Call your dentist after the 7<sup>th</sup> day

Citation: Sorrell, J. T., McNeil, D. W., Gochenour, L. L., & Jackson, R. Evidence-based patient education: knowledge transfer to endodontic patients. *Journal of Dental Education*, 2009; 73, 1293-1305.

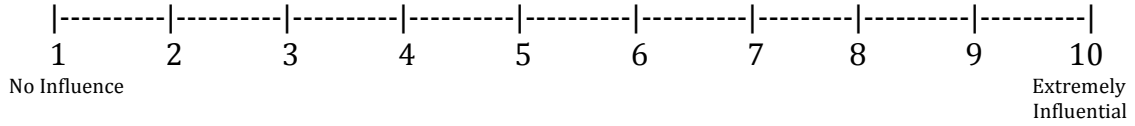
Subscales

Teeth & Gums Subscale: 1, 6, 8, 10, 14  
Root Canal Procedure Subscale: 2, 3, 7, 11, 15  
Fear of Dental Pain Subscale: 4, 5, 9, 12, 13

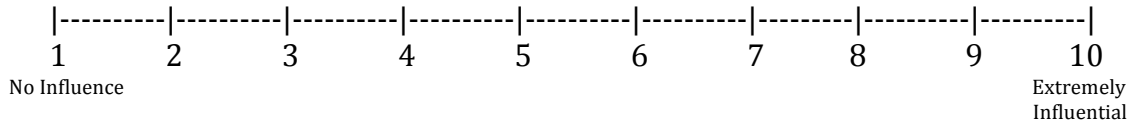
\* Permission granted by the authors to reproduce for clinical and research purposes.

## Appendix C

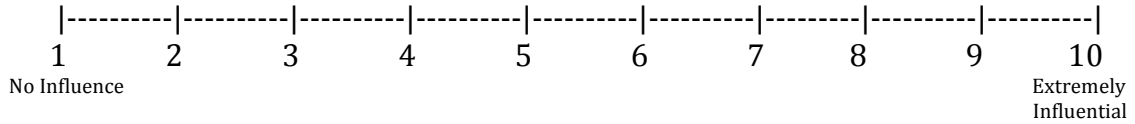
Q1: To what degree has your family influenced your anxiety?



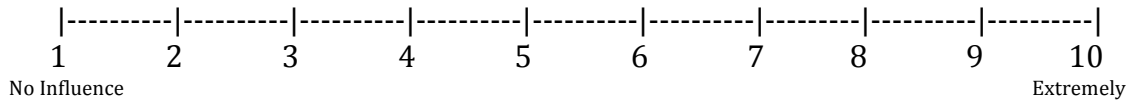
Q2: To what degree have your friends and/or acquaintances influenced your anxiety?



Q3: To what degree has the media influenced your anxiety?



Q4: To what degree have previous traumatic dental experiences influenced your anxiety?



## IX. Raw Data

### Corah Dental Anxiety Questionnaire

	If you had to go to the dentist tomorrow, how would you feel about it?	When you are waiting in the dentist's office for your / turn in the chair, how / do you feel?	When you are in the dentist's chair waiting while he gets his drill ready to begin working on your t...	You are in the dentist's / chair to have your teeth cleaned. / While you are waiting...
Patient 01 - Pre-op	4	2	3	3
Patient 01 - Post-op	1	1	1	1
Patient 02 - Pre-op	4	3	3	4
Patient 02 - Post-op	1	2	2	1
Patient 03- Pre-op	3	2	3	3
Patient 03 - Post-op	3	2	3	2
Patient 04- Pre-op	4	4	4	3
Patient 04 - Post-op	2	1	2	2
Patient 05 - Pre-op	4	4	4	4
Patient 05 - Post-op	2	2	2	1
Patient 06 - Pre-op	5	5	5	4
Patient 06 - Post-op	4	4	3	2
Patient 07 - Pre-op	4	3	4	2
Patient 07 - Post-op	3	2	2	2
Patient 08 - Pre-op	3	2	3	2
Patient 08 - Post-op	3	2	2	2
Patient 09 - Pre-op	3	2	3	1
Patient 09 - Post-op	1	1	1	1
Patient 10 - Pre-op	3	2	2	2
Patient 10 - Post-op	1	2	2	2
Patient 11 - Pre-op	4	4	4	4
Patient 11 - Post-op	2	2	3	2
Patient 12 - Pre-op	4	5	5	4
Patient 12 - Post-op	3	2	2	2
Patient 13 - Pre-op	3	2	2	3
Patient 13 - Post-op	2	1	2	2
Patient 14 - Pre-op	4	2	3	4
Patient 14 - Post-op	4	3	3	3
Patient 15 - Pre-op	3	2	2	3
Patient 15 - Post-op	3	2	2	2
Patient 16 - Pre-op	4	3	4	4
Patient 16 - Post-op	3	2	1	1
Patient 17 - Pre-op	5	4	4	4
Patient 17 - Post-op	5	4	4	4
Patient 18 - Pre-op	2	4	5	3
Patient 18 - Post-op	3	5	3	4
Patient 19 - Pre-op	3	2	2	2
Patient 19 - Post-op	3	1	2	2
Patient 20 - Pre-op	5	3	4	2
Patient 20 - Post-op	4	4	4	2
Patient 21 - Pre-op	2	1	2	1
Patient 21 - Post-op	1	1	1	1
Patient 22 - Pre-op	4	3	4	4
Patient 22 - Post-op	3	2	2	2
Patient 23 - Pre-op	3	2	2	2
Patient 23 - Post-op	3	1	1	1
Patient 24 - Pre-op	4	4	3	2
Patient 24 - Post-op	2	2	2	1
Patient 25 - Pre-op	3	2	3	3
Patient 25 - Post-op	1	1	1	1
Patient 26 - Pre-op	3	2	3	3
Patient 26 - Post-op	1	1	1	2
Patient 27 - Pre-op	4	4	4	2
Patient 27 - Post-op	3	4	4	2
Patient 28 - Pre-op	4	3	4	3

Patient 28 - Post-op	3	2	2	2
Patient 29 - Pre-op	5	5	5	2
Patient 29 - Post-op	3	4	2	2
Patient 30 - Pre-op	3	2	3	3
Patient 30 - Post-op	3	2	3	2
Patient 31 - Pre-op	4	4	5	5
Patient 31 - Post-op	3	3	4	3
Patient 32 - Pre-op	5	4	4	4
Patient 32 - Post-op	3	4	4	2
Patient 33 - Pre-op	4	4	4	4
Patient 33 - Post-op	3	4	4	4
Patient 34 - Pre-op	3	2	3	2
Patient 34 - Post-op	3	2	2	2
Patient 35 - Pre-op	4	5	5	3
Patient 35 - Post-op	5	3	3	3
Patient 36 - Pre-op	3	3	4	3
Patient 36 - Post-op	3	2	3	2
Patient 37 - Pre-op	3	3	3	3
Patient 37 - Post-op	3	2	3	3
Patient 38 - Pre-op	4	5	5	5
Patient 38 - Post-op	3	4	5	5
Patient 39 - Pre-op	4	4	4	2
Patient 39 - Post-op	4	4	4	1
Patient 40 - Pre-op	3	2	2	2
Patient 40 - Post-op	2	1	1	1
Patient 41 - Pre-op	3	2	2	2
Patient 41 - Post-op	3	2	1	2
Patient 42 - Pre-op	3	2	2	2
Patient 42 - Post-op	1	1	1	1
Patient 43 - Pre-op	3	4	3	2
Patient 43 - Post-op	2	2	3	2
Patient 44 - Pre-op	3	2	3	4
Patient 44 - Post-op	3	3	3	2
Patient 45 - Pre-op	4	5	5	5
Patient 45 - Post-op	4	5	5	5
Patient 46 - Pre-op	4	3	5	3
Patient 46 - Post-op	3	2	3	3
Patient 47 - Pre-op	4	3	4	4
Patient 47 - Post-op	4	3	3	3
Patient 48 - Pre-op	3	4	4	3
Patient 48 - Post-op	3	4	4	4
Patient 49 - Pre-op	4	5	3	2
Patient 49 - Post-op	2	2	2	2
Patient 50 - Pre-op	3	3	2	2
Patient 50 - Post-op	1	1	1	1
Patient 51 - Pre-op	3	3	3	4
Patient 51 - Post-op	3	3	4	3
Patient 52 - Pre-op	4	4	5	4
Patient 52 - Post-op	3	2	2	2
Patient 53 - Pre-op	4	5	5	4
Patient 53 - Post-op	3	2	3	2
Patient 54 - Pre-op	4	4	4	3
Patient 54 - Post-op	4	4	4	3
Patient 55 - Pre-op	4	4	4	3
Patient 55 - Post-op	3	2	3	2
Patient 56 - Pre-op	4	4	5	5
Patient 56 - Post-op	3	2	2	3
Patient 57 - Pre-op	4	2	3	2
Patient 57 - Post-op	4	3	2	2
Patient 58 - Pre-op	4	2	2	3
Patient 58 - Post-op	4	3	4	3
Patient 59 - Pre-op	4	4	5	4
Patient 59 - Post-op	3	3	3	2
Patient 60 - Pre-op	4	4	4	4
Patient 60 - Post-op	3	4	4	2

## Dental Knowledge Questionnaire, Questions 1-7

	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6	Question 7
Patient 01	1	4	3	2	4	1	2
Patient 02	2	3	3	1	2	1	2
Patient 03	1	1	3	4	3	1	2
Patient 04	1	3	2	4	2	1	2
Patient 05	1	4	3	1	2	1	2
Patient 06	2	3	3	2	3	1	2
Patient 07	1	3	2	2	3	3	2
Patient 08	2	3	3	2	3	3	2
Patient 09	1	4	3	4	2	1	2
Patient 10	2	3	3	2	3	1	2
Patient 11	2	3	2	2	2	1	2
Patient 12	1	3	3	2	3	1	2
Patient 13	2	4	3	4	2	1	2
Patient 14	2	2	3	1	3	1	2
Patient 15	2	3	2	2	3	1	1
Patient 16	4	4	2	2	1	1	4
Patient 17	2	3	3	2	3	1	1
Patient 18	3	1	3	2	4	3	1
Patient 19	2	2	3	1	3	1	1
Patient 20	2	1	3	2	2	1	2
Patient 21	2	4	3	1	3	1	1
Patient 22	1	3	2	1	2	1	2
Patient 23	2	3	3	4	4	1	4
Patient 24	2	4	2	1	3	3	4
Patient 25	2	4	3	2	3	4	3
Patient 26	1	4	2	2	2	3	2
Patient 27	1	1	3	4	4	1	2
Patient 28	2	1	2	2	2	1	1
Patient 29	3	2	2	2	2	1	1
Patient 30	2	2	2	2	3	1	2
Patient 31	2	3	3	2	4	1	2
Patient 32	1	4	1	2	1	3	4
Patient 33	2	1	3	2	2	1	2
Patient 34	3	4	2	2	2	1	2
Patient 35	2	2	3	2	4	1	4
Patient 36	1	1	2	2	2	1	4
Patient 37	2	2	3	2	2	2	2
Patient 38	2	1	3	2	2	1	1
Patient 39	1	3	3	2	2	3	2
Patient 40	2	3	2	2	2	3	2
Patient 41	3	1	2	1	2	1	2
Patient 42	2	2	3	1	1	3	2
Patient 43	3	2	2	2	3	1	4
Patient 44	2	4	3	2	2	1	4
Patient 45	1	3	3	1	3	1	1
Patient 46	2	2	3	2	2	1	2
Patient 47	1	3	3	1	2	1	2
Patient 48	2	1	3	4	2	1	4
Patient 49	2	3	2	2	4	1	2
Patient 50	1	1	1	4	2	1	2
Patient 51	2	3	3	2	1	1	1
Patient 52	2	1	3	1	4	1	2
Patient 53	2	1	3	4	3	1	2
Patient 54	2	2	3	3	1	1	1
Patient 55	2	3	3	1	2	1	1
Patient 56	2	3	3	4	4	1	1
Patient 57	1	2	4	2	2	1	2
Patient 58	2	4	3	1	4	1	2
Patient 59	2	2	3	4	2	1	2
Patient 60	2	2	3	2	2	1	2

## Dental Knowledge Questionnaire, Questions 8-15

	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Patient 01	3	3	3	4	4	1	1	2
Patient 02	3	4	2	4	3	3	1	2
Patient 03	1	1	2	3	4	4	3	3
Patient 04	3	3	3	1	4	3	3	3
Patient 05	3	2	4	4	4	3	3	3
Patient 06	4	2	2	4	4	4	3	4
Patient 07	3	1	4	4	4	1	2	2
Patient 08	3	1	3	2	4	3	3	3
Patient 09	1	3	3	4	4	4	3	3
Patient 10	3	1	3	2	4	4	3	3
Patient 11	4	1	1	4	2	4	3	3
Patient 12	3	3	3	4	4	3	3	1
Patient 13	2	3	2	4	4	3	2	2
Patient 14	3	1	3	4	4	4	4	3
Patient 15	1	4	3	4	4	4	3	3
Patient 16	3	1	2	1	1	4	1	3
Patient 17	1	2	3	4	4	3	2	3
Patient 18	3	3	2	4	3	4	4	3
Patient 19	1	1	4	4	4	4	3	2
Patient 20	1	1	4	2	1	4	2	1
Patient 21	3	3	2	4	4	3	3	3
Patient 22	3	3	3	4	4	1	3	3
Patient 23	3	2	2	4	4	3	3	3
Patient 24	1	1	4	4	4	3	2	3
Patient 25	3	1	3	4	1	4	3	2
Patient 26	3	3	4	2	4	1	2	3
Patient 27	3	3	3	4	3	1	2	3
Patient 28	1	1	3	4	4	4	1	3
Patient 29	3	1	1	4	3	4	2	2
Patient 30	3	2	2	2	4	4	1	3
Patient 31	1	1	1	4	4	3	3	3
Patient 32	1	4	2	4	4	4	3	3
Patient 33	3	1	4	4	4	3	3	3
Patient 34	4	4	3	4	4	4	2	3
Patient 35	2	1	4	4	4	4	3	3
Patient 36	3	3	2	4	4	1	4	3
Patient 37	1	1	2	4	3	4	1	3
Patient 38	3	2	2	4	1	3	2	2
Patient 39	1	3	3	4	4	1	3	1
Patient 40	4	4	3	4	3	2	2	2
Patient 41	1	3	3	3	4	3	4	3
Patient 42	1	3	3	4	1	4	3	3
Patient 43	4	3	2	4	1	4	2	2
Patient 44	4	4	1	4	3	3	1	3
Patient 45	1	3	3	4	3	4	1	3
Patient 46	1	4	4	4	4	3	2	2
Patient 47	3	3	2	4	4	1	2	4
Patient 48	3	3	4	4	4	4	2	1
Patient 49	3	4	2	4	4	3	3	3
Patient 50	3	4	3	4	3	4	1	2
Patient 51	4	2	4	3	3	4	1	2
Patient 52	4	4	4	4	1	1	3	3
Patient 53	3	4	1	4	3	3	3	3
Patient 54	1	1	4	4	4	4	1	3
Patient 55	3	3	3	4	4	4	3	3
Patient 56	4	1	4	4	4	1	4	3
Patient 57	3	4	2	2	2	3	2	1
Patient 58	3	1	1	4	4	1	4	1
Patient 59	3	3	3	4	3	3	1	4
Patient 60	3	2	2	4	4	3	1	2

## Appendix C Data

	To what degree has your / family...	To what degree have your friends and/or acquaintances...	To what degree has the media influenced your anxiety?	To what degree have previous traumatic dental experiences...
Patient 01	8	1	2	9
Patient 02	7	7	8	7
Patient 03	3	5	3	7
Patient 04	1	4	1	7
Patient 05	5	7	1	9
Patient 06	8	2	1	2
Patient 07	1	1	5	6
Patient 08	1	1	1	7
Patient 09	2	8	1	5
Patient 10	6	6	3	6
Patient 11	8	3	1	8
Patient 12	1	1	1	8
Patient 13	4	5	1	7
Patient 14	3	1	1	9
Patient 15	2	2	2	2
Patient 16	1	9	4	1
Patient 17	1	1	1	9
Patient 18	1	2	1	6
Patient 19	7	5	5	9
Patient 20	1	1	1	5
Patient 21	1	1	1	1
Patient 22	4	5	3	8
Patient 23	1	3	1	5
Patient 24	5	7	3	1
Patient 25	5	7	8	7
Patient 26	2	8	2	4
Patient 27	1	1	4	9
Patient 28	3	3	5	6
Patient 29	1	1	1	1
Patient 30	6	3	3	4
Patient 31	2	5	6	7
Patient 32	1	1	1	6
Patient 33	9	7	5	7
Patient 34	3	3	3	6
Patient 35	7	3	9	9
Patient 36	7	2	1	7
Patient 37	1	5	5	5
Patient 38	3	2	3	8
Patient 39	9	3	6	7
Patient 40	3	3	5	6
Patient 41	2	2	1	3
Patient 42	6	7	5	8
Patient 43	3	3	3	7
Patient 44	1	1	1	7
Patient 45	1	1	9	1
Patient 46	1	2	2	9
Patient 47	3	3	2	9
Patient 48	6	3	3	9
Patient 49	9	7	3	9
Patient 50	1	1	2	3
Patient 51	9	9	3	9
Patient 52	4	1	1	8
Patient 53	1	1	1	9
Patient 54	5	5	7	8
Patient 55	6	7	4	7
Patient 56	3	5	1	9
Patient 57	1	1	1	5
Patient 58	4	7	3	7

Patient 59	3	3	2	9
Patient 60	9	7	3	9



## Reported Anxiety Throughout Root Canal Therapy

	Treatment Group	Pre-op Anxiety	15min	30 min	45 min	60 min	75 min	90 min
Patient 01	1	8	4	2	2	2	1	1
Patient 02	1	3	1	0	0	0	0	0
Patient 03	1	5	3	3	3	2	2	2
Patient 04	1	7	6	3	2	2	1	1
Patient 05	1	5	3	1	0	0	0	0
Patient 06	1	7	4	2	1	1	0	0
Patient 07	1	9	7	7	6	5	5	4
Patient 08	1	3	1	0	0	0	0	0
Patient 09	1	7	6	6	5	5	5	4
Patient 10	1	5	7	5	5	5	5	5
Patient 11	1	5	2	2	5	2	1	1
Patient 12	1	5	2	0	0	0	0	0
Patient 13	1	3	3	2	2	2	1	1
Patient 14	1	4	1	1	1	1	0	0
Patient 15	1	9	8	5	3	3	2	2
Patient 16	1	8	7	7	6	5	5	4
Patient 17	1	3	3	2	2	2	1	1
Patient 18	1	6	5	4	4	4	4	4
Patient 19	1	4	3	1	1	1	0	0
Patient 20	1	3	2	3	3	2	2	2
Patient 21	1	5	5	3	2	2	1	1
Patient 22	1	4	3	2	1	1	1	1
Patient 23	1	8	6	6	5	5	4	4
Patient 24	1	6	5	5	4	3	3	2
Patient 25	1	4	4	2	2	1	1	1
Patient 26	1	8	3	5	3	2	2	2
Patient 27	1	5	2	4	2	2	1	1
Patient 28	1	8	6	6	5	4	4	2
Patient 29	1	7	5	5	4	4	3	3
Patient 30	1	8	4	2	2	1	1	1
Patient 31	3	4	5	5	4	4	4	4
Patient 32	3	2	3	3	3	3	2	2
Patient 33	3	5	4	4	4	3	4	3
Patient 34	3	8	6	5	5	5	5	5
Patient 35	3	4	2	2	1	1	1	1
Patient 36	3	6	5	4	4	4	4	4
Patient 37	3	6	6	5	5	5	5	5
Patient 38	3	10	10	10	9	9	9	9
Patient 39	3	10	10	8	10	9	7	4
Patient 40	3	5	4	4	5	4	3	4
Patient 41	3	8	8	7	5	4	4	4
Patient 42	3	6	5	5	5	5	5	5
Patient 43	3	6	5	3	2	2	1	1
Patient 44	3	5	5	5	3	3	3	3
Patient 45	3	4	4	3	2	2	1	1
Patient 46	3	5	4	5	6	4	5	5
Patient 47	3	7	9	7	8	7	6	6
Patient 48	3	5	7	8	8	6	7	6
Patient 49	3	5	5	5	5	5	5	5
Patient 50	3	4	4	4	5	5	5	5
Patient 51	3	5	4	4	3	3	3	3
Patient 52	3	3	2	2	2	2	2	2
Patient 53	3	8	8	7	5	5	5	5
Patient 54	3	5	5	5	5	5	5	5
Patient 55	3	8	8	5	5	5	3	3
Patient 56	3	7	5	5	5	5	5	5
Patient 57	3	5	4	4	4	4	4	4
Patient 58	3	7	7	7	7	7	7	7
Patient 59	3	8	8	8	8	6	6	6
Patient 60	3	10	9	9	8	8	7	7

## Pulse Oximetry

	Pre-operative	15 min	30 min	45 min	60 min	75 min	90 min
Patient 01	98	97	96	97	98	97	98
Patient 02	97	92	91	94	92	91	91
Patient 03	97	97	96	97	97	97	98
Patient 04	96	97	95	96	97	97	97
Patient 05	96	97	96	96	96	95	95
Patient 06	91	89	88	88	86	86	87
Patient 07	96	98	96	96	96	96	95
Patient 08	97	94	92	91	91	93	92
Patient 09	97	97	95	94	96	96	95
Patient 10	93	90	92	92	92	93	94
Patient 11	95	97	99	97	97	98	97
Patient 12	95	92	92	94	97	96	95
Patient 13	95	95	94	94	95	95	94
Patient 14	88	87	88	86	84	92	89
Patient 15	96	95	96	96	96	95	97
Patient 16	98	99	98	98	98	97	98
Patient 17	96	93	91	94	95	93	93
Patient 18	93	96	96	97	96	97	98
Patient 19	97	97	93	96	97	95	97
Patient 20	98	97	96	96	95	95	96
Patient 21	91	90	90	90	90	91	90
Patient 22	93	95	95	97	96	97	96
Patient 23	94	96	96	95	95	96	95
Patient 24	95	93	94	93	93	94	94
Patient 25	96	96	97	96	96	96	97
Patient 26							
Patient 27	98	98	96	96	97	97	96
Patient 28	95	97	97	97	97	96	97
Patient 29	95	94	97	97	96	97	97
Patient 30	95	95	95	97	96	95	96
Patient 31	95	96	94	92	94	93	95
Patient 32	96	96	95	95	93	97	96
Patient 33	94	98	97	97	96	96	97
Patient 34	97	96	97	93	97	96	98
Patient 35	98	97	96	96	97	97	96
Patient 36	98	98	96	98	98	98	98
Patient 37	98	98	98	99	98	98	98
Patient 38	96	98	96	96	95	98	99
Patient 39	96	94	94	94	95	95	95
Patient 40	98	95	96	97	98	98	98
Patient 41	94	95	94	94	94	96	96
Patient 42	93	92	91	93	92	94	93
Patient 43	95	97	97	95	97	97	97
Patient 44	93	94	92	94	94	95	92
Patient 45	94	96	95	93	94	96	95
Patient 46	96	94	95	94	94	97	95
Patient 47	94	93	95	95	95	98	97
Patient 48	92	94	97	94	95	95	97
Patient 49	94	95	96	96	95	96	95
Patient 50	94	95	94	92	94	96	96
Patient 51	92	93	93	94	95	95	94
Patient 52	95	96	96	96	97	96	96
Patient 53	96	94	96	95	93	93	94
Patient 54	99	93	96	95	94	93	95
Patient 55	93	92	90	90	93	90	92
Patient 56	98	98	96	95	97	97	96
Patient 57	98	97	98	97	96	97	96
Patient 58	95	94	93	95	93	93	93
Patient 59	96	97	98	97	97	97	98
Patient 60	93	92	93	92	93	93	92

## Pulse

	Pre-op	15 min	30 min	45 min	60 min	75 min	90 min
Patient 01	68	71	68	68	65	66	70
Patient 02	82	96	85	94	81	87	79
Patient 03	78	82	82	79	78	77	74
Patient 04	71	67	65	73	66	68	66
Patient 05	82	79	73	74	72	75	73
Patient 06	69	67	65	61	56	54	52
Patient 07	75	76	77	74	75	76	80
Patient 08	70	71	71	68	66	68	67
Patient 09	58	60	58	66	64	63	67
Patient 10	81	83	81	82	80	81	83
Patient 11	86	86	80	88	84	83	81
Patient 12	63	66	71	63	61	62	60
Patient 13	69	80	79	81	80	78	80
Patient 14	63	57	58	58	60	63	62
Patient 15	84	76	79	81	82	76	80
Patient 16	90	86	85	91	92	90	91
Patient 17	81	77	80	69	70	72	73
Patient 18	67	59	54	55	56	55	56
Patient 19	85	89	77	85	80	81	83
Patient 20	91	90	85	86	85	86	91
Patient 21	84	82	82	80	81	80	82
Patient 22	55	54	51	46	51	60	61
Patient 23	75	77	77	78	80	77	74
Patient 24	67	64	68	64	60	61	64
Patient 25	71	72	70	68	75	72	70
Patient 26							
Patient 27	68	55	64	59	60	68	62
Patient 28	94	94	90	96	95	96	90
Patient 29	82	76	74	73	75	72	73
Patient 30	92	86	79	83	84	78	80
Patient 31	70	72	76	72	73	74	72
Patient 32	99	89	92	89	88	89	87
Patient 33	92	107	90	82	80	82	90
Patient 34	82	72	66	69	64	62	65
Patient 35	83	76	81	67	68	69	70
Patient 36	94	80	82	81	78	80	82
Patient 37	84	73	76	68	62	64	72
Patient 38	95	93	86	83	86	88	84
Patient 39	91	87	86	89	85	88	86
Patient 40	72	56	60	66	73	65	64
Patient 41	61	62	62	61	60	59	57
Patient 42	83	82	82	79	73	72	70
Patient 43	85	83	78	75	75	74	73
Patient 44	71	70	72	68	64	64	75
Patient 45	68	67	70	71	68	70	67
Patient 46	80	79	78	61	64	75	82
Patient 47	52	51	47	53	50	53	52
Patient 48	78	75	73	70	72	77	76
Patient 49	76	80	78	78	79	81	83
Patient 50	60	58	57	55	56	56	59
Patient 51	94	88	87	86	86	89	90
Patient 52	62	54	56	57	56	58	60
Patient 53	72	73	76	75	74	73	70
Patient 54	74	67	70	72	73	70	71
Patient 55	94	86	82	83	82	78	81
Patient 56	65	63	59	56	60	62	59
Patient 57	83	88	82	84	85	81	78
Patient 58	99	88	86	91	100	92	98
Patient 59	64	74	69	74	67	70	72
Patient 60	80	75	78	76	75	78	75

## X. References:

1. Abrahamsson KH, Berggren U, Hakeberg M, Carlsson SG. The importance of dental beliefs for the outcome of dental-fear treatment. *Eur J Oral Sci* 2003; 111:99-105.
2. Scott DS, Hirschman R. Psychological aspects of dental anxiety in adults. *J Am Dent Assoc* 1982; 104:27-31.
3. Arntz A, van Eck M, Heijmans M. Prediction of dental pain: the fear of any expected evil, is worse than the evil itself. *Behav Res Ther* 1990; 28(1): 29-41.
4. van Wijk AJ, Hoogstraten J. Anxiety and pain during dental injections. *J Dent* 2009; 37: 700-4.
5. Wong M, Lytle WR. A comparison of anxiety levels associated with root canal therapy and oral surgery treatment. *J Endod* 1991; 17: 461-5.
6. Prabhakar A, Marwah N, Raju, O. A comparison between audio and audiovisual distraction techniques in managing anxious pediatric dental patients. *Journal of Indian Society of Pedodontics and Preventive Dentistry* 2007; 25(4): 177-182.
7. Lahmann C, Schoen R, Henningsen P, Ronel J, Muehlbacher M, Loew T, Tritt K, Nickel M and Doering S. Brief Relaxation Versus Music Distraction in the Treatment of Dental Anxiety: A Randomized Controlled Clinical Trial. *JADA* 2008; 139: 317-24.

8. Lai HL, Hwang MJ, Chen CJ, Chang KF, Peng TC, Chang FM. Randomized controlled trial of music on state anxiety and physiological indices in patients undergoing root canal treatment. *J Clin Nurs* 2008; 17: 2654-60.
9. Saxen MA, Newton CW. Managing the endodontic patient with disabling anxiety or phobia. *Journal of the Indian Dental Assoc.* 1999; 78: 21-3.
10. van Wijk AJ, Hoogstraten J. Reducing fear of pain associated with endodontic therapy. *IEJ* 2006; 39: 384-388.
11. Shoben EJ and Borland, L. An empirical study of the etiology of dental fears. *J Clin Psychol* 1954; 10: 171-174.
12. Eli I, Uziel N, Blumensohn R, Baht R. Modulation of dental anxiety: the role of past experiences, psychopathologic traits and individual attachment patterns. *Br Dent J* 2004; 196(11): 689-694.
13. Corah NL. Development of a dental anxiety scale. *J Dent Res* 1969; 48: 596.
14. Corah NL, Gale EN, Illig SJ. Assessment of a dental anxiety scale. *J Am Dent Assoc* 1978; 97: 816-819.
15. Kvale G, Berg E, Raadal M. The ability of Corah's Dental Anxiety Scale and Spielberger's State Anxiety Inventory to distinguish between fearful and regular Norwegian dental patients. *Acta Odontol Scand* 1998; 56:105-109.
16. Gorenstein C, Andrade L. Validation of a Portuguese version of the Beck Depression Inventory and the State-Trait Anxiety Inventory in Brazilian subjects. *Braz J Med Bio Res* 1996; 29: 453-457.
17. Fuentes D, Gorenstein C, Hu LW. Dental anxiety and trait anxiety: an investigation of their relationship. *Br Dent J* 2009; 206: E17.

18. Hornblow AR, Kidson MA. The visual analogue scale for anxiety: a validation study. *Aust N Z J Psychiatry* 1976; 10(4): 339-41.
19. van Duinen M, Rickelt J, Griez E. Validation of the electronic Visual Analogue Scale of Anxiety. *Progress in Neuro-Psychopharmacology & Biological Psychiatry* 32 (2008) 1045-1047.
20. Caprara HJ, Eleazer PD, Barfield RD, Chavers S. Objective Measurement of Patient's Dental Anxiety by Galvanic Skin Reaction. *JOE* 2003; 29 (8): 493-496.
21. Sorrell, JT, McNeil, DW, Gochenour, LL, Jackson, R. Evidence-based patient education: knowledge transfer to endodontic patients. *Journal of Dental Education*, 2009; 73, 1293-1305.
22. Frere CL, Crout R, Yorty J, McNeil DW. Effects of audiovisual distraction during dental prophylaxis. *J Am Dent Assoc* 2001; 132:1031-8.
23. Ram D, Shapira J, Holan G, Magora F, Cohen S, Davidovich E. Audiovisual video eyeglass distraction during dental treatment in children. *Quintessence Int* 2010; 41:673-9.
24. Bartfield JM, Janikas JS, Lee RS. Heart rate response to intravenous catheter placement. *Acad Emerg Med*. 2003; 10:1005-8.
25. Goerig M, Schulte am Esch J. History of Nitrous Oxide – with special reference to its early use in Germany. *Best Practice & Research Clinical Anesthesiology*. 2001; 15: 313-338.
26. Kleinknecht RA. The Assessment of Dental Fear. *Behavior Therapy*. 1978; 9: 626-634.

27. <http://highbloodpressure.about.com/od/prevention/f/anxiety-bp.htm>

28. Peretz B and Moshonov J. Dental anxiety among patients undergoing endodontic treatment. JOE. 1998; 24: 435-437.

29. Hmud R and Walsh LJ. Dental anxiety: causes, complications and management approaches. J Min Interv in Dent. 2009; 2: 67 – 78.